JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

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Guest Editors: R. Cameron Wolf, Trista Bingham, Greg Millett, Rose Wilcher
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Volume 21, Supplement 5, July 2018

WILEY

Acknowledgements

The Guest Editors – R. Cameron Wolf, Trista Bingham, Greg Millett, and Rose Wilcher – would like to thank all of the authors who submitted expressions of interest and full manuscripts and worked so hard throughout the selection process, which was very rigorous. We wish that many more studies could have been included, but hope that this effort to compile the latest evidence for key populations responses will continue in the future. We also wish to thank the Journal of the International AIDS Society for the support and guidance throughout the process.

Support

This supplement grew out of a collaborative effort between technical advisors at the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) and the Foundation for AIDS Research (amfAR). It was supported by multiple agencies including the United States Agency for International Development (USAID) and PEPFAR through the Linkages across the Continuum of HIV Services for Key Populations Affected by HIV project (LINKAGES, Cooperative Agreement AID-OAA-A-14-00045); PEPFAR through the Centers for Disease Control and Prevention (CDC); and amfAR. Its contents are solely the responsibility of the authors and do not necessarily represent the official position of the funding agencies.

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Volume 21, Supplement 5
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Wolf RC et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25146
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25146/full | https://doi.org/10.1002/jia2.25146

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EDITORIAL

Building the evidence base to optimize the impact of key population programming across the HIV cascade

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Keywords: key populations; men who have sex with men; sex workers; people who inject drugs; transgender persons; HIV; service delivery; implementation science

Received 18 May 2018; **Accepted** 24 May 2018

1 | GLOBAL CONTEXT

The most recent global HIV data have brought great optimism that controlling the HIV epidemic could become a reality. These encouraging data show overall declines in both AIDS-related deaths and new HIV infections worldwide [1]. Recent data also demonstrate impressive gains toward the global 90-90-90 targets. As of 2016, an estimated 70% of all people living with HIV (PLHIV) globally knew their HIV status. Among those who had been diagnosed, 77% were accessing antiretroviral therapy, and 82% of people on treatment had achieved viral suppression [1].

Despite this progress, the optimism is tempered by concern that reducing HIV incidence rates must be further accelerated to guarantee epidemic control [2]. Moreover, the recent gains have not been uniform. While global data indicate important achievements in addressing the epidemic among key populations – defined by the World Health Organization (WHO) as men who have sex with men (MSM), sex workers, transgender people, people who inject drugs (PWID), and prisoners [3] – these gains still lag far behind those made in the general population.

UNAIDS estimates that 44% of all new HIV infections among adults worldwide occur among key populations and their partners [1]. In generalized epidemic contexts of sub-Saharan Africa, key populations and their sexual partners account for 25% of new HIV infections, while in concentrated epidemic settings, they account for as much as 80% of infections [1]. Globally, sex workers, MSM and PWID are 10, 24 and 24 times more likely, respectively, to acquire HIV compared with the general population ages 15 years and older [4]. Transgender women are 49 times more likely to be living with HIV and prisoners are five times more likely to be living with HIV compared to other adults [4,5].

2 | GROWTH IN SUPPORTING HIV PROGRAMMES FOR KEY POPULATIONS

Evidence of the disproportionate epidemiological burden that members of key populations shoulder has been met with important policy developments and funding commitments. In 2014, the Global Fund to Fight AIDS, Tuberculosis and Malaria launched the Key Populations Action Plan, reflecting its commitment to help meet their HIV prevention, care and treatment needs and rights [6]. That same year, WHO released consolidated guidelines on HIV prevention, diagnosis, treatment and care for key populations [3]. These guidelines were updated in 2016 to reflect the urgent call to treat all individuals regardless of CD4 count and to provide pre-exposure prophylaxis (PrEP) to those "at substantial risk" [7]. Additional global implementation guidance and programmatic tools soon followed to support key population programme design and scale up [8-12].

The President's Emergency Plan for AIDS Relief (PEPFAR) has also launched specific initiatives to expand key populations' access to and retention in HIV services. Through programmes such as the Key Populations Challenge Fund, the Key Populations Implementation Science Initiative and the Local Capacity Initiative, PEPFAR supported work to understand and better serve key populations, as well as to strengthen capacity of key population-led organizations to address the epidemic in their communities [13]. Moreover, PEPFAR recognizes that "ensuring key populations have access to and increase their use of comprehensive packages of health and social services" is essential for achieving epidemic control [14].

Finally, the UNAIDS HIV Prevention 2020 Roadmap deems combination prevention programmes for key populations necessary to accelerate declines in new HIV infections at country

level. The Roadmap calls for combination prevention programmes that are evidence-informed, community-owned, and human rights-based; implemented at scale; and tailored to the specific needs of key populations [15].

3 | KEY POPULATIONS, DATA CHALLENGES AND THE HIV CASCADE

These commitments are critical to advancing a more effective response. However, progress translating commitments into improved outcomes for key populations has been hindered by persistent barriers, such as stigma (including self-stigma), discrimination, and punitive legal and policy environments. In addition, the field faces ever-present data challenges with key populations, who often do not self-disclose their current or former status as key population members. Consequently, they may be included as members of the "general population" and their contribution to HIV transmission underreported and unrecognized. Alternatively, they may be connected to key population community services in one place but receive testing or treatment services anonymously in another, making it difficult for programmes to track and support clients across multiple service points.

The limited population-based data that are available show that testing and treatment coverage among key populations remains disproportionately low with no key population group close to achieving 90-90-90 targets [1,16]. This has led to calls for improving outcomes for key populations through data-driven interventions. Indeed, this supplement grew out of the urgent need to share the emerging evidence from both new and evolving service delivery interventions for key populations.

The HIV prevention, care and treatment cascade has been globally adopted as a useful framework for guiding key population programming (Figure 1) [8]. It can indicate where programmatic efforts are falling short in reaching and retaining key populations across the continuum of care, and thereby pinpoint areas for intensified work. Moreover, this cascade model highlights the importance of engaging and building capacity of communities to lead efforts to reach, test, treat, and retain key populations in services, as well as the need to tackle structural barriers – including stigma, discrimination, violence, gender-based bias and, in many cases, criminalization. Cutting across the cascade is the need to ensure programmatic efforts are rights based and that confidentiality, safety and security are respected.

Achieving epidemic control will not be possible without more robust and rapid progress in delivering evidence-based interventions that improve key populations' access to and uptake of HIV services across the cascade. Fundamental to that progress is the generation and use of key population-specific cascade data. The recently relaunched Key Populations Atlas from UNAIDS represents an important step in that direction [17]. This tool brings together country-specific data on a variety of indicators disaggregated by key population group. We need to complement this with better data from a variety of methodological approaches that identify strategies effective at reaching and engaging key populations at different points along the HIV cascade, and allow targeted investments in programming at those points where they are most needed.

4 | TOWARDS A MORE EFFECTIVE RESPONSE FOR KEY POPULATIONS

Recognition of these needs has led to advances in monitoring key populations' uptake of services across the cascade to identify "leaks" in the system, as well as more sophisticated analysis and use of data to identify solutions and strengthen programming [18,19]. In addition, a number of key population-focused implementation science studies are underway across a range of geographies to evaluate the effectiveness of new approaches, outreach strategies and delivery modalities in overcoming structural obstacles and improving service

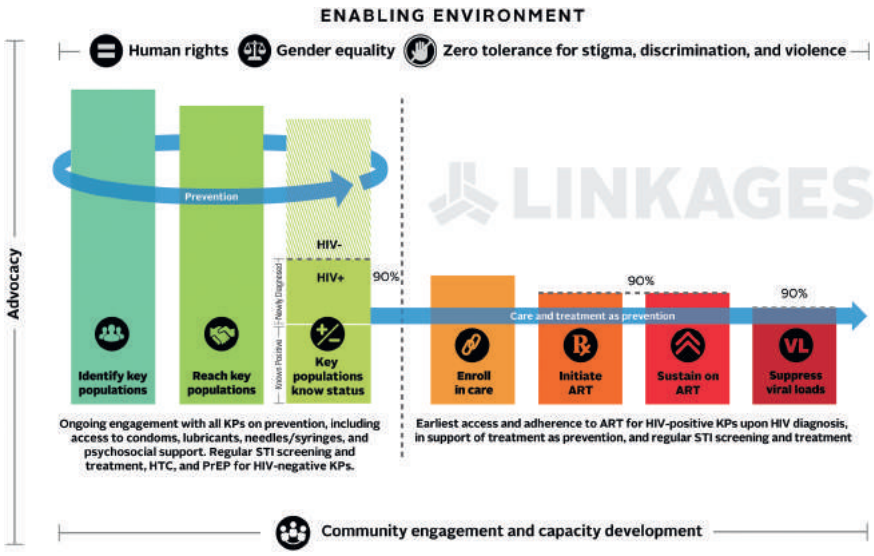

Figure 1. Cascade of HIV prevention, care, and treatment services for key populations

uptake and retention with different key population groups [20].

As programming is scaled up globally, it is critical that we maximize public health impact by sharing the latest evidence of what works to engage key populations in targeted prevention, treatment, and retention programmes. The contents of this supplement represent high-quality articles from a range of multidisciplinary efforts to advance key population science and practice across the cascade. They offer new evidence and data-driven strategies for improving programming with MSM, sex workers, transgender people and PWID across diverse geographies. The supplement does not contain articles addressing prisoners as they require significantly different approaches from key populations in communities outside incarcerated settings.

5 | DATA APPROACHES TO IMPROVE CASCADE MONITORING

Five of the papers in this supplement describe methods and analyses specific to key populations that can be used to refine and focus interventions. The data generated from these approaches are important to guide strategic planning, resource allocation and programme quality improvement initiatives.

The supplement opens with a commentary by Hakim *et al*. in which the authors make the case for why we need better key population cascade data and how we can get it [21]. They argue that targeted bio-behavioural surveys represent an important source of data to guide the epidemic response but have been underutilised to monitor and inform key population service delivery efforts. While there may be sampling concerns and other limitations to these types of surveys, the authors underscore that bio-behavioural survey data are critical to triangulate with available programme data for a comprehensive assessment of the reach and impact of services for key populations.

An article by Mukandavire *et al*. presents a new methodology to estimate the contribution of onward HIV transmission among key populations to the overall HIV dynamic in Dakar, Senegal [22]. They report that the contribution of commercial sex to HIV transmission is diminishing; however, unprotected sex between men contributed to 42% of transmissions between 1995 and 2005, and increases to an estimated 64% in the 2015 to 2025 period. The authors posit that this dynamic may also be observed in other low- and middle-income countries where the contribution of MSM to overall HIV transmission may be under-appreciated.

To better refine key population programming at country level, Lillie *et al*. describe a partnership between PEPFAR and The Global Fund to conduct key populations cascade assessments [23]. By jointly participating in these assessments, major funders and national stakeholders are able to better align packages of services, training, geographic coverage, innovations, data collection and quality improvement efforts. These cascade assessments were completed in eight countries: Malawi, Cameroon, Swaziland, Haiti, Angola, Nepal, Cote d'Ivoire and Botswana. For this commentary, the authors review common challenges and recommendations made at the programme, national and donor level at each step in the cascade.

Using data collected from an online survey implemented through the gay social networking application, Hornet, Ayala *et al*. describe determinants of HIV service uptake among a global sample of MSM [24]. Of the 10,774 HIV-negative respondents, 13% reported PrEP use. Among HIV-positive respondents (n = 1243), both ART use and undetectable viral load (UVL) were associated with older age, a recent sexually transmitted infection (STI) test or STI treatment; and awareness of unlikely HIV transmission with UVL. The findings underscore the importance of STI testing and treatment as well as information about HIV transmissibility (U = U) for encouraging PrEP and ART use. This study is noteworthy for its innovative use of a gay dating app to rapidly generate data from a large online community of MSM that can be used for advocacy and tailored programme decision-making.

Finally, Suraratcheda *et al*. contribute the first estimates on the costs and cost-effectiveness of providing oral PrEP for MSM in Thailand [25]. Costing studies related to key population programming are extremely limited yet costing data are critical for effective programme planning. This paper makes an important first contribution for the Asia-Pacific region by estimating the annual costs (US$223 to US$331 per MSM per year, including demand creation activities) and cost-effectiveness of PrEP under several delivery scenarios. While providing PrEP to all MSM over the next five years would have greater epidemiological and economic benefit to Thailand, the authors conclude that providing PrEP to high-risk MSM would be the most cost-effective approach.

6 | IMPROVING RECRUITMENT, TESTING UPTAKE AND CASE FINDING

The supplement features two articles that broaden our understanding of strategies for improving the reach of prevention services and uptake of HIV testing among previously unreached key population members. Herce *et al*. report data from two bio-behavioural surveys in Malawi and Angola that illustrate the value of providing venue-based outreach and testing services in "hotspots," where people including MSM, FSWs and transgender people meet and seek sex partners [26]. Over 70% of the individuals diagnosed with HIV through the venue-based approach were not previously aware of their status, indicating that this was effective at increasing testing uptake and case finding among these populations.

A study by Kan *et al*. from Tajikistan compares the effectiveness of three network-based approaches to recruitment and case finding among PWID [27]. The approaches include two respondent-driven sampling (RDS) strategies – one restricted and the other unrestricted – and an active case-finding (ACF) strategy that involves direct outreach by peers who are living with HIV or current/former PWID. Collectively, these approaches identified 190 new cases of HIV in an eight-month period, linked 80% of them to confirmatory testing, and initiated 87.5% of the confirmed positives on treatment. While RDS strategies were more effective than ACF in detecting new HIV cases, the ACF approach attracted a higher proportion of first-time testers. This finding led the authors to note that both strategies are likely needed to achieve their case-finding goals among PWID in this setting.

7 | INNOVATIONS IN HIV TESTING MODALITIES AND LINKAGE TO TREATMENT

Recognizing that innovations in HIV testing options are needed to improve coverage, three articles in the supplement examine feasibility, acceptability, and effectiveness of new HIV testing modalities. Tun *et al*. present the results of a pilot intervention to distribute oral HIV self-testing kits to MSM through key opinion leaders in Lagos, Nigeria [28]. This study found that not only is oral self-testing feasible and highly acceptable among MSM in this urban population, but also that effective linkage to treatment can be achieved for those who test positive through self-testing with active follow-up and access to a trusted MSM-friendly community clinic that offers HIV treatment.

In a study from Vietnam, Green *et al*. explore HIV testing interventions through MSM lay providers and HIV self-testing, promoted through online channels and face-to-face interactions [29]. The study found that more than half of the MSM who sought lay- or self-testing were first-time testers. These new testing strategies resulted in higher detection of new HIV cases (6.8%) compared to conventional facility-based testing (estimated at 1.6%), while those linked to testing from social media interventions presented with even higher HIV-positive people (11.6%). Moreover, 90% of those identified as positive were successfully registered for ART.

A study from Thailand also demonstrates the promise of leveraging technology and self-testing to improve reach and testing uptake among MSM and transgender women [30]. In this study, Phanuphak *et al*. explore preferences among three different modalities of HIV testing including: (1) offline HIV counselling and testing; (2) online pre-test counselling and offline HIV testing; and (3) online counselling and online, supervised, HIV self-testing. The study demonstrated that online counselling coupled with online, supervised, HIV self-testing is feasible and acceptable. In addition, the online strategy produced the highest proportion of first time testers (47.3%) and had the highest HIV prevalence (15.9%). Being a transgender woman and spending more than four hours per day on social media increased a participant's likelihood to self-select for online counselling and HIV testing.

8 | TAKING COMMUNITY-LED PROGRAMMING ACROSS THE CONTINUUM TO SCALE

Two papers in the supplement report outcomes from large-scale, key population-led efforts to improve outcomes across the cascade. Ndori-Mharadze *et al*. report results from an evaluation of 'Sisters with a Voice', Zimbabwe's nationally scaled comprehensive programme for FSWs, following intensified community mobilization activities [31]. The findings demonstrate that early peer mobilization efforts to familiarize community members with tailored HIV services were associated with improved outcomes, notably increases in HIV testing frequency, knowledge of HIV status and increased linkage to ART.

Results of an innovative HIV self-testing component within a broader, community-wide implementation science project in Curitiba, Brazil demonstrated feasibility and improved HIV diagnosis among young MSM who had not previously tested for HIV [32]. Based on their findings, De Boni *et al*. report on the expansion and tailoring of the Internet-based self-testing platform to increase HIV testing coverage among MSM in São Paulo, Brazil's largest metropolitan area with the highest number of new HIV infections.

9 | ADDRESSING STRUCTURAL BARRIERS

Due to the criminalized and stigmatized nature of key populations globally, sex workers, MSM, PWID and transgender people are often afraid to visit healthcare services and, when they do go, are reluctant to disclose their sexual histories for fear of rejection, derision or other negative reactions from providers [33,34]. In addition, the perpetration of violence against key populations is frequent and often severe. Experiences of violence not only increase the risk of key populations acquiring HIV but also deeply affect their desire and ability to get tested for HIV and adhere to HIV treatment [35,36].

Two papers in this supplement address structural barriers to better HIV-related outcomes. Bhattacharjee *et al*. describe successful efforts to integrate violence prevention and response services into the national key population programme in Kenya [37]. Drawing on programme data over a four-year period, this paper contributes important evidence that it is possible to address violence against key populations under the leadership of the national government, even in an environment where sex work, same-sex sexual practices and drug use are criminalized [38].

A commentary by Friedland *et al*. reflects on the evolution of the PLHIV Stigma Index, which at the end of 2017 had interviewed more than 100,000 PLHIV in 90 countries [39]. The paper describes efforts at updating the new PLHIV Stigma Index 2.0 to better capture HIV-related *and key population-related* stigma, within the context of modern global testing and treatment guidelines. The updated tool was pilot-tested through a community-led process in Cameroon, Senegal and Uganda, and provides essential evidence and opportunities for communities in other countries to more effectively document stigma and advocate for and implement stigma mitigation interventions as part of human rights-affirming HIV responses.

10 | MOVING AHEAD

These papers provide much-needed contributions to the evidence base for key population programming across the HIV prevention, care and treatment cascade. Our hope is that this supplement will compel funders, policymakers, implementers and other stakeholders to do more now to champion data-driven programming. One common theme that emerges from this supplement is that we should establish and scale-up innovative, community-led services, while expanding the integration and options for key populations within the health system. In addition, we will not make sustainable improvements in outcomes if we do not better address the stigma,

discrimination and violence that key populations experience at the hands of family, community members, health care providers and the state.

As more evidence on key population programmes emerges, it is critical that the international community catalyse these advances with supportive policies that promote widespread uptake of effective approaches. Important studies are ongoing through the PEPFAR Key Populations Implementation Science and amfAR Implementation Science Grants initiatives, from which we anticipate more rich data designed to fill further gaps in our understanding of how to implement better services for key populations.

After more than three decades in the fight against HIV, plans to end the HIV epidemic through goals such as UNAIDS 90-90-90 have been adopted by governments, major donors, and stakeholders globally. Investments to address the epidemic among key populations should be central to these efforts. With ever-present threats of stigma, discrimination, violence, and other human rights abuses, the gains that have been made among key populations are precarious. The urgency of continuing to maintain focus on these groups cannot be understated. To leave no one behind, the substantial progress that has been made to date against the epidemic will need to be bolstered with rigorous, key population-specific data collection and use, with partnerships focused on vigilance, courage, tolerance and commitment.

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COMPETING INTERESTS

The authors have no other funding or conflicts of interest to disclose.

AUTHORS' CONTRIBUTIONS

RCW, TB, GM and RW all contributed to the preparation of the first draft. All authors approved the final manuscript.

ACKNOWLEDGEMENTS

The authors acknowledge important ongoing efforts underway through the PEPFAR Key Populations Implementation Science and amfAR Implementation Science Grants initiatives. The authors also thank Billy Pick (USAID) for his input on this editorial.

FUNDING

This manuscript was supported by multiple agencies including the United States Agency for International Development (USAID) and the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) through the Linkages across the Continuum of HIV Services for Key Populations Affected by HIV project (LINKAGES, Cooperative Agreement AID-OAA-A-14-00,045); PEPFAR through the Centers for Disease Control and Prevention (CDC); and amfAR, the Foundation for AIDS Research. The content is solely the responsibility of the authors and does not necessarily represent the official views of any of the funding agencies.

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COMMENTARY

Gaps and opportunities: measuring the key population cascade through surveys and services to guide the HIV response

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Abstract

Introduction: The UNAIDS 90-90-90 targets to diagnose 90% of people living with HIV, put 90% of them on treatment, and for 90% of them to have suppressed viral load have focused the international HIV response on the goal of eliminating HIV by 2030. They are also a constructive tool for measuring progress toward reaching this goal but their utility is dependent upon data availability. Though more than 25% of new infections are among key populations (KP)- sex workers, men who have sex with men, transgender people, people who inject drugs, and prisoners- and their sex partners, there is a dearth of treatment cascade data for KP. We assess the availability of cascade data and review the opportunities offered by biobehavioral and programme data to inform the HIV response.

Discussion: The emphasis on the collection of treatment cascade data among the general population in higher prevalence countries has not led to a similar increase in the availability of cascade data for KP. The limited data available for KP highlight large gaps in service uptake across the cascade, particularly in the first 90, awareness of HIV status. Biobehavioral surveys (BBS), with linked population size estimation, provide population-based data on the treatment cascade and should be conducted every two to three years in locations with services for KP. With the inclusion of viral load testing, these surveys are able to monitor the entire treatment cascade among KP regardless of whether these populations access HIV services targeting the general population or KP. BBS also reach people accessing services and those who do not, thereby providing a unique opportunity to learn about barriers to service uptake including stigma and discrimination. At the same time high-quality programme data can play a complementary role in identifying missed opportunities that can be addressed in real-time.

Conclusions: Data are more important than ever for guiding the HIV response toward reaching 90-90-90 targets and eliminating HIV, particularly in the face of decreased funding for HIV and specifically for KP. Timely high-quality BBS data can be triangulated with high-quality programme data to provide a comprehensive picture of the epidemic response for KP.

Keywords: Key populations; 90-90-90 cascade; surveillance; surveys; programme monitoring

Received 15 December 2017; **Accepted** 12 May 2018

1 | INTRODUCTION

UNAIDS 90-90-90 targets provide a valuable framework to guide the HIV response and monitor progress towards ending the epidemic [1]. These targets of having 90% of people living with HIV (PLHIV) aware of their infection, with 90% of them on antiretroviral therapy (ART), and 90% of them with suppressed viral load were conceived so that they could be informed through programme or survey data [2]. Though programme data exist about the number of HIV tests conducted and the number of people on ART, estimates of ART coverage are largely based on models such as Spectrum, and until recently, little has been known about population viral suppression [3]. However, the international embrace of the 90-90-90 targets has spurred surveys to collect data towards these indicators [4,5]. It has also led to a recognition that the key populations treatment cascade should be expanded to include outreach prevention and testing services as this is where many key population members first engage with the health system [6,7].

In order to elucidate progress toward UNAIDS targets, the US President's Emergency Plan for AIDS Relief (PEPFAR) is assessing national and sub-national 90-90-90 cascades among the general population in more than one dozen high HIV prevalence countries through the Population-based HIV Impact Assessment (PHIA) [8]. These surveys are seen as the best available method for nationally representative estimates of progress toward 90-90-90 targets. Results from Zimbabwe, Malawi and Zambia have highlighted the need to focus efforts on diagnosing infections because once diagnosed, countries are making good progress at linking and retaining people on antiretroviral treatment and suppressing viral load [9,10]. Data from Swaziland have confirmed the potential of combination prevention efforts and increasing treatment coverage in

reducing HIV incidence [11,12]. However, while population-based national and sub-national 90-90-90 cascade data are quickly becoming available for the general population in higher prevalence countries, no population-based surveys provide cascade data for key populations—sex workers (SW), men who have sex with men (MSM), transgender people (TP), and people who inject drugs (PWID). The lack of survey-derived cascade data for key populations is striking missed opportunity given that a larger number of biobehavioral surveys (BBS) have been conducted among key populations than among the general population [13-18].

In the absence of BBS data, key population programme data are often insufficient to fill data gaps about the cascade. These data are limited by the challenges of tracking individuals from community-based interventions to health facilities, and from facility to facility, particularly if that facility does not utilize key population unique client codes [19,20]. In some settings, people may not feel comfortable reporting their sexual or drug injecting practices or identities and in others it may not be safe to collect such data due to stigma and discrimination. This lack of data impedes the effective targeting of services by population, location, and intervention need, and measuring of progress toward epidemic control. We conducted a literature search in PubMed and reviewed reports for PEPFAR and Global Fund-supported surveys to identify surveys reporting at least two elements of the 90-90-90 cascade. We compare general population and key population cascades and their availability; and review the opportunities offered by BBS and programme data as well as their limitations.

2 | DISCUSSION

2.1 | A tale of two responses: progress towards general population and key population epidemic control

The immense progress combating HIV in the general population, evidenced by PHIA results, has been rightly celebrated but simultaneously underscores how far there is to go with key populations. It is well established that the risk of HIV acquisition is far higher among key populations than the general population, that HIV prevalence is higher among key populations, and that key populations access to HIV services is low [21-24]. Even within the same country, recent national population-based surveys (e.g. PHIA and Kenya AIDS Indicator Survey) and population-based BBS among key populations put in stark contrast the disparities in the 90-90-90 cascades between general population and key population members in the same country. They further illustrate the low coverage among key populations or the absence of key population cascade data in other countries (Table 1). Of great importance is that no cascade data exist for transgender people apart from in combination with MSM and no publicly available data exist for prisoners. As BBS should be conducted in locations with key population services and populations of sufficient size for sampling, the number of sites contributing to key population estimates are indicated below [5].

Only in Malawi and South Africa is the proportion of PLHIV self-reporting being aware of their HIV infection higher in a key population group (female sex workers, FSW, in this case) than the general population, though the South African key population survey occurred two years after the general population survey during which time services may have been expanded. Another explanation is that the FSW surveys were conducted in urban areas while the general population data represents the entire country, and HIV testing access, and therefore awareness, may be higher in urban than rural areas.

The limited BBS viral load in Table 1 may reflect the availability of viral load testing. The scale-up of viral load testing for treatment monitoring in many resource-limited settings will aid in estimating viral load measures in surveys. Where access to viral load testing is limited, investigators can send dried blood spots or plasma serum to other laboratories (e.g. in the capital or to another country) for testing while making an effort to return viral load results to survey participants.

Similar to the general population, the largest gap in 90-90-90 key population cascades above is among the proportion of people self-reported to be living with HIV and aware of their infection. Where data exist, self-reported awareness of HIV infection is lowest among MSM. While linkage to treatment is comparable between populations, it is still lower among key populations, and viral suppression data suggest that treatment adherence or retention may also be lower among key populations compared to the general population, signifying that all three steps in the key population cascade need attention, with priority on diagnosis.

Structural factors such as continued discrimination and criminalization of key populations impede access to health services and willingness to conduct surveys. Barriers to timely BBS include political will and funding as services are prioritized over strategic information to guide them, and the general population over key populations.

The representativeness and timeliness of data are extremely important for maximizing their utility. The data in Table 1 come from respondent-driven sampling surveys for key populations and nationally representative cluster-based household surveys for the general population, both of which are able to provide representative data about the target population. Though other data may exist, they are of lesser quality (i.e. utilized non-probability probability sampling methods or were restricted to a key population sub-group) and therefore not included. Table 1 reveals that key population BBS may not be conducted with sufficient frequency (i.e. every two to three years), and the publication dates of the data presented suggest that results may take a considerable amount of time to be released [5]. Survey-derived treatment cascades do not exist for key populations in all other resource-constrained countries.

At a basic level, many southern African countries have no BBS data at all on men who have sex with men. In addition, Table 1 illustrates that where data do exist, data on the general population are generally more recent than on key populations. Key populations can play a critical role advocating for data collection. Kenya conducted BBS among key populations and a national general population survey in 2012 but only measured the cascade in the general population survey [33]. While another national survey will be conducted in 2018, no survey was planned amongst female sex workers, men who have sex with men, or transgender people until recent advocacy efforts by civil society resulted in the allocation of resources for such surveys.

Table 1. General population and key population 90-90-90 cascades

Country	Population	Sites	Year of data collection	First 90: self-reported diagnosed	Second 90: self-reported on ART of those diagnosed	Third 90: virally suppressed, of those on ART
Cameroon [25]	FSW	5	2015 to 2016	52%	81%	[a]
Cameroon [25]	MSM/TP	5	2015 to 2016	42%	63%	[a]
India [26]	MSM	12	2012 to 2013	30%	53%	63%
India [26]	PWID	15	2012 to 2013	41%	44%	83%
Kenya [27]	General population	National	2012	62.4%	71.9%	79.8%
Malawi [10]	General population	National	2015 to 2016	72.7%	89.6%	91.2%
Mozambique [28]	General population	National	2015	34.3%	77.3%	[a]
Mozambique [29]	FSW	3	2011 to 2012	22.3%	52.5%	[a]
Mozambique [29]	MSM	3	2011	8.8%	39.8%	[a]
Mozambique [29]	PWID	2	2014	63.2%	44.9%	[a]
Papua New Guinea [15]	FSW	1	2016	38.9%	84.4%	54.6%
South Africa [30]	General population	National	2012	37.8% male/55.0% female	25.7% male/34.7% female	[a]
South Africa [31]	FSW	1	2014 to 2015	82%	48%	[a]
Swaziland [32]	General population	National	2016 to 2017	84.7%	87.4%	91.9%
Uganda [14]	FSW	1	2012	37.5%	67.7%	51.6%
Uganda [13]	MSM	1	2012 to 2013	20.2%	75.0%	58.3%
Zambia [10]	General Population	National	2015 to 2016	66.0%	85.0%	89.3%
Zimbabwe [9]	General Population	National	2015 to 2016	72.9%	86.8%	86.5%
Zimbabwe [16]	FSW	14	2013	64.0%	67.7%	77.8%

[a]Data not available.

2.2 | A tale of two cascades: population-based and programme-based

Population-based surveys in the form of BBS are an essential part of key population surveillance and should be conducted every two to three years to measure changes in the epidemic and the impact of the response [2,5]. BBS have many advantages. Foremost is their ability to obtain data on people regardless of whether they are accessing HIV services, allowing the development of representative estimates of service coverage, including outreach and prevention services such as pre-exposure prophylaxis, and 90-90-90 cascades for the survey location [2]. By asking questions of participants about non-engagement in services, BBS allow an understanding of the characteristics and reasons why people are not testing for HIV, not on treatment, or not virally suppressed, information that is essential for increasing HIV service coverage. Such reasons may include perceived or experienced stigma, cost, not knowing where to test, or feeling not at risk [13,34,35]. BBS can also facilitate the production of population size estimates. They are often challenged, however, by the time required for planning, implementation, data analysis, and report writing, as well as budget constraints. Structural factors such as stigma and criminalization may also impede participation in BBS. This can be assessed through formative assessment and non-response interviews during BBS, and mitigated by early engagement of key populations in survey planning.

It may be tempting to use data from general population surveys in place of BBS data to characterize the HIV epidemic; however, such efforts are fraught with many challenges and the surveys are only conducted in a subset of countries. Key populations may be less likely to be sampled in household surveys due to homelessness, or informal or clandestine living arrangements. Many ministries of health are reluctant to include questions about same-sex sexual activity, transgender people, or even the gender of sex partners in household surveys, particularly when these are criminalized. Where key populations are sampled and questions about their practices and identities are included in a survey, they may not disclose them to interviewers. Taken together, these factors may bias key population cascades obtained in general population surveys. Finally, individual surveys may not have sufficient power to disaggregate data by key population. As surveys such as PHIA are powered for national incidence estimation and subnational viral load suppression for the general population, they lack the power to estimate the same for key populations who make up a small proportion of the population. General population surveys do, however, offer a unique opportunity to estimate national and subnational key population size through the use of the network scale-up method. Such estimates may facilitate the expression of key population cascades when combined with high quality programme data.

Whereas BBS reach people accessing services and those who do not, programme data only describes those accessing services. In addition, key population programme data only

describe those key population members who access services at key population-friendly facilities that disaggregate data by population rather than all key population members living with HIV (KPLHIV) who access services, leaving an incomplete picture of KPLHIV who access services. Stigma continues to hinder uptake of services by key populations and disclosure of key population practices and identities among those who do access them, resulting in low programme coverage and consequently, inadequate data for drawing conclusions about the population [36-40]. And in some countries, the provision of services to key populations has been barred, effectively excluding the possibility of using programme data to inform cascades [41]. BBS can help highlight the detrimental effects of such policies and structural barriers. They can further assess mental health measures and the mediating role between exposure to stigma, violence, and discrimination, and practices, identities, and service uptake. The 2017 WHO Biobehavioral Survey Guidelines for Populations at Risk for HIV offers questions for investigators to include in order to measure these and other important topics, including shame and social cohesion [5].

High-quality programme or service data that are individualized and deduplicated can provide important information about the number and sub-groups of people accessing services and their ART outcomes [42]. This can help service providers monitor interventions to verify that they are efficiently reaching the right people in the right places and that interventions are functioning as planned. When programme data reveal that the number of new people reached with outreach services decreases over time, when the testing yield declines, or when patients do not collect medicine, providers can respond in real time to changes in the population and their needs. Short surveys using audio-computer assisted personal interviews can also be integrated into routine services to obtain behavioural data on individuals accessing services. Such surveys have been used at a testing facility for men who have sex with men in Uganda (e.g. the Know Your Sero-Status, KYSS, survey) as well as at one of Uganda's largest general population testing facilities, Mildmay Clinic. A unique client code can be used to track people and their practices and serostatus over time. These data should not be used to replace BBS as they only represent people already accessing services. Furthermore, sentinel sites are ill-suited for key population surveillance because their very nature, for instance as an sexually transmitted infections clinic, make them associated with service uptake and HIV, and the resulting data are biased.

Despite these advantages, data quality can vary widely and routine programme data only provide information about service uptake and health status. Detailed behavioural data that can inform service delivery generally are not collected. Tracking individuals, and linkage to and retention on treatment can also be challenging. Double counting of individuals accessing services at the same site, or at multiple sites or providers may inflate the reach of services or skew testing yield. The generation of unique client codes, as many key population services have done, may improve data quality but may also create challenges when trying to assess the number of key population members accessing services at key population-friendly or general population services that do not use these unique identifiers or collect information about key population status. This is further limited where stigma or fear lead key population members not to disclose their defining risk practice or identity [43-46]. Noting the significance of confidentiality and security issues for key populations, WHO does not recommend the inclusion of key population groups on patient monitoring records [47]. In addition, where it may seem that people diagnosed with HIV are not linked to treatment or that people on ART have defaulted, it may also be the case that individuals chose to seek services elsewhere [48-50]. These silent transfers may prompt policy makers and service providers to target resources at a problem that may not exist. In addition, without a robust population size estimate, it is nearly impossible to estimate outreach coverage, the starting point of the key population cascade.

The triangulation of both BBS and programme data has great potential to guide service providers and policy makers in the epidemic response [51-53]. Together, these data, collected using different methods and data sources, may be able to provide a comprehensive picture of the epidemic response, with programme monitoring revealing trends in service provision and missed opportunities, and BBS data on the reach and impact of services. For instance, programme data showing high loss to follow up and BBS data showing high ART coverage and viral suppression, may reveal that people are simply changing service providers, possibly even to general population sites, thereby suggesting that fewer resources are needed to identify and reengage those who were thought to be lost to follow up and retain others. The higher than expected viral suppression may also suggest a reduction in HIV incidence. While triangulation exercises should be updated regularly as new data become available, they are not common and the production of a report or publication is even less common.

It is imperative that key population members play a meaningful role in the collection and use of data about and for them. Formative assessments provide key populations with an important role in informing BBS. They should also be included as collaborators and investigators, and where appropriate, data collectors. In Papua New Guinea, survey results were shared with key population members ahead of public release and their feedback and recommendations were incorporated into survey reports, including in the form of statements from key population organizations [54,55]. Such engagement enhances a sense of ownership of the results by these groups and their ability to use the data for advocacy.

3 | CONCLUSIONS

The HIV treatment cascade is a valuable tool for measuring progress toward epidemic control and when measured through BBS, elucidating barriers, structural and otherwise, to service utilization. While there are many gaps in measuring the cascade, there are also many opportunities for data collection and use. Though BBS of key populations are recommended to be conducted every two to three years, in practice they occur less frequently or not at all [5]. Meanwhile, their importance for monitoring the epidemic will increase as countries get closer to reaching 95-95-95.

Many efficiencies can be found to expedite data collection and facilitate timely data availability and use, in turn decreasing costs of data collection and service provision. These efficiencies include starting surveys with more seeds, utilizing

audio computer-assisted self-interviews that require fewer staff and decrease bias, and developing analytic programs during data collection [56-58]. Incorporating BBS into national surveillance strategies and making them routine activities implemented every two to three years can help enhance the timeliness, standardization, quality, and utility of data. Following the example of the ARISTOTLE study which showed the cost effectiveness of their survey and intervention, other surveys are now beginning to assess the cost effectiveness of BBS resulting from their critical role in diagnosing and (re)linking people to ART, including those who have stopped being on ART [59].

Between survey rounds, programme data can indicate whether services are reaching more people and areas for improvement in programme quality. In the context of decreasing funding from external donors in countries with concentrated epidemics, it becomes ever more important to use data to inform the response and make an investment case for national and donor resources.

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COMPETING INTERESTS

We have no competing interests to report.

AUTHORS' CONTRIBUTIONS

AH, WH, DP and KS conceived of this manuscript. AH and WH contributed substantially to the writing. VM, JZ, JB, KS, DP and JC reviewed the manuscript.

ACKNOWLEDGEMENTS

FUNDING

This paper has been supported in part by the President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention (CDC).

DISCLAIMER

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the funding agencies.

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Mukandavire C et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25126
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25126/full | https://doi.org/10.1002/jia2.25126

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

Estimating the contribution of key populations towards the spread of HIV in Dakar, Senegal

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Abstract

Introduction: Key populations including female sex workers (FSW) and men who have sex with men (MSM) bear a disproportionate burden of HIV. However, the role of focusing prevention efforts on these groups for reducing a country's HIV epidemic is debated. We estimate the extent to which HIV transmission among FSW and MSM contributes to overall HIV transmission in Dakar, Senegal, using a dynamic assessment of the population attributable fraction (PAF).

Methods: A dynamic transmission model of HIV among FSW, their clients, MSM and the lower-risk adult population was parameterized and calibrated within a Bayesian framework using setting-specific demographic, behavioural, HIV epidemiological and antiretroviral treatment (ART) coverage data for 1985 to 2015. We used the model to estimate the 10-year PAF of commercial sex between FSW and their clients, and sex between men, to overall HIV transmission (defined as the percentage of new infections prevented when these modes of transmission are removed). In addition, we estimated the prevention benefits associated with historical increases in condom use and ART uptake, and impact of further increases in prevention and treatment.

Results: The model projections suggest that unprotected sex between men contributed to 42% (2.5 to 97.5th percentile range 24 to 59%) of transmissions between 1995 and 2005, increasing to 64% (37 to 79%) from 2015 to 2025. The 10-year PAF of commercial sex is smaller, diminishing from 21% (7 to 39%) in 1995 to 14% (5 to 35%) in 2015. Without ART, 49% (32 to 71%) more HIV infections would have occurred since 2000, when ART was initiated, whereas without condom use since 1985, 67% (27 to 179%) more HIV infections would have occurred, and the overall HIV prevalence would have been 60% (29 to 211%) greater than what it is now. Further large decreases in HIV incidence (68%) can be achieved by scaling up ART in MSM to 74% coverage and reducing their susceptibility to HIV by two-thirds through any prevention modality.

Conclusions: Unprotected sex between men may be an important contributor to HIV transmission in Dakar, due to suboptimal coverage of evidence-informed interventions. Although existing interventions have effectively reduced HIV transmission among adults, it is crucial that further strategies address the unmet need among MSM.

Keywords: population attributable fraction; HIV; female sex workers; men who have sex with men; clients; condom use; key populations

Additional Supporting Information may be found online in the Supporting information tab for this article.

Received 15 December 2017; **Accepted** 16 May 2018

1 | INTRODUCTION

Key populations (KP) such as female sex workers (FSW) and men who have sex with men (MSM) bear a disproportionate burden of HIV [1-5]. The HIV-associated vulnerabilities experienced by KP are thought to play an important role in the transmission of HIV in low HIV prevalence settings, but less so in settings with generalized HIV epidemics. Existing analyses suggest that FSW and their clients contribute less than 30% [1,3] and 10% [6] of prevalent HIV infections among adults in sub-Saharan Africa (SSA), respectively, although these analyses only considered the proportion of prevalent infections that were among clients or FSW. In addition, recent reviews of the UNAIDS Modes of Transmission (MOT) model [7,8] suggest that the role of KP is small in SSA, with the cumulative percentage of new annual infections due to KP generally being less than 25%.

These estimations of the role of KP to HIV epidemics do not incorporate the full chain of transmission originating from

KPs, such that a male who becomes infected by another male could then infect a female, resulting in the initial male not only contributing to the MSM HIV epidemic but also the heterosexual epidemic. Indeed, for commercial sex, these analyses conflict with emerging dynamic modelling analyses suggesting that >90% of all HIV transmissions to date are directly or indirectly due to sex work in the low-to-moderate prevalence HIV epidemics of Burkina Faso, Cote d'Ivoire and Benin, and over 65% in the higher-prevalence HIV epidemic in Kenya [9-14]. These analyses challenge the conventional wisdom and existing epidemiological tools such as the MOT model. In contrast, two recent studies for Nigeria and Cote d'Ivoire suggest MSM contribute little (<10%) to these HIV epidemics [14,15]. This is despite MSM experiencing a high HIV burden [4,16,17] and engaging in sexual partnerships with women, so contributing bridging infections to the wider population [18]. Limitations in existing evidence emphasizes the urgent need to improve our estimates of the contribution of KP to HIV epidemics in SSA; this basic epidemiological measure is crucial for prioritizing HIV programming.

Senegal has a low HIV prevalence among adults (0.4% in 2016) [19], thought to be due to a comprehensive response to the epidemic [20]. Nevertheless, the HIV burden among KP is much higher (5.9% in FSW and 29.7% in MSM in 2016) [21-27]. Despite the low prevalence of HIV in the adult population and high prevalence among KP, current estimates suggest that commercial sex and sex between men contribute little (<15%) to existing HIV transmission in Senegal [3,8], although these estimations were limited as they did not incorporate the dynamic aspect of transmission.

To remedy these limitations, we undertook a dynamic model assessment of the contribution of commercial sex and sex between men to HIV transmission in Dakar, Senegal. We also estimated the impact of historical increases in the coverage of antiretroviral therapy (ART) and condom use among KP, and the potential impact of further uptake of prevention and treatment interventions.

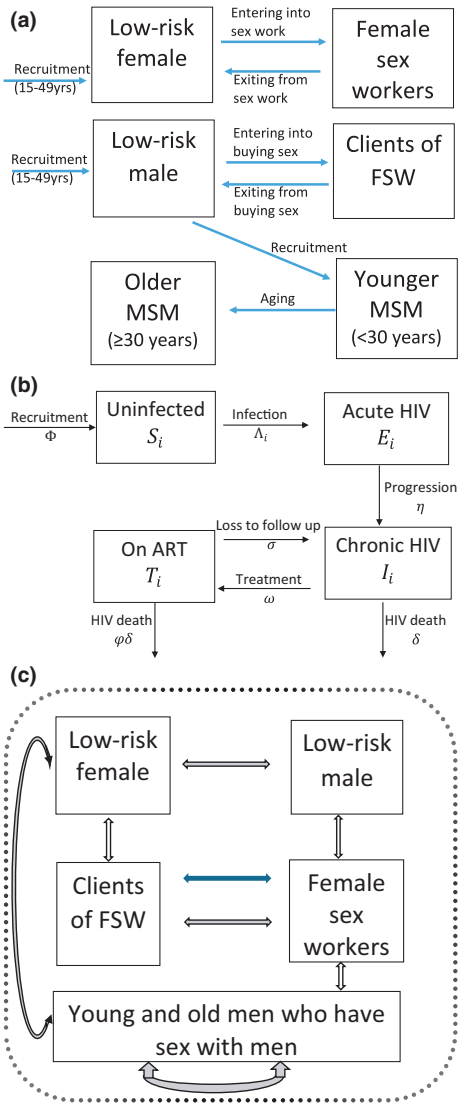

Figure 1. Model schematic illustrating the (a) movement of individuals in and out of different sub-populations (male and female low-risk, clients, female sex workers (FSW), younger and older men who have sex with men (MSM), (b) stratification of the population with respect to HIV infection and (c) sexual interactions which can result in HIV transmission among female, male, FSW, their clients and MSM. Blue arrow in Figure 1c shows commercial sex and all other arrows show sex with main and casual partners.

2 | METHODS

2.1 | Model description

We developed a dynamic HIV transmission model to evaluate the extent to which FSW, clients of FSW (referred to as clients hereafter) and MSM contribute to the overall HIV epidemic in Dakar, Senegal. The model did not include people who inject drugs because of their low prevalence in Dakar (<0.07% of the adult population [28]). The model considers adults (15 to 49 years), and divides the population into six sub-populations: low-risk females and males, clients, FSW, young MSM (<30 years) and old MSM (≥30 years) (Figure 1). Transgender women (TGW) were not explicitly included in the model because of insufficient data to parameterize this risk population. Low-risk individuals are defined as people who are not MSM and do not report commercial sex.

Individuals enter the modelled population in the low-risk groups when they become sexually active, at a rate that balances non-HIV deaths and reflects population growth. Low-risk males and females can become clients and FSW at specified rates, with both practising commercial sex for an average duration. Similarly, MSM transition from the low-risk male population, and age from the young to the old MSM group, but remain as MSM until death.

The model captures HIV transmission among the sub-populations through vaginal and anal sex (VI and AI, respectively) between all males and females, and AI within the MSM group (Figure 1). The model stratifies the population with respect to HIV infection and disease progression (Figure 1b). Upon infection, susceptible individuals acquire acute HIV infection before progressing to chronic infection. Chronically-infected individuals experience HIV-related mortality, but can also be recruited onto ART, which reduces HIV-related mortality. Individuals on ART can be lost to follow up, whereupon they

return to the chronic infection stage. All sub-populations also experience non-HIV-related death.

The model incorporates HIV transmission due to main, casual and commercial sexual partnerships. Commercial partnerships occur between FSW and their clients, while main and casual partnerships between men only occur among MSM. All other heterosexual main and casual partnerships occur between all groups. The risk of HIV transmission for each individual is related to the HIV prevalence of their sexual partners, with the HIV transmission risk being elevated if they have acute infection, and reduced if they are on ART. Transmission risk is also related to the frequency of sex between different partnerships and is reduced through condom use. The consistency of condom use is time dependent and varies by type of partnership. The model assumes some males are circumcised, which reduces the risk of HIV acquisition. We assume heightened transmission risk in the initial stages of an HIV epidemic to capture the effects of risk heterogeneity. The model is described in Data S1.

2.2 | Model parameterization and calibration

Recent model parameter and calibration data for FSW, clients and MSM were obtained from three integrated behavioural and biological assessment (IBBA) surveys undertaken in Dakar, Senegal, from 2015 to 2016 [25] (client data are unpublished). Sexual behaviour data related to FSW, clients and MSM came from these surveys. The survey used to parameterize the MSM component of the model also included some TGW.

In addition, older IBBA surveys were used to determine whether risk behaviour has changed over time, and how the HIV epidemic in different risk groups has evolved. Importantly, this included trends in condom use for different risk groups. However, differences in the behavioural measures used made it difficult to evaluate how behaviours changed over time, and so uncertainty was incorporated into those trends. Adult population HIV-related epidemiological and sexual behaviour data were obtained from the Demographic Health Surveys (DHS) for 2005 and 2010 [29,30]. Table S1 gives a summary of IBBA surveys used in the modelling, while the model parameterization is summarized in Table 1 and included in full in Table S2.

Based on data from numerous FSW and client IBBA surveys between 1985 and 2016 [26,31-36], and national data on increases in condom distribution between 1988 and 1997 [37], condom use during commercial VI sex between FSW and their clients (Figure 2a) was assumed to increase from negligible levels in 1985 [33], up to a high stable level from 1998 onwards between 54 and 90% [24,26,34]. This large range was based on the difference between client- and FSW-reported condom use estimates in 2015 to 2016. Similarly, based on data from MSM IBBA surveys, condom use in last sex act for male partners of MSM was assumed to be negligible in 1985, low (10% to 30%) in 2001 [38], up to 70 to 85% by 2003 to 2007 [22,39,40] and constant thereafter (Figure 2b) (2016 survey). The Data S1 and Figure S1 include further details on the condom use assumptions.

Table 1. Parameters used for female sex workers (FSW), their clients and men who have sex with men (MSM) in 2016

Model parameter	FSW	Clients	Young MSM (<30 years)	Old MSM (≥30 years)
Size estimates (% of adult women or men)	0.5% (0.3 to 0.9%)	5.1% (1.8 to 12.1%)	1.2% (0.8 to 2.3%)	
HIV-1 prevalence	5.9% (1.8 to 10.0%)	1.2% (0.5 to 2.4%)	28.6% (19.8 to 37.5%)[a]	37.0% (14.8 to 59.2%)
Level of viral suppression in individuals living with HIV	73.7% (60.9 to 84.2%)	NA	35.4% (23.9 to 48.2%)	
Frequency of partners per year				
Commercial (FSW/Clients)	516.4 (368.2 to 691.2)[b]	69.6 (62.4 to 78.0)	–	–
Main heterosexual	0.58 (0.47 to 0.73)	1.9 (1.3 to 2.6)	0.88 (0.39 to 1.5)	0.88 (0.39 to 1.5)
Casual heterosexual	0.96 (0.48 to 1.6)	0.6 (0.15 to 1.4)	2.3 (0.55 to 5.1)	2.3 (0.55 to 5.1)
Main (MSM sex)	–	–	0.71 (0.59 to 0.83)	0.71 (0.59 to 0.83)
Casual (MSM sex)	–	–	5.4 (2.5 to 9.2)	4.8 (1.3 to 9.2)
% of commercial sex acts that are anal[c]	4.1% (2.1 to 6.5%)	5.1% (3.8 to 6.5%)		
Frequency of vaginal sex acts per year				
Main heterosexual partners	98.3 (78.5 to 117.5)	97.3 (73.6 to 124.6)	65.3 (56.2 to 74.4)	65.3 (56.2 to 74.4)
Casual heterosexual partners	6.2 (4.2 to 8.2)	3.8 (2.1 to 5.9)	4.5 (2.6 to 6.4)	4.5 (2.6 to 6.4)
Frequency of anal sex acts per year				
Main heterosexual partners	9.9 (3.6 to 15.6)	6.6 (3.4 to 11.1)	5.2 (1.6 to 9.4)	5.2 (1.6 to 9.4)
Casual heterosexual partners	0.49 (0.12 to 1.2)	0.33 (0.097 to 0.75)	0.52 (0.04 to 1.0)	0.52 (0.04 to 1.0)
Frequency of anal sex for men with men per year (MSM sex)				
Main partnerships of MSM	–	–	105.6 (91.0 to 120.6)	105.6 (91.0 to 120.6)
Casual partnerships of MSM	–	–	7.6 (6.7 to 8.2)	15.2 (13.2 to 16.4)

NA denotes not available.
[a]Alternative IBBA survey from 2014 suggests lower HIV prevalence of 13.3% (9.7 to 17.4%).
[b]Uncertainty range widened based on different estimates from the 2016 survey and earlier surveys.
[c]The rest are vaginal.

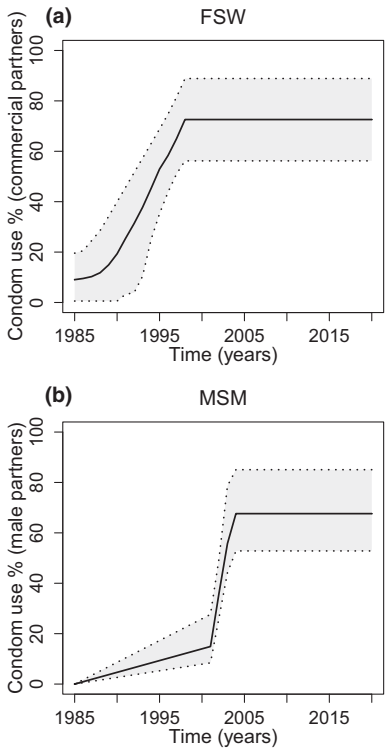

Figure 2. Modelled condom use trends for (a) female sex workers (FSW) and (b) men who have sex with men (MSM). (a) FSW condom use with commercial partners for vaginal intercourse. Assume condom use for anal intercourse is half that of vaginal intercourse for all years. (b) MSM condom use with regular and casual male partners. We assume some bias in reporting so all rates have been multiplied by a bias factor of 0.7 to 1.0 – lower bound of 0.7 chosen to give overall lower bound of 0.5, as seen in figure.

Senegal population size estimates for 1980 to 2020 and gender-specific death rates were obtained from UNDP [41], with population growth rates being fit to this data. Population size estimates for FSW and MSM were produced as part of the 2015 IBBA surveys using the service multiplier and unique object methods [42]. The population size of clients was estimated through balancing the overall demand for commercial sex of FSW with that of clients (see Data S1).

ART data for the Senegal population came from the World Bank and UNAIDS [43,44] (Figure S2), suggesting ART coverage increased from negligible levels in 2000 to 40% of individuals living with HIV in 2015. For FSW, these coverage trends were scaled up because the 2016 IBBA found 74% of FSW living with HIV were virally suppressed (unpublished data from 2016 FSW survey [25]). ART recruitment rates were calibrated to give the trends in ART coverage. Other HIV biological parameters came from literature (Table S2).

Uncertainty ranges were assigned to most model parameters, with most parameters being fixed over time except for the rate of ART recruitment, levels of condom use and frequency of sex for MSM with their male partners, which data suggest increased from 2007 to 2016 [21,25]. To incorporate uncertainty, 10,000 parameter sets were randomly sampled from their uncertainty ranges (Table S2 and Table 1). For each parameter set, the model was run while including temporal increases in condom use, ART coverage and the frequency of sex for male MSM partners. Any run producing HIV prevalence projections that agreed with early IBBA HIV prevalence data for FSW (1990 or 1995) and clients (1999) and recent HIV prevalence data for young MSM from 2014 to 2016 were selected as a model fit. These data suggested a HIV prevalence of 2.0 to 10.0% in 1990 and 5.0 to 15.0% in 1995 in FSW, 1.1 to 5.5% in clients (1999) and 9.7 to 37.7% in MSM, with these prevalence estimates shown in Figure 3 (data sources in Table S1). The wide range for MSM is due to contrasting estimates from two IBBA surveys in 2014 and 2016. Other HIV prevalence data for all sub-groups are also shown in Figure 3. The model was not calibrated to these data, but instead the data were used to validate the accuracy of the model projections.

2.3 | Analyses

2.3.1 | *Contribution of commercial sex and sex between men to HIV transmission*

To estimate the contribution of commercial sex between FSW and clients and sex between men to the overall HIV epidemic (referred to as population attributable fraction or PAF), model fits were used to estimate the proportion of new HIV infections that would be prevented by setting the transmission probability for commercial sex or sex between men to zero over a specific time period. This was estimated for 1 or 10 years from 1995, 2005 and 2015.

2.3.2 | *Impact of existing interventions*

Model fits were used to explore the likely impact of historical increases in ART coverage and condom use on the evolution of the HIV epidemic for different population sub-groups. This was determined by re-running the model fits, but with no ART and/or condom use.

2.3.3 | *Impact of scaling up interventions*

We then assessed the impact of increasing the coverage of ART among MSM from 2017 to 2030, such that the proportion of MSM living with HIV who are virally suppressed increases to the same coverage as FSW (74%) by 2020. This increase in ART coverage was also considered among low-risk individuals. To capture the possible effect of introducing pre-exposure prophylaxis for HIV (PrEP) and/or further increases in condom use, we also investigated the impact of an intervention that reduces an individual's average risk of becoming HIV positive. This was estimated by reducing by a third the susceptibility to HIV transmission among (i) MSM, (ii) FSW or (iii) all low-risk individuals. This is roughly equivalent to putting 40% of MSM on PrEP (assuming 85% effectiveness [46,47]), 50% of FSW on PrEP (assuming 66% effectiveness [47,48]) or reducing the number of unprotected sex acts by 40% through increased condom use (assuming 82.5% effectiveness per sex act). We also assumed a scenario where both were achieved for MSM (PrEP and condom use), reducing susceptibility by two-thirds.

2.3.4 | *Uncertainty analysis*

We performed linear regression analyses of covariance (ANCOVA) [49] to determine which parameters contribute most to the variability in the 10-year PAF estimates for commercial sex and sex between men for 2015.

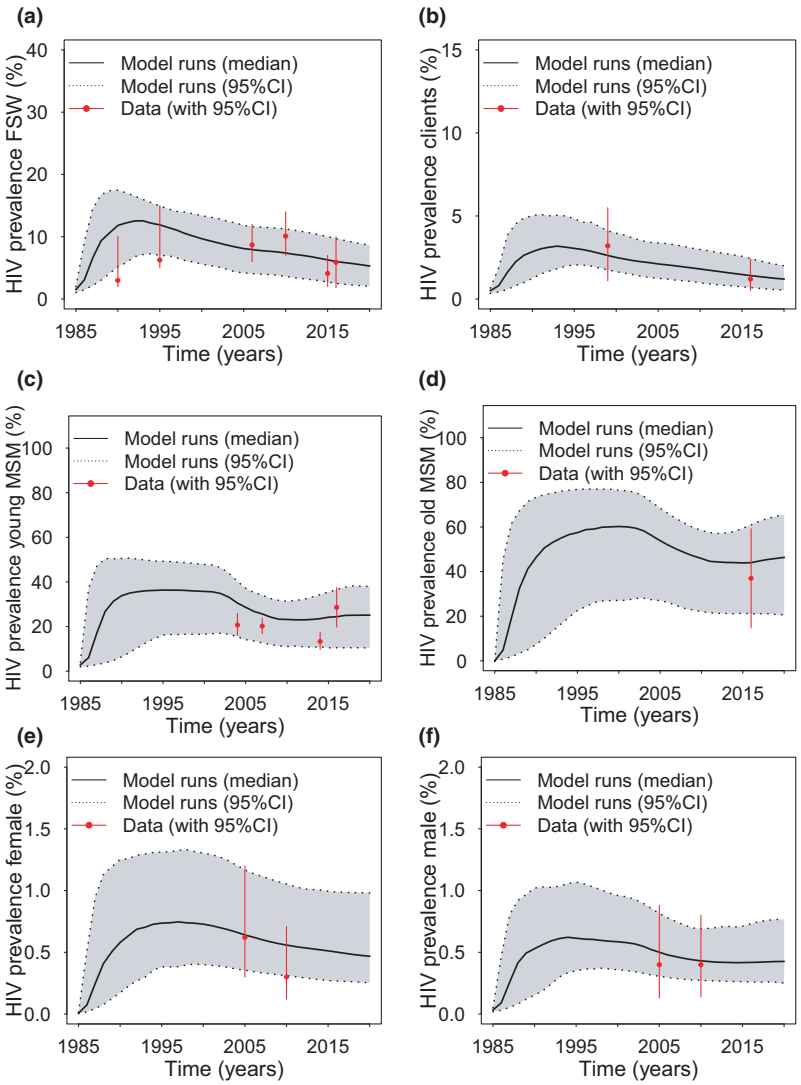

Figure 3. A comparison of model fits with HIV prevalence estimates from 1985 to 2020 for (a) female sex workers (FSW) (b) clients of FSW, (c) younger men who have sex with men (MSM) (<30 years old), (d) older MSM (≥30 years old) and (e) female and (f) male overall adult populations. Continuous black line shows median projections from all the model fits, with dashed lines and grey shaded areas showing 95% credibility intervals. Red points and lines show data with 95% confidence intervals.

3 | RESULTS

3.1 | Existing epidemiological insights

Two hundred model runs agreed with the HIV prevalence calibration data from FSW, clients and MSM. Despite only being calibrated to one-third of the prevalence estimates (5/17 data points), these model fits agreed closely with observed HIV prevalence trends for all groups (Figure 3). These model fits suggest the HIV prevalence among FSW, clients and the adult population has been in steady decline since the mid-90s, but may have increased recently among MSM.

3.2 | Contribution of commercial sex and sex between men to HIV transmission

For the 10 years from 1995, a median of 42.1% (2.5 to 97.5%, percentile range 23.7 to 59.0%) of new HIV infections could have been prevented (10-year PAF) if the risk due to sex between men had been removed over this period, respectively, with this increasing to 64.1% (37.4 to 79.4%) by 2015 (Figure 4). The increase in the 10-year PAF for sex between men in 2015 is due to the increase in the frequency of AI sex acts between MSM over this time period. Much of this effect of MSM is due to their heterosexual partnerships with females, such that removing this risk prevents 37.1% (18.7 to 51.3%) of HIV infections over 10 years from 2015 (Figure 4). In contrast, the 10-year PAF for commercial sex was 20.6% (7.3 to 38.7%) and 13.6% (4.8 to 35.0%) for 1995 and 2015 respectively (Figure 4). For sex between men, one-year PAFs were lower than 10-year PAFs, but were similar for commercial sex (Table 2).

The analysis of covariance showed that many parameters contributed to the uncertainty in the PAF estimates (Data S1).

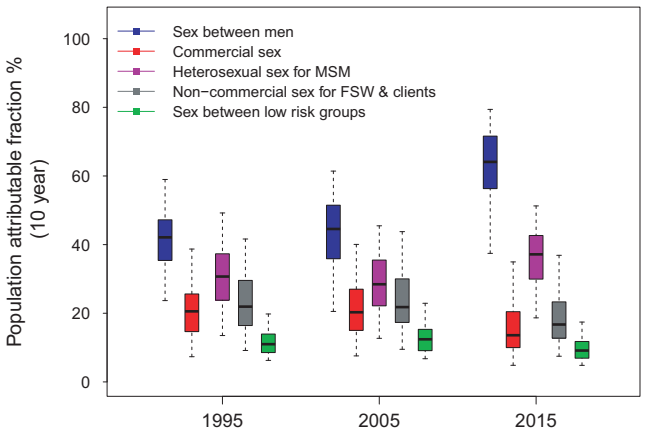

Figure 4. Ten-year population attributable fraction (PAF) for sex between men (blue), commercial sex (red), heterosexual sex for men who have sex with men (MSM) (purple), non-commercial sex for female sex workers (FSW) and their clients (grey), and sex between low-risk groups (green). The PAF is estimated as the proportion of all HIV infections prevented over 10 years from 1995, 2005 or 2015 if the HIV transmission risk due to a specific type of sexual behaviour is removed. The box plots signify the uncertainty (middle line is median, limits of boxes are the 25% and 75% percentiles and whiskers are 2.5% and 97.5% percentile range) in the PAF estimates due to uncertainty in the model parameters.

3.3 | Impact of existing interventions

Model projections (Figure 5) suggest that if there had been no ART scale-up since 2000, in relative terms, the HIV prevalence in FSW in 2015 would have been 13.5% (6.1 to 23.8%) higher, 7.0% (4.0 to 11.0%) higher in MSM and 5.7% (2.2 to 10.2%) higher overall. In contrast, if condom use had not increased in the mid- to late-1990s, the HIV prevalence in MSM would have been 56.6% (27.9 to 160.3%) higher in 2015, 2.1 times (1.5 to 6.8) higher in FSW and 60.2% (28.9 to 210.9%) higher in the general population (Figure 5). In terms of new HIV infections, without ART scale-up, 49.0% (32.3 to 71.3%) more HIV infections would have occurred in Dakar since 2000 when ART was introduced, whereas without any condom use since the mid-1980s, 66.5% (27.2 to 178.5%) more HIV infections would have occurred.

3.4 | Impact of scaling up interventions

Scaling up ART among MSM such that 74% are virally suppressed by 2020 (35.4% of MSM living with HIV are currently virally suppressed) would decrease the overall HIV incidence in Dakar by 14.7% (4.9 to 47.1%) by 2030 (Figure 6). If the HIV susceptibility in MSM is also reduced by a third then incidence would decrease by 43.9% (14.9 to 76.0%), while it decreases by 68.3% (42.0 to 88.6%) if susceptibility reduces by 66%. This captures what could be achieved from putting 40% of HIV-negative MSM on PrEP and reducing the number of non-condom protected sex acts by 40%. However, further decreases in FSW or general population susceptibility (by a third) or increases in ART coverage in the general population (so 74% are virally suppressed) will not add much more impact, with these interventions in combination decreasing the overall incidence by 82.4% (62.4 to 93.3%). This is due to the small contribution of these groups to HIV transmission in Dakar.

4 | DISCUSSION

Our findings suggest that unprotected anal sex between men, both through individuals who identify as cis-male and TGW, may be the main contributor to the HIV epidemic in Dakar, Senegal, with up to 64% of new HIV infections being preventable if the HIV prevention and treatment needs of these individuals could be met. Conversely, unlike other low HIV prevalence settings in SSA, much fewer (<15%) HIV infections are attributable to commercial sex between FSW and their clients [10,11,14]. The greater role of MSM in Dakar is partly due to their greater number compared to FSW (1.2% of adult males compared to 0.5% of adult females in 2015) and much higher HIV prevalence (29.7% for MSM compared to 6.6% for FSW in 2016), with this disparity being due to long-term prevention activities among FSWs in Dakar, but not MSM. In addition, the heterosexual activity of MSM is also important; stopping this mode of transmission could prevent 37% of new HIV infections from 2015 to 2025.

These results are useful for planning intervention strategies going forward, with most impact being achieved from expanding interventions among MSM, including cis-male and TGW. These data suggest that increasing ART provision to MSM could reduce HIV incidence by 15% if the proportion of MSM living with HIV who are virally suppressed doubled from 35%

Table 2. Population attributable fraction for sex between men and commercial sex. The population attributable fraction is defined as the proportion of HIV infections prevented if the HIV transmission risk due to sex between men or commercial sex was removed from 1995, 2005 or 2015 for 1 or 10 years

	1995	2005	2015
PAF (1 year)			
Sex between men	36.2% (21.5% to 52.5%)	28.9% (13.3% to 42.8%)	51.4% (27.3% to 66.7%)
Commercial sex	19.8% (8.3% to 38.7%)	21.6% (8.8% to 36.9%)	13.8% (5.1% to 31.1%)
PAF (10 years)			
Sex between men	42.1% (23.7% to 59.0%)	44.6% (20.5% to 61.4%)	64.1% (37.4% to 79.4%)
Commercial sex	20.6% (7.3% to 38.7%)	20.3% (7.6% to 40.1%)	13.6% (4.8% to 35.0%)

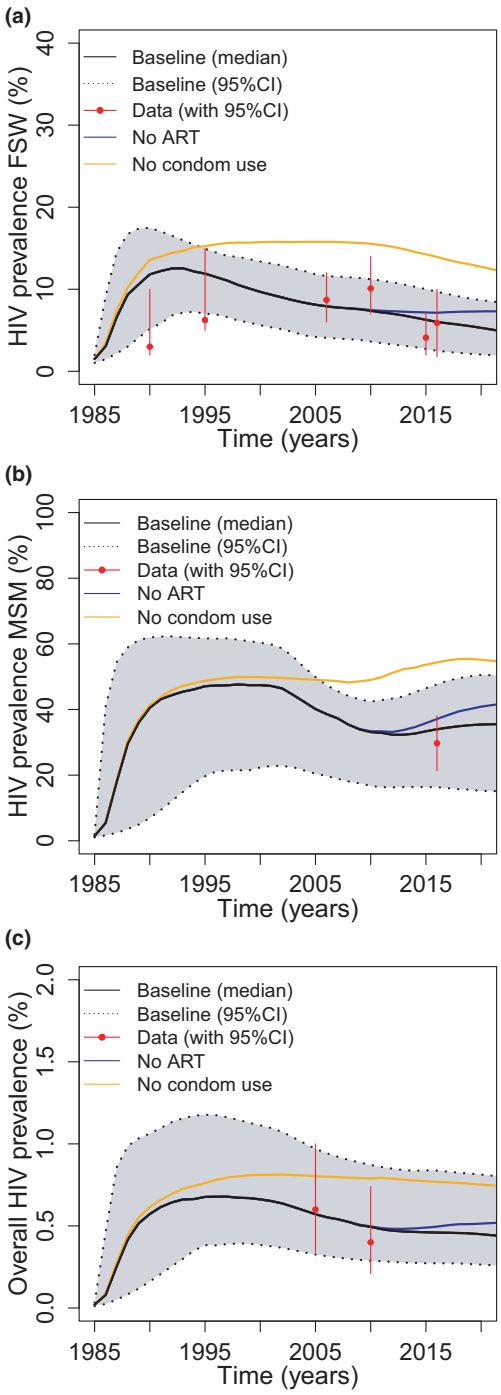

Figure 5. Projections of the impact of removing existing levels of antiretroviral therapy (ART) and condom use on HIV prevalence trends for (a) female sex workers (FSW), (b) all men who have sex with men (MSM) and (c) overall general population prevalence. Figures show baseline (median with 95% credibility intervals) trends, and median trends with no effect of ART (median-blue) or no condom use (median-orange).

to 74%. In addition, reducing their susceptibility to HIV infection could also have important benefits, with the successful introduction of PrEP among MSM possibly reducing HIV incidence by a further 30 percentage points, and an expansion of condom use having similar benefits. Such interventions, on their own and in combination with ART scale-up have been shown to be effective [46,50-53], cost-effective[54,55] and feasible among MSM, and so their expansion should not be delayed. As same-sex practices remain criminalized in Senegal, and MSM face discrimination [56], it is also important that effective stigma mitigation interventions are combined with these interventions to ensure their effectiveness [25].

Our findings suggest little impact is achieved from reducing risk or increasing ART coverage among other population subgroups, including FSW, further emphasizing the need to focus new interventions on MSM. However, this is contingent on sustained high levels of condom use and ART uptake among FSW. That is, our results do not suggest that efforts should be transferred from existing interventions to refocus on MSM interventions, but rather that additional efforts are focused on MSM. Indeed, our projections emphasize existing interventions have had considerable impact, halving HIV prevalence compared to what it could have been in 2017.

5 | STRENGTHS AND LIMITATIONS

Strengths of our analysis include the use of detailed setting-specific data from numerous bio-behavioural surveys among FSW, their clients and MSM from 1985 to 2015, as well as two general population surveys from 2005 and 2010. In addition, the inclusion of MSM in our modelling improves on previous models that have frequently ignored MSM based on assumptions of decreased relevance across Sub-Saharan Africa [57], and rarely included them in dynamic PAF estimates [9,58]. Lastly, another key strength in our analyses is the accuracy of our model projections compared to data that were not fitted, which included two-thirds of available HIV prevalence estimates.

Despite using best available data, this model has several limitations. It did not incorporate any commercial sex among MSM due to limited data. Fortunately, including commercial sex among MSM would not have changed our general results since the HIV infections would still be attributed to same-sex practices. The model also did not explicitly include TGW because of insufficient data to do so. However, the 2016 MSM survey used to parameterize and calibrate the model included some TGW, as did the MSM size estimation data used by the model, and so their contribution was captured to an extent by the model. Moving forward, these analyses and associated bio-behavioural surveys need to better assess gender identity to enable a better assessment of their role in HIV transmission. The modelling was also limited by uncertainty in many model parameters. In addition, differences in the condom use and behavioural measures used by studies made it hard to evaluate temporal changes in risk. To account for these uncertainties, we associated wide ranges to all uncertain parameters and trends in condom use and risk behaviours, and used Bayesian fitting methods to account for and constrain this uncertainty through calibrating to HIV prevalence data. Importantly, our findings were robust to this uncertainty.

Another limitation of our analysis was the relative simplicity of the model with respect to HIV natural history, the portrayal of ART and heterogeneity in sexual behaviours among each sub-population. Although greater detail has been included in other models, there is no consensus on the appropriate level

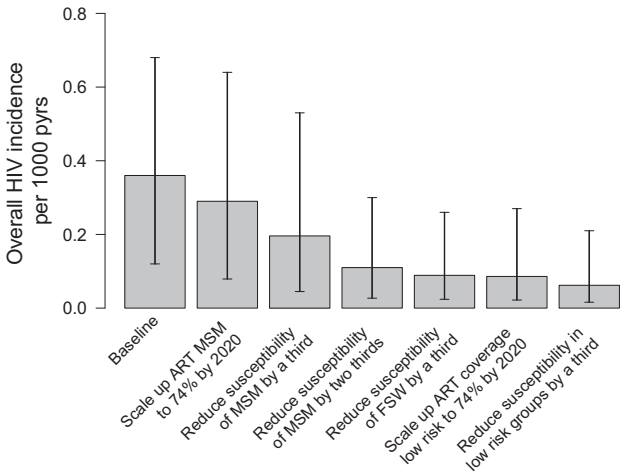

Figure 6. Effect of changes in antiretroviral therapy (ART) coverage or susceptibility to infection (due to pre-exposure prophylaxis (PrEP) or increases in condom use) from 2017 to 2030 on overall projected HIV incidence per 1000-person years in 2030. The plots show median and 95% credibility intervals of the projections. Scenarios included are additive on top of the previous scenarios from left to right, firstly including baseline projections, then projections with scale-up of ART coverage in men who have sex with men (MSM) from 2017 such that 74% of MSM living with HIV are virally suppressed by 2020 (same as female sex workers (FSW)), reduce susceptibility of MSM by 33% and then 66% (similar to increase condom use or PrEP coverage in MSM), reducing susceptibility of FSW by 33%, scale-up ART coverage in low risk such that 74% are virally suppressed by 2020 and reduce susceptibility of low-risk groups by 33%.

of complexity for specific models. One specific simplification is not stratifying MSM by whether they normally have insertive or receptive anal sex. This was done to avoid overly complicating the model, which should not have affected our results because they have the same sexual behaviour with females; the main indirect mechanism for MSM contributing to overall HIV transmission.

Lastly, the model only considered Dakar. Although this limits the generalizability of the findings, it does increase the likely precision of the modelling because we did not make generalizing assumptions to produce an average portrayal of the Senegal epidemic. Despite the limited scope of the analysis, it is still likely that the results are relevant to the whole of Senegal because the HIV prevalence in MSM is generally high and increasing, while it is lower and decreasing among FSW. In addition, our analyses are also likely relevant to other West African settings with growing epidemics in MSM, similar or lower HIV prevalence in FSW [3,4], and similar reporting of heterosexual sex among MSM [59–61].

6 | CONCLUSION AND IMPLICATIONS

Previous analyses have shown a large role for commercial sex in some sub-Saharan HIV epidemics [10-14], but this is the first to suggest that MSM, including individuals who identify as cis-male and TGW, could also be having an important role in some lower- and middle-income country settings, where other analyses have suggested a small role [14,15,62]. This is likely due to the different behavioural and epidemiological situation among MSM in Dakar compared to these other settings. Although existing interventions have been successful in reducing HIV transmission, including early increases in condom use and recent scale-up of ART among FSW, public health efforts are now needed to address the ongoing unmet need among MSM. This unmet need is resulting in MSM in Senegal and other settings in SSA experiencing uncontrolled HIV epidemics with high prevalence [57], which is driving HIV transmission in this setting and could be elsewhere. Scaling up prevention and treatment interventions for MSM should now be a high priority, with these initiatives needing to be sensitive to the legal context, and associated stigmas or discrimination that MSM experience. Without this policy shift, the HIV epidemics among MSM in Senegal and elsewhere in SSA are unlikely to decrease.

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COMPETING INTERESTS

The authors have no competing interests.

AUTHORS' CONTRIBUTIONS

PV, MCB, SB, SM and SS conceptualized the study. CM performed the model analyses and wrote the first draft of the manuscript with PV. CM and LD developed the model and reviewed the literature for data sources for the model, helped by the Senegal and JHU team. PV supervised the model analyses. SB, SS, DD, CL, BL, NLD, FD, KC, RSMM, ST, PAND, CT and CN collected or contributed data for the modelling. JW and LD undertook data analyses for parameterizing and calibrating the model. All authors contributed to data interpretation, writing the manuscript and approved the final version.

ACKNOWLEDGEMENTS

FUNDING

This publication resulted in part from research funded by a supplement to the Johns Hopkins University Center for AIDS Research, an NIH-funded programme (P30AI094189) with support specifically from the Office of AIDS Research (OAR). The programme also received support from Linkages across the Continuum of HIV Services for Key Populations Affected by HIV project (LINKAGES, Cooperative Agreement AID-OAA-A-14-00,045) and the parent study HIV Prevention 2.0 (HP2): Achieving an AIDS-Free Generation in Senegal (AID-OAA-A-13-00,089). The supplement, LINKAGES and HP2 received support from the United States Agency for International Development (USAID) and the U.S. President's Emergency Plan for AIDS Relief (PEPFAR). PV also acknowledges support from the National Institute of Health Research Health Protection Research Unit in the Evaluation of Interventions. SM is supported by a Canadian Institutes of Health and Ontario HIV Treatment Network Research New Investigator Award. The content is solely the responsibility of the authors and does not necessarily represent the official views of any of the funding agencies.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Data S1. Supplementary materials.

Table S1. Details of surveys used to parameterise and calibrate the model for different risk groups in Dakar

Table S2. (a) Demographic, sexual and behavioural parameters of female sex workers, clients, MSM and low risk populations. **(b)** HIV epidemiological parameters

Figure S1. Modelled condom use trends for female sex workers (FSW) and men who have sex with men (MSM). **(a)** FSW condom use with commercial partners for vaginal intercourse. Assume condom use for anal intercourse (AI) is half that of vaginal intercourse (VI) for all the years. **(b)** FSW condom use with main partners for VI. Condom use for anal intercourse (AI) with main partners is assumed to be 0.6 to 1.0 times that for VI. FSW condom use with casual partners for VI is 1 to 1.5 times that for main partners VI; AI with casual partners is 0.6 to 1.0 times that for VI with casual partners. **(c)** MSM condom use with male regular and casual partners. Assume some bias in reporting so all rates are multiplied by a bias factor of 0.7 to 1.0 – lower bound of 0.7 chosen to give overall lower bound of 0.5. **(d)** MSM condom use with female main and casual partners. Condom use is assumed to be the same for VI and AI.

Figure S2. ART coverage in Senegal from 2000 from UNAIDS AIDS info[44] and World Bank[43]

Figure S3. Analysis of covariance results of parameters that contribute more than 4% variability to the 2015 **(a)** 10-year commercial sex PAF and **(b)** 10-year MSM PAF.

Lillie TA et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25125
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25125/full | https://doi.org/10.1002/jia2.25125

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

COMMENTARY

Think global, act local: the experience of Global Fund and PEPFAR joint cascade assessments to harmonize and strengthen key population HIV programmes in eight countries

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Abstract

Introduction: The Global Fund and the US President's Emergency Plan for AIDS Relief (PEPFAR) are major donors to HIV services with key populations (KPs) to achieve the UNAIDS 95-95-95 epidemic control goals. The programmes they fund are not always well aligned or coordinated, decreasing their effectiveness. Joint assessments are designed and led by LINKAGES, a project funded by PEPFAR and the US Agency for International Development, to improve coordination among donors and on-the-ground implementation of KP HIV programmes. Joint assessments help identify barriers that prevent KPs from accessing interventions along the cascade of prevention, diagnosis and treatment services, and provide recommendations to improve and align programmes. Detailed reports from eight assessments in Malawi, Cameroon, Swaziland, Haiti, Angola, Nepal, Côte d'Ivoire and Botswana were analysed for thematic challenges, and recommendations are presented. The purpose of the paper is to identify commonalities across KP HIV programmes that were found through the assessments so others can learn and then strengthen their programmes to become more effective.

Discussion: The joint cascade assessments offered countries feedback on HIV programme challenges and recommendations for strengthening them at national, subnational and local levels. Shared intervention areas included: (1) robust population size estimates to inform service delivery targets and to budget resources for KP outreach; (2) accessible and KP-friendly services most relevant to individuals to increase retention in the HIV cascade; (3) decentralized, community-based services for HIV testing and antiretroviral therapy, and new approaches including self-testing and PrEP; (4) addressing structural issues of stigma, discrimination and violence against KPs to create a more enabling environment; and (5) more effective and continual tracking of KPs across the cascade, and coordinated, harmonized monitoring tools and reporting systems between donor-funded and national programmes.

Conclusions: The assessment teams and country stakeholders viewed the assessments as a best practice for coordinating donor-funded programmes that may overlap or inefficiently serve KPs. Global and national HIV programmes need investments of time, resources, and commitment from stakeholders to continually course-correct to align and improve programmes for sustained impact. The type of continued partnership demonstrated by the joint assessments is key to address HIV among KPs globally.

Keywords: HIV; key populations; assessment; donors; collaboration

Received 11 December 2017; **Accepted** 16 May 2018

1 | INTRODUCTION

In all countries affected by the HIV epidemic, key populations (KPs) – including sex workers, men who have sex with men (MSM), people who inject drugs, transgender people, and people in prisons and other closed settings – bear a disproportionate burden of HIV infection [1-5] and face formidable barriers to accessing services for HIV prevention, diagnosis, treatment and care. These barriers include stigma and discrimination, restrictive laws, violence and human-rights violations [6]. Many KP HIV programmes have insufficient scale, scope and quality to overcome these barriers. KPs are a high priority in efforts to prevent new HIV infections and achieve the ambitious UNAIDS 95-95-95 treatment goals by 2030 [7]. The Global Fund to Fight AIDS, Tuberculosis and Malaria (GF) and the US President's Emergency Plan for AIDS Relief (PEPFAR) are working to improve KP programmes based on World Health Organization (WHO) general and KP-specific guidelines and are the largest funders of KP HIV services in many low- and middle-income countries [8-14].

To help improve in-country implementation responses, GF and PEPFAR have conducted joint KP HIV cascade assessments with teams of international donors and implementers, national governments and ministries of health, local implementing partners and representatives from KP groups. These assessments focus on aligning geographical areas, technical

approaches, service packages, referral networks, targets and monitoring systems. Joint assessments can help address many of the complex challenges that arise during implementation and coordination of multiple KP programmes within a country. They also provide an opportunity to address on-the-ground challenges and advocate for delivery of HIV services to KPs at scale.

The joint assessments are designed and led by *Linkages across the Continuum of HIV Services for Key Populations Affected by HIV* (LINKAGES), a project funded by PEPFAR and the US Agency for International Development (USAID). LINKAGES has worked in over 30 countries to accelerate the ability of partner governments, civil society organizations, and private sector healthcare service providers to plan, deliver and optimize a package of comprehensive services, at scale, for HIV prevention, diagnosis, treatment and viral suppression for KPs. In most of these countries, GF also has active grants for KP HIV programmes.

LINKAGES has adopted the "cascade" of HIV services, a framework to track the movement of individuals across the continuum of care provided by community and health services. Country programmes supported by LINKAGES are monitoring their programmes using the cascade, based on WHO consolidated guidance [8]. The framework views service delivery as going beyond traditional HIV services to include crosscutting topics such as sexual and reproductive health and critical enablers (e.g. laws, policies, community empowerment, and violence prevention and response) [8-14].

1.1 | IMPLEMENTING JOINT CASCADE ASSESSMENTS FOR KEY POPULATIONS

The broad goals of joint KP cascade assessments are to: (1) determine the extent to which the services cascade is working for KPs by understanding the service flow and strategies within a project area, including services delivered by nongovernmental organizations (NGOs), community-based organizations (CBOs) and clinics, government sites and other facilities, and hybrid models; (2) identify and analyse the causes of "leaks" in the system, where KPs are lost to follow-up or are unable to access essential commodities and services, and recommend solutions that can be replicated and scaled up; and (3) identify possibilities for linking and aligning the monitoring systems of different providers at unique stages of the cascade.

This joint cascade assessment method is not intended to be a research activity generalizable across a country, nor a data audit or data validation tool. It is a rapid, stocktaking exercise using a convenience sample of KP HIV programmes within the country that feeds practical recommendations directly back into programmes and decision makers for immediate action and quality improvement. Community and clinical sites (i.e. both donor-supported and public health facilities) are selected based on where US Government agencies implementing PEPFAR (i.e. the US Centers for Disease Control and Prevention and USAID) and GF are funding KP programmes, logistical ease and time constraints. Splitting the assessment team into smaller sub-teams allows for multiple geographic locations and sites to be visited and reviewed at the same time. The assessment provides a solid basis for local implementers and national-level programmes to advocate for the adoption of best practices and innovations with government and donors. Assessments are a consensus-building process among multiple stakeholders, whereby they may agree on common approaches to harmonize technical and monitoring and evaluation (M&E) strategies, leading to programmatic and budget efficiencies.

Between February 2016 and September 2017, eight joint cascade assessments were conducted in Malawi, Cameroon, Swaziland, Haiti, Angola, Nepal, Côte d'Ivoire and Botswana. For this commentary, we reviewed and analysed all out-brief presentations and full reports to identify commonalities observed in at least three countries. Common themes in challenges and recommendations at programme, national and donor levels, at each step in the cascade of services are highlighted. Findings were shared with representatives from in-country implementation teams for validation. While the presentations focused on strengths as well as challenges, here we present and discuss the challenges and recommendations that were common to at least three countries.

The purpose of the paper is to identify commonalities across several KP HIV programmes that were found through the assessments so others can learn and then strengthen their programmes to become more effective.

2 | DISCUSSION

The KP HIV cascade assessments were the first formal exercises that built cross-cooperation for KP programming among these major donors and stakeholders in the countries where they were conducted. The assessments were meant to develop a shared vision through a collaborative and participatory appraisal of the national KP programme, as implemented through local partners.

The assessment teams categorized challenges and recommendations using the HIV cascade framework: reach, HIV testing services, linkages to treatment, treatment, retention and viral suppression, monitoring and crosscutting issues (Table 1). The findings are summarized below.

2.1 | Reaching KPs

Having strategies for outreach to KPs that are founded on trust and confidentiality is an important first step for HIV programmes. LINKAGES recommends a peer outreach worker (POW) to peer contact ratio of 1:50 for female sex workers (FSW) and 1:30 for MSM to provide frequent, high-quality, individualized services based on international guidance [9-12,15,16]. In most assessments, it was found that there were too few POWs to adequately cover KPs in known hot spots, leading to irregular or poor levels of contact with KPs. Microplanning is based on the results of the hot spot mapping and size estimations, which provide a basis for planning and implementation, such as where drop-in centres and testing sites should be located, how many POWs are needed, and where/how to focus resources and services based on population numbers [15,16]. Microplanning emphasizes individualized risk assessments to better target and provide services based on need. Another challenge identified was the lack of formal strategies for contacting harder-to-reach sub-populations, such as MSM who do not gather at physical hot spots, but instead go online or use virtual networks.

Table 1. Primary challenges identified, and recommendations of joint cascade assessment teams

Stage of cascade	Challenges	Recommendations – programme level	Recommendations – national level	Recommendations – donor level
Identify KPs	Unreliable KP size estimates (S, A, CI, B) Targets set by donors not based on local-level mapping and size estimation (S, H, CI, B)	Validate hot spot mapping (S, H, A) Regular revalidation of KP numbers at hot spots (N, CI, B)	Develop a system to determine national-level estimates for KPs (M, A, CI, B)	Develop a system to determine national-level estimates for KPs (M, A, CI, B)
Reach KPs	Insufficient number of peer outreach workers (i.e. KP individuals trained to do outreach) (Ca, A, N, CI, B) Lack of strategy for outreach to KP individuals who do not frequent physical hot spots (A, CI, B) Stock outs of condoms, limited availability of some commodities, e.g. female condoms, lubricants (S, H, A, N, CI, B)	Expand number of peer outreach workers (Ca, A, CI, B) Improve supervision and introduce microplanning (i.e. outreach and support plans based on the mapping/size estimation, and individual KP members' risk assessment and needs) (Ca, S, H, A, N, CI, B) Systematize risk assessments and follow-up, to identify harder-to-reach KPs (H, N, CI, B) Develop online outreach strategy (Ca, A, CI, B) Improve understanding among KPs of post-exposure prophylaxis, treatment literary, viral load ("undetectable = untransmittable"), and violence reporting and response during outreach sessions (Ca, S, H, A, N, CI, B)	Establish or apply national standard for ratio of peer outreach workers to KPs (Ca, H, CI, B) Update national package of services to standardize and align with WHO KP guidelines, including PrEP (S, H, A, CI, B) Expand and integrate KP issues into national STI guidelines based on WHO guidelines (Ca, A, B) Ensure adequate stock of STI drugs, condoms/ lubricants, STI & HIV test kits, reagents and ARVs (Ca, S, A, N, CI, B)	Streamline and harmonize outreach package to include targets, geographical coverage areas, curricula, educational materials, peer outreach worker scope of work and incentives, and the package of services for KPs (M, Ca, S, H, N, CI, B)
KPs know status (test/retest)	Difficulty in accessing testing (Ca, N, B) Low HIV case-finding rates (A, N, CI) Referrals to public facilities not always completed (Ca, A, CI, B)	Promote testing through improved messaging in all client communications (Ca, A, N) Provide multiple avenues for testing (e.g. community-based, lay provider testing) (M, Ca, S, H, N, CI, B) Explore new approaches (self-testing, lay-administered oral fluid/finger-prick tests) (Ca, S, A, N, CI, B) Integrate HIV testing with STI screening (Ca, H, A, B) Encourage partner testing for KP individuals living with HIV (A, N, CI, B) Use microplanning to regularize contact with KP individuals and remind them to be tested. Conduct individualized risk assessments to refine messaging based on KP individuals' needs (Ca, S, H, N, CI, B) Offer PrEP (Ca, CI, B)	Ensure multiple avenues for testing are available (mobile, fixed sites, community-based, lay provider testing) (M, Ca, S, H, N, CI, B) Explore new approaches (self-testing, lay-administered oral fluid/finger-prick tests) (Ca, S, N, CI, B)	

Table 1. (*Continued*)

Stage of cascade	Challenges	Recommendations – programme level	Recommendations – national level	Recommendations – donor level
Enrol KPs living with HIV in care, initiate ART	Complexity, time and expense of enrolment procedures (Ca, H, A, N) KP individuals' denial about HIV diagnosis (A, N, CI, B) Insufficient number of peer navigators (i.e. trained KP individuals living with HIV who provide support for ART enrolment and adherence) (Ca, S, A)	Offer peer navigators to accompany KPs for ART enrolment, boost treatment literacy and support ART adherence (M, Ca, S, H, A, N, CI, B) Institute or strengthen "test and treat" to speed up initiation of ART (M, Ca, S, A, N, CI, B) Offer community-based ART (M, Ca, S, H, A, N, CI, B) Offer psychosocial support (counselling) for the newly diagnosed (Ca, A, B) Formalize relationship between KP programmes and HIV clinics (Ca, S, A)	Increase and diversify the number of ART sites to make it easier for KP individuals living with HIV to initiate and stay on treatment (Ca, S, N, CI) Dispense multi-month antiretroviral (ARV) prescriptions and ensure supply for stable clients (A, N, CI, B)	Provide additional technical assistance and guidance documents on "test and treat" to providers (M, Ca, S, H, A, N, CI, B)
Sustain on ART, suppress viral load	Need for monthly visits to fill ARV prescription (Ca, A, CI) Need for nutritional support (Ca, H, A, N) Mobility of KPs increases loss to follow-up (S, N, CI, B) Delay in receiving viral load testing results; testing not always done reliably or recorded in patient records (H, N, CI) Lack of KP understanding that "undetectable= untransmittable" (S, A, N, CI, B)	Offer three-month ARV prescriptions (Ca, A, N, CI, B) Reinforce treatment literacy programmes (Ca, S, H, A, N, CI, B) Establish systems to send appointment reminders, follow up on missed appointments (Ca, N, B) Decentralize viral load testing (H, N, CI) Offer nutritional support for those starting ART (Ca, S, H, N, A)	Explore use of GenXpert machines for viral load testing at point of service (A, N, CI, B)	
Programme monitoring and data use	Lack of coordination between implementing partners and between donors in data collection tools, indicators, and programme databases (Ca, S, H, A, N, CI, B) Duplication of KP individuals when recording services delivered (Ca, H, A, N, CI, B) Data not secure, confidential, or backed up (Ca, N, B) Data reported up without analysis for programme improvement at local level (M, N, CI, B)	Introduce/strengthen UICs (M, Ca, S, H, A, N, CI, B) Design coordinated computerized management information systems (H, N, B) Develop protocols for data security within computerized systems (passwords, back-ups) and in paper copies (locked filing cabinets), and code of confidentiality for staff, including KP individuals involved in outreach (Ca, H, A, N, B) Provide training on data analysis and use for real-time decision making and programme improvement (M, Ca, A)	Harmonize data collection forms and indicators at national level (M, H, A, CI)	Improve coordination and alignment between implementing partners, public health facilities and donors, in data collection tools, tracking systems (UICs), indicators and programme databases (Ca, S, H, A, N, CI, B) Support development of M&E systems at programme level with harmonized indicators; UICs across cascade of services; electronic systems; ensure programme-level systems are compatible with national M&E system (M, Ca, S, H, A, N, CI, B) Create communities of practice by increasing technical exchanges between implementing partners through a national-level technical working group or other fora (e.g. GF Country Coordinating Mechanism) (M, A, CI)

Lillie TA et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25125
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25125/full | https://doi.org/10.1002/jia2.25125

Table 1. (*Continued*)

Stage of cascade	Challenges	Recommendations – programme level	Recommendations – national level	Recommendations – donor level
Stigma, discrimination, and violence	Widespread stigma, discrimination by multiple power holders (M, Ca, S, H, A, N, CI, B) Frequent violence (M, Ca, S, A, N, B) Discrimination within KP communities (M, A, CI, B) Poor reporting and follow-up to violence (A, CI, B) Limited access to PEP (Ca, H, A, CI, B)	Training and sensitization, especially of police and health care providers (M, Ca, S, H, A, N, CI, B) Increase knowledge and use of PEP (Ca, H, A, CI, B) Training of KPs on their legal and civil rights (H, A, N, CI, B) Systems to track and report stigma, discrimination, and violence (M, Ca, A, N, CI) Community-based violence response systems (M, S, H, A, N)		
Community empowerment and engagement	Low motivation/high turnover of peer outreach workers (H, N, CI, B)	Establish/expand drop-in centres (H, CI, B) Train peer outreach workers and navigators, develop systems for peer progression and recognition (H, N, CI, B)		Align incentives for peer outreach workers between programmes (H, CI, B)

M, Malawi; Ca, Cameroon; S, Swaziland; H, Haiti; A, Angola; N, Nepal; CI, Côte d'Ivoire; B, Botswana.

Recommendations to address these challenges included recruiting and training more POWs to improve outreach ratios. Improving microplanning was recommended in most countries to ensure that KPs were covered by a standardized package of services that also addressed their individual needs. Offering post- and pre-exposure prophylaxis (PEP and PrEP) was also recommended for inclusion in the standard package of services, as these services have been shown to increase demand for services [10,11,17,18]. Programmes were encouraged to develop strategies for hard-to-reach populations, including Internet/virtual outreach, and enhanced peer outreach approaches that incentivize recruitment through social networks, which have been found to increase demand for HIV testing and other services [19-22].

2.2 | KPs know their HIV status

There were three major challenges in reaching the first 95 goal: (1) lack of accessible KP-friendly testing services; (2) lower case-finding rates than expected targets (i.e. low rates of positive HIV test results) because of saturation within existing networks and difficulties identifying and engaging KP individuals at highest risk; and (3) HIV testing referrals made in the community frequently not being completed or properly tracked.

A common recommendation was to increase HIV testing modalities to make them more accessible by expanding community-based testing, training more lay workers to conduct testing and increasing the number of testing options through drop-in centres and mobile clinics [23,24]. The use of new approaches, such as lay-provider HIV testing using finger-prick or oral-fluid tests or making self-test kits available to KPs, was recommended based on global guidance [25,26]. If community-based or self-testing were not available, it was recommended to train and support POWs and peer navigators (i.e. trained KP individuals, themselves often living with HIV (KPLHIV), who provide support for antiretroviral therapy (ART) adherence) to offer accompanied referrals from community programs to health facilities to ensure services are linked [23,24,27]. To address low case finding, strategies such as enhanced (network- and performance-based) peer outreach and using data to better target those at higher risk were proposed to reach and test KP individuals who had not been previously been identified [28-31]. Programmes also were encouraged to increase index partner testing of KPLHIV of sexual and injection contacts to improve HIV case finding [28,32,33].

2.3 | KPs living with HIV are enrolled in treatment

All countries reported having too few trained KP individuals to support referrals and linkages from testing to treatment, especially by accompanying KPLHIV to the treatment facility. Significant barriers to treatment initiation found in the assessments and literature included stigma and discrimination, internalized stigma, poor nutrition and substance abuse, along with lack of understanding of the full benefits of treatment, not only for the KPLHIV, but also as prevention for their partners [34-36]. Another challenge commonly identified was the time to initiate ART after being newly diagnosed. The inconvenience and cost of travel to ART clinics and the high fees

sometimes charged for appointments and tests were related barriers.

To improve ART initiation rates, the assessment teams and global experts recommended that programs provide community-based support for ART initiation [23,37]. Further recommendations were for accompanied referrals to ART clinics whose staff have been formally sensitized and trained to work with KPLHIV, and support groups for KPLHIV. Treatment literacy education by POWs and those who provide testing was also stressed, so that KP individuals would understand the importance of treatment should they test positive and be supportive of their peers living with HIV [38]. All assessments and global guidance recommended implementing or scaling up "test and treat" programmes that offer *immediate* ART initiation, and decentralizing distribution of antiretroviral drugs (ARVs) to stable patients, for example dispensing to stable patients by community-based POWs or peer navigators and at drop-in centres [37].

2.4 | KP individuals living with HIV are sustained on ART and have suppressed viral load

The limited dosages of ARVs dispensed, typically enough for only one month, even for stable patients, were a serious challenge to retention. Inflexible appointment schedules and long waiting times at clinics made it hard for KP individuals to adhere to monthly appointments. Sometimes multi-month prescriptions were provided, but limited supply meant that pharmacies would dispense only one or two months' worth of antiretrovirals (ARVs) Nutritional support was also noted as a challenge, especially for those initiating ART who needed access to regular meals to help them tolerate the new drugs. In some sites, laboratory results on viral load could take up to a month to be communicated to providers, who sometimes did not use them for clinical monitoring. KP individuals in most countries did not understand that a sustained undetectable viral-load status meant that they would have virtually no risk of transmitting HIV to a sexual partner.

Recommendations to counter these challenges included community-based ART distribution following WHO's differentiated models of care [37] through various channels, and three-month ART prescriptions for KP individuals who were stable in their treatment. In almost all the assessments, it was recommended that treatment literacy programmes help clients understand the importance of a suppressed viral load and thus adherence to their medication [38] through new communication messages and campaigns tailored for this purpose. Appointment reminders via text messaging and systems to track missed appointments were also recommended.

2.5 | Programme monitoring and data use

It was a common challenge that programme targets were set using dated or unreliable KP size estimations, which resulted in the perception that programmes were either under- or overachieving based on poor denominators. It was recommended that some programmes conduct and validate mapping and size estimation to plan implementation in their assigned geographical areas [15,16]. A concurrent, robust mechanism to determine national- and sub-national level KP estimates are necessary to accurately plan and implement programmes, streamline activities and reduce service duplication. Countries should follow WHO guidelines to estimate KP population size [20,39].

A significant challenge for data collection and monitoring included the use of differing forms and systems across implementing partners, and a lack of alignment between the data required for reporting on programmes to the government (e.g. for clinical services) and those needed for reporting programme indicators to GF and PEPFAR. Government forms often did not allow for collection of data on peer-led outreach, and data were often not disaggregated for KPs. Information was not routinely shared between implementing partners. This could lead to data duplication on individuals receiving services, making it difficult to generate reliable data on the performance of partners across the cascade [40]. Clients sometimes used more than one identity or identifying feature, and this too could cause duplication of individuals in recording systems. The lack of unique identifier codes (UICs), or the existence of multiple UICs among different providers, also contributed to this problem.

Half of the assessments found that data were often not analysed routinely to guide programme implementation, due to high workloads and an inability to process data and generate usable insights from them. Data security was also a challenge, with data not consistently kept secure on computers or in hard copy, or not backed up.

Teams recommended coordination of data reporting systems through regular meetings of stakeholders at the national level, and technical working groups to design reporting systems to harmonize data collection needs, standardise tools, and reduce duplication of KP records. Policies and procedures on data security and confidentiality were also recommended. Adoption or expansion of UICs was discussed with all countries to ensure that individual KP members could be tracked across the cascade of services, and to avoid double-counting individuals who received services at different times or locations, or from different funders [41].

2.6 | Stigma, discrimination and violence

In all countries, programmes reported that KPs were subject to stigmatization and discrimination from multiple sources, including law enforcement, health care providers, family members, and members of the wider community, as well as within KP communities themselves. Members of any of these groups, plus clients of sex workers, were sometimes perpetrators of violence. Violence, stigma and discrimination deterred KP individuals from seeking services and increased their vulnerability to HIV and other sexually transmitted infections (STIs) [42,43]. KPs suffered from lack of police protection, weak enforcement of anti-discrimination laws where these existed, and lack of awareness of their rights. Cases of violence frequently went unreported to the authorities or were not properly recorded, making it hard to advocate for resources or systemic efforts to reduce violence. There was also limited access to PEP for KP individuals who suffered sexual assault, often because its availability was not promoted or understood.

Recommendations for all countries included building on existing relationships with police and healthcare workers to offer sensitization on violence, stigma, discrimination and the rights of KPs to access HIV and other services. Work was also

recommended with KP groups to better understand their rights as citizens, and to learn not to consider violence as normal or inevitable. Community-based violence response systems using best practices were proposed [44,45].

2.7 | Community empowerment and engagement

The assessments recommended that drop-in centres and other safe spaces should be established to provide KP communities a place to gather and to build a sense of community. The systematic engagement of community advisory boards in the KP programmes was another recommendation to strengthen a KP-led response. POWs and navigators are key parts of the HIV programme, and in countries where there was high turnover, burnout, or poor motivation, it was recommended to boost training and supportive supervision, consider the selective use of incentives, and develop opportunities for progression to roles of increasing responsibility within CBOs and NGOs [8-12].

3 | SUMMARY

The joint cascade assessments offered countries candid feedback on the challenges of their HIV programmes and recommendations for ways to strengthen them at national and local levels. Areas highlighted included: (1) the need for robust population size estimates to inform targets and assign resources for outreach, such as an adequate number of POWs and other staff to provide necessary levels of prevention, testing and ART adherence support; (2) the usefulness of microplanning to provide accessible and KP-friendly services most relevant to individuals and to increase retention in the prevention and clinical cascade; (3) the importance of decentralized, community-based services for HIV testing and ART, and of introducing new approaches such as self-testing and PrEP; (4) the need to address the structural issues of stigma, discrimination, and violence against KPs to create a more enabling environment; and (5) the need for more effective and continual tracking of KPs across the cascade of services, and for monitoring tools and reporting systems to be coordinated between donor-funded and national programs.

4 | LIMITATIONS

The assessments have several limitations, including the lack of generalizability both within and among countries and their focus on only some of the WHO-defined KP groups. The cascade assessments are not generalizable within the country where they were conducted, since they are meant to be a quick stocktaking exercise of existing KP service delivery sites chosen by convenience sampling. Since the KP implementers selected sites where they were operating programmes, it may be that services there were more KP friendly than in areas where these implementers were not active, although in planning the assessments, both higher and lower performing sites were targeted. In addition, the cascade assessments were conducted predominantly in Africa, and their findings and conclusions are thus skewed to that geographical context where programmes may be more nascent than in other regions.

The assessments were conducted over a six- to ten-day period, often with three days devoted to site visits outside of the capital city, and teams often covered multiple types of KP programmes. The combination of the short duration of the assessments and visiting multiple KP programmes resulted in higher level, rather than specific, observations. The assessments were not designed to provide combined cascade estimates but did review programme data and data systems to align data collection methods and plan for joint analyses. Donors and ministries of health often chose which KPs would be the focus of the assessments, which resulted in people who inject drugs being underrepresented and no prisoners being included. None of the programmes in Africa had dedicated programming for transgender populations, but following the assessments, several programmes introduced disaggregated monitoring of transgender populations separate from MSM data [11,46]. No follow-up assessments in the countries have been conducted to date, which makes systematic review of progress challenging. Follow-up assessments were recommended to continue to monitor and develop KP programs.

5 | CONCLUSION

In recent years, international donors and national governments have allocated additional resources to KP programmes to address the higher level of HIV incidence and prevalence among KPs. Reducing HIV transmission and acquisition within these populations will increase the equity and impact of broader national efforts. To ensure the impact of KP programmes, it is important to strategically invest the limited resources available. The assessment teams and country stakeholders viewed the country KP cascade assessments as an innovative model to align GF and PEPFAR in countries with shared KP investments. They may be a best practice for coordinating donor-funded programmes that may overlap or inefficiently serve KPs.

Joint assessments help initiate a consensus vision between the major donors on how to design and implement their national KP programmes. They also help garner government support for recommendations, and result in on-the-ground action when headquarters and country-level staff from both donors and government conduct the assessments together. For example, in Cameroon, the PEPFAR- and GF-funded partner signed a letter of collaboration to align geographic areas, service packages, training, monitoring tools and the use of UICs. Key recommendations from Nepal's joint cascade assessment were included in the country's National HIV Investment Plan 2016-2021, with standardization of the cascade framework across funders. Swaziland's assessment helped the national programme understand KP programming as relevant to include within the entire country HIV cascade, and the recommendations were used to harmonize and expand the emerging GF programmes.

While agreement between global and national actors empowers implementers to put recommendations into action at the local level to develop a more efficient and technically sound KP programme, cascade assessments are just one step in the right direction. Global and national HIV programmes need investment of time, resources, and commitment from stakeholders to continually course-correct, to align and improve programmes for sustained impact. The type of

continued partnership demonstrated by these joint GF and PEPFAR assessments is key.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

TL, DA and CW developed the concept for this article. TL and JB drafted and edited the manuscript. DA, JZ and CW reviewed and commented upon the manuscript at each stage of drafting.

ACKNOWLEDGEMENTS

The authors acknowledge all those who participated in the joint cascade assessments, including members of the US Government working on PEPFAR, LINKAGES and GF country programme staff and implementing partners, staff of healthcare and other facilities, ministry of health and other government representatives, and key population members, United Nations family organizations, and members of the joint cascade assessment teams and their stakeholders. US Center for Disease Prevention and Control (CDC) staff including Gaston Djomand, Christine Ross, Moses Bateganya and Ikwo Oboho also greatly contributed to the assessment key observations and recommendations. We are grateful to the individuals who commented on an early draft of this manuscript: Chris Akolo (FHI 360/LINKAGES), Gina Dallabetta (Bill & Melinda Gates Foundation), Ana Diaz (FHI 360/LINKAGES), Meghan DiCarlo (FHI 360/LINKAGES), Hally Mahler (FHI 360/LINKAGES), Laura Muzart (FHI 360/LINKAGES) Bhagawan Shrestha (FHI 360/LINKAGES), and Clint Trout (Heartland Alliance).

FUNDING

USAID, with support by PEPFAR, funded level of effort for Joint GF/PEPFAR KP HIV Cascade Assessments. The Global Fund supported the cascade assessments through staff time and logistical support (e.g. vehicles).

DISCLAIMER

The views expressed in this paper do not necessarily reflect the views of the U.S. President's Emergency Plan for AIDS Relief, the U.S. Agency for International Development or the U.S. Government.

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Ayala G et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25130
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25130/full | https://doi.org/10.1002/jia2.25130

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

Blue-Ribbon Boys: factors associated with PrEP use, ART use and undetectable viral load among gay app users across six regions of the world

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Abstract

Introduction: Gay social networking apps have grown in popularity among men who have sex with men offering opportunities for rapid and confidential collection of vital data as well as social connection. The goal of our study was to explore factors associated with utilization of pre-exposure prophylaxis (PrEP) and antiretroviral treatment (ART), and self-reported undetectable viral load (UVL) using data collected by the gay social networking app Hornet.

Methods: In 2016, the Global Forum on MSM & HIV (MSMGF) partnered with Hornet, to support an educational initiative called Blue-Ribbon Boys. One aspect of the initiative prompts Hornet users to answer a short series of yes-no questions about their sexual health. Using survey responses, we evaluated factors associated with PrEP and ART use as well as self-reported UVL by fitting separate multivariable generalized estimating equation models.

Results: In total, 16,008 unique Hornet users started the survey, of which 12,126 (76%) provided sufficient data for analyses. Of the 10,774 HIV-negative men, 13% reported PrEP use in the past year. PrEP use was associated with a recent sexually transmitted infection (STI) test or treatment (aOR = 2.19, CI = 1.49 to 3.21); and taking steps to protect oneself from HIV (aOR = 1.41, CI = 1.13 to 1.76). Among HIV-positive Hornet users (n = 1243), ART use was associated with older age (each year increase aOR = 1.02, CI = 1.01 to 1.04), a recent STI test or treatment (aOR = 4.54, CI = 2.65 to 7.78); and awareness of unlikely HIV transmission with UVL (aOR = 1.53, CI = 1.03 to 2.26). UVL was associated with older age (each year increase aOR = 1.03, CI = 1.01 to 1.04), a recent STI test or treatment (aOR = 4.84, CI = 2.74 to 8.55), and awareness of unlikely HIV transmission with UVL (aOR = 1.98, CI = 1.37 to 2.85).

Conclusions: Study findings underscore the importance of STI testing and treatment as well as information about HIV transmissibility for encouraging PrEP and ART use. Our findings also reveal age disparities, which can undermine incidence reduction among gay men. Gay social networking apps can be effectively used for rapid data collection and sexual health promotion with men who have sex with men. STI testing and treatment programmes offer important opportunities for encouraging PrEP and ART use. Information about HIV transmissibility with consistent ART use should be incorporated into prevention messaging tailored to various age groups.

Keywords: HIV; gay men; men who have sex with men; sexual health; HIV services; ART; HIV viral load; gay social network apps

Received 19 December 2017; **Accepted** 17 May 2018

1 | INTRODUCTION

HIV prevalence among gay and bisexual men and other men who have sex with men is well over 10% worldwide, higher than general population prevalence in many countries [1]. In low- and middle-income countries, men who have sex with men are 19 times more likely to be living with HIV compared with people in the general population and represent more than 12% of all new infections each year [2]. Although decreases in HIV incidence are well documented, prevalence and incidence are consistently higher among men who have sex with men when compared with other groups [3-6].

Homophobia can limit the provision and uptake of evidence-informed and rights-based HIV prevention, treatment and care services [7-10]. Criminalization of homosexuality encourages human rights abuses, violence, discrimination and stigma, which contribute to health disparities for men who have sex with men [11-13]. Social connectedness with the gay community has been shown to have a protective effect against the often-devastating effects of homophobia [14-18]. In policy environments that are hostile to lesbian, gay, bisexual and

transgender people, men who have sex with men must find creative and discrete ways to find each other for support and health information.

It is therefore not surprising that the use of gay social networking applications has grown in popularity among men who have sex with men, offering opportunities for social and sexual connection. The internet provides benefits to gay and bisexual men who are marginalized or otherwise excluded from mainstream society by providing a safe space and by alleviating social isolation that may result from societal homophobia [19-21]. Social networking applications are an innovative tool for safely reaching marginalized groups like men who have sex with men, especially with expanding accessibility of smart phone technology. They also provide a rapid and confidential means for collecting vital data about the HIV services cascade in hostile country contexts.

In 2016, the Global Forum on MSM & HIV (MSMGF) entered into an innovative public-private partnership with the geospatial gay social networking application Hornet, to create and launch Blue-Ribbon Boys. Blue-Ribbon Boys is a global initiative to educate, empower, and mobilize gay and bisexual men around sexual health. The initiative makes information about HIV pre-exposure prophylaxis (PrEP), testing, and treatment easily available to both HIV-negative and HIV-positive Hornet users in select markets. With 9 million users worldwide at the time it launched Blue-Ribbon Boys, Hornet was the leading gay social networking app in Brazil, Egypt, Mexico, the Philippines, Russia, Taiwan, Thailand and Turkey. At present, Hornet has 25 million users. The overall goal of Blue-Ribbon Boys was to create robust demand for unobstructed access to quality sexual health services.

The goal of our study was to explore factors associated with uptake of HIV services among men who have sex with men using data collected through Hornet's Blue-Ribbon Boys initiative. Specifically, the study aimed to: (1) describe utilization of anti-retroviral medications (used prophylactically and as treatment for HIV) in a global sample of Hornet users; and (2) examine factors associated with self-reported PrEP and treatment use and viral suppression in multivariate analyses. Study findings draw attention to the important and unique role gay social apps play in collecting data, promoting sexual health and addressing barriers to HIV service utilization among men who have sex with men that could lead to improvements along the HIV services cascade. In this paper, we use the terms gay and bisexual men, and men who have sex with men interchangeably, with the understanding that sexual orientation and same-sex sexual behaviour are intricately and specifically influenced by context, culture, community affiliation, identity, gender expression and emotional connection.

2 | METHODS

2.1 | Participants and procedures

This study is based on a secondary data analysis using responses from a brief online survey that was part of the Blue-Ribbon Boys initiative, implemented by the gay social networking app, Hornet. Hornet Data collection occurred from November 2015 to April 2016, during which time Hornet users were invited to participate in a brief questionnaire regarding their sexual health. Hornet users were eligible to participate in the study if they self-identified as male, were age 18 and over, and gave their consent. All participants received a blue ribbon icon on their profile photo signifying their participation in the initiative.

This project followed a two-step consent procedure. First, Hornet users were provided the app's privacy policy as part of Hornet's terms of service. Second, Hornet users were informed that participation in the survey portion of the Blue-Ribbon Boys initiative would be voluntary and that responses would be linked with anonymized personal information contained in their user's account online profiles using a unique participant user ID. Survey takers were able to opt-out of the survey at any time, with no interruption to their app services and at no consequence to their Hornet membership. Users must have read and endorsed the privacy policy before being able to use the app and receive an invitation to participate in the survey. After endorsement of the privacy policy, Hornet users could choose to make their demographic information publicly available to other users via app filters. The privacy policy explicitly restricts use of personal demographic information provided by Hornet users for the purposes of administering app updates, providing customer services, and making available other initiatives, like surveys. In addition, Hornet users are informed that anonymized personal information could be shared in aggregate.

At the completion of the study, sexual health data collected were merged with an anonymized dataset containing study participant personal demographic and behavioural characteristics (e.g. age, relationship status, language, race/ethnicity, country of residence, preferred sexual position/role) using a unique participant user ID. Study procedures were reviewed by the University of California, San Francisco's Institutional Review Board (IRB# 18-24991, REF# 217272), which determined that the protocol was exempt under Category 4.

2.2 | Measures

Blue-Ribbon Boys utilised a short, yes-no survey, which began with the question: *Do you know your HIV status?* HIV-negative participants were then asked: *Are you taking PrEP? Have you asked your healthcare provider if PrEP is right for you? Are you taking steps to protect yourself from HIV? In the past year, have you had an test and/or received treatment for a sexually transmitted infection (STI)?* HIV-positive respondents were asked: *Are you taking anti-retroviral treatment daily? Have you achieved or maintained an undetectable viral load? Are you aware that if you are undetectable it's virtually impossible to transmit HIV? In the past year, have you had an STI test and/or treatment?* Men who indicated they did not know their HIV status were asked: *In the past year, have you had an STI test and/or received treatment? Are you taking steps to protect yourself from HIV? Do you plan to get an HIV test in the next three months? Have you researched resources for getting an HIV test?* Blue-Ribbon Boys was offered as an initiative (including its survey) in 71 countries and in languages spoken by most Hornet users across participants' country of residence, including English, Portuguese, French, Spanish, Thai and Vietnamese. Hornet's market expansion into Latin America, Southeast Asia and Western Europe influenced language offerings.

2.3 | Statistical analyses

Our primary outcomes of interest were: (1) PrEP use among HIV-negative participants; (2) antiretroviral treatment (ART)

use among HIV-positive participants; and (3) undetectable viral load (UVL) among HIV-positive participants. All outcomes of interest were dichotomized to no and yes. We evaluated demographic and behavioural factors associated with of PrEP use, ART use and UVL by fitting separate multivariable generalized estimating equations (GEE) models with a logit link function for our dichotomous outcomes that used an exchangeable correlation matrix with robust standard errors, accounting for clustering by country (n = 71) using all complete data available. Analyses were limited to observations with available data on the outcomes of interest. For model building, the demographic and behavioural characteristics were informed by hypothesized predictors of our outcomes a priori. Associations were considered statistically significant using an α cut-off of 0.05. All statistical analyses were conducted using STATA version 13.1 (College Station, TX, USA).

3 | RESULTS

3.1 | Participant characteristics

In total, 16,008 unique Hornet users started the survey, of which 12,126 (76%) provided sufficient data for analyses. The median age of participants was 25 (IQR = 21 to 30). The study sample was comprised of individuals who identify as Asian (29%), White (20%), Latino/Hispanic (7%) and Black (5%). Thirty-four percent of participants did not report their race/ethnicity and 2% indicated "other." More than half of study participants (56%) indicated they were not in a relationship and another 34% did not answer this question. The most frequent languages used by the participants in their profiles were English (38%), Thai (24%), Portuguese (12%) and Spanish (10%). Other languages comprised 17% of the sample. Regionally, most participants were from Asia (50%), North America (17%), Europe (16%), or South America (14%). Most participants reported being HIV negative (n = 8420, 69%), or unsure of their HIV status (n = 2354, 19%), while ten percent (n = 1243) of participants reported being HIV positive (see Table 1).

Among the 8420 HIV-negative Hornet users, 7920 responded to the question regarding daily PrEP use, of whom 13% reported using PrEP. Among the 1243 HIV-positive Hornet users who responded to the questions regarding ART (n = 1164) and viral load (n = 1145), 79% reported ART (n = 924) use and 79% (n = 900) reported having UVL. Of the HIV-positive survey participants who responded to the ART awareness question (n = 1118), 81% reported being aware that an UVL made it virtually impossible to transmit HIV (see Table 2).

3.2 | Factors associated with PrEP use, ART use and UVL

In GEE models adjusting for clustering by country, PrEP use was positively associated with having recently received an STI test or treatment (aOR = 2.19, CI = 1.49 to 3.21); and taking steps to protect oneself from HIV (aOR = 1.41, CI = 1.13 to 1.76). PrEP use was also less likely to be reported by respondents who had their language application set as Spanish (aOR = 0.52, CI = 0.33 to 0.82) and Thai (aOR = 0.33, CI = 0.27 to 0.40) when compared to English speakers. PrEP use was not associated with sexual position or role preferences.

Table 1. Participant demographic characteristics (n = 12,126)

Characteristic	N	% including missing	% excluding missing
Age (years)			
18 to 24	4498	37.1	44.8
25 to 29	2871	23.7	28.6
30 to 34	1336	11.0	13.3
35 to 88	1343	11.1	13.4
Not reported/missing	2078	17.1	–
Race/ethnicity			
Asian, South Asian	3550	29.3	44.2
Black	216	1.8	2.7
Latino	939	7.8	11.7
Other	907	7.5	11.3
White	2426	20.0	30.1
Not reported/missing	4088	33.7	–
Sex role			
Versatile	2347	19.4	57.2
Bottom	835	6.9	20.4
Top	921	7.6	22.5
Not reported/missing	8023	66.2	–
Relationship status			
Single	6830	56.3	85.8
Not single (relationship/ companion)	1129	9.3	14.2
Not reported/missing	4167	34.4	–
HIV-status			
Negative	8420	69.4	70.1
Positive	1243	10.3	10.3
Not sure	2354	19.4	19.6
Not reported/missing	109	0.9	–
Language			
English	4558	37.6	37.9
Spanish	1160	9.6	9.7
Portuguese	1435	11.8	11.9
Thai	2852	23.5	23.7
Other	2012	16.6	16.7
Not reported/missing	109	0.9	–
Region			
Africa	211	1.7	1.7
Asia	6054	49.9	49.9
Europe	1900	15.7	15.8
North America	2026	16.7	16.7
South America	1715	14.1	14.1
Other	220	1.8	1.8

ART use was positively associated with older age (aOR = 1.02; CI = 1.01 to 1.04), having recently received an STI test or STI treatment (aOR = 4.54, CI = 2.65 to 7.78); being aware that HIV transmission is very unlikely with UVL (aOR = 1.53, CI = 1.03 to 2.26); and having the application language set as Portuguese (aOR = 2.21, CI = 1.60 to 3.06) and Thai (aOR = 1.77, CI = 1.32 to 2.39) *versus* English. ART

Table 2. Survey responses by sero-status

	N (%)	
	Yes	**No**
All (n = 12,126)		
In the past year, have you had an STI test and/or received treatment?	4698 (43.2)	6186 (56.8)
Are you taking steps to protect yourself from HIV?	8877 (88.7)	1127 (11.3)
HIV-negative (n = 8420)		
Are you taking PrEP?	1041 (13.1)	6879 (86.9)
Have you asked your healthcare provider if PrEP is right for you?	2264 (29.1)	5515 (70.9)
HIV-positive (n = 1243)		
Are you taking anti-retroviral treatment daily?	924 (79.4)	240 (20.9)
Have you achieved or maintained an undetectable viral load?	900 (78.6)	245 (21.4)
Are you aware that if you are undetectable it's virtually impossible to transmit HIV?	904 (80.9)	214 (19.1)
Unknown HIV status (n = 2354)		
Do you plan to get an HIV test in the next three months?	1511 (63.3)	875 (36. 7)
Have you researched resources for getting an HIV test?	1383 (57.0)	1045 (43.0)

STI, sexually transmitted infection; PrEP, pre-exposure prophylaxis.

use was not associated with sexual position or role preferences and relationship status.

UVL was also positively associated with older age (aOR = 1.03, CI = 1.01 to 1.04); being aware that HIV transmission is very unlikely with UVL (aOR = 1.98, CI = 1.37 to 2.85); and having recently gotten an STI screen or STI treatment (aOR = 4.84, CI = 2.74 to 8.55). Compared to English-speakers, respondents who set their application language to Portuguese (aOR = 2.60, CI = 1.88 to 3.61) or Thai (aOR = 2.94, CI = 2.05 to 4.22) were more likely to report having UVL. Having UVL was not associated with sexual position or role preferences and relationship status. Factors associated with PrEP use, ART use and UVL are presented in Table 3.

4 | DISCUSSION

Our study examined factors associated with PrEP use, ART use and UVL in a large, international sample of gay and bisexual men who are the users of the popular gay social networking app Hornet. The sample size and median age of Hornet users offered a unique window into the sexual health of a population that is at elevated risk for STIs, including HIV. Ten percent of study participants reported being HIV-positive. HIV prevalence among gay and bisexual men reported from other online convenience samples range from 12% to 30% [22-24]. Self-reported HIV prevalence among study participants is troubling given the young median age of this cohort. HIV incidence among gay and bisexual men under the age of 30 is especially high and of concern [25-27].

Low PrEP use among study participants is not surprising. Although the PrEP landscape has changed dramatically since 2016 when Hornet surveyed its users through the Blue-Ribbon Boys initiative, PrEP is still not broadly available, especially in low and middle-income countries [28]. Findings like these could help establish important baseline estimates early in the roll-out of PrEP programmes against which future progress can be measured. Low PrEP coverage is a missed prevention opportunity for gay and bisexual men who are highly motivated about their sexual health and about PrEP as a prevention option [29]. For example, in this study, nearly 90% of respondents (n = 8877) reported taking steps to protect themselves from HIV.

ART utilization and viral suppression rates reported by study participants are higher than previously reported among men who have sex with men in other studies [25-27]. This may be due to increasing awareness among gay and bisexual men about the health and prevention benefits of UVL because of community education efforts (e.g. Undetectable = Untransmissible) [30]. It could also reflect selection bias towards gay and bisexual men who have better access to the Internet and who tend to be better educated and linked to HIV-related services [31].

Language differences we found in multivariate analyses are not surprising given the limited availability of PrEP at the time of the study. For example, there is no national PrEP policy or guidance in Thailand and PrEP availability is limited to pilot studies, with additional limited accessibility among gay and bisexual men with private insurance [32]. Similarly, PrEP availability was limited in Latin America between 2015 and 2016. It was not until 2017, that the Brazilian Ministry of Health announced their plans to make PrEP available to individuals at elevated risk for HIV, for which gay communities actively lobbied.

Age differences in ART use and UVL reinforce previously reported age disparities in access to services between younger and older men who have sex with men [33]. In this study, Portuguese- and Thai-speaking men who have sex with men reported higher ART use and UVL than English-speaking men, which was an unexpected finding that warrants further investigation. While rolling out the Blue-Ribbon Boys initiative, Hornet focused its earlier community educational campaigns in countries with their largest market footprint. Those countries included Thailand, Brazil and Mexico. These campaigns instigated robust community mobilization around viral

Table 3. Characteristics associated with PrEP use, ART use and UVL

	PrEP among HIV-negative participants (n = 8420)			ART among HIV-positive participants (n = 1019)			UVL among HIV-positive participants (n = 1023)		
	aOR	95% CI	*p*	aOR	95% CI	*p*	aOR	95% CI	*p*
Age (per year increase)	1.00	0.99 to 1.01	0.90	1.02	1.01 to 1.04	**<0.01**	1.03	1.01 to 1.04	**<0.01**
Relationship status									
Single	*Ref*								
Not single (relationship/companion)	1.13	0.93 to 1.36	0.21	1.13	0.58 to 2.19	0.72	1.18	0.64 to 2.19	0.59
Unknown	1.03	0.93 to 1.15	0.56	1.13	0.78 to 1.63	0.51	0.87	0.64 to 1.17	0.34
Sexual position/role preference									
Versatile	*Ref*								
Bottom	1.18	0.94 to 1.49	0.16	1.28	0.55 to 2.94	0.57	1.27	0.63 to 2.56	0.50
Top	0.83	0.68 to 1.02	0.08	0.56	0.21 to 1.48	0.24	0.60	0.35 to 1.04	0.07
Unknown	1.09	0.91 to 1.30	0.34	0.71	0.47 to 1.07	0.10	0.68	0.45 to 1.02	0.06
Language									
English	*Ref*								
Spanish	0.52	0.33 to 0.82	**0.01**	1.44	0.48 to 4.33	0.52	1.30	0.38 to 4.49	0.67
Portuguese	1.09	0.83 to 1.44	0.54	2.21	1.60 to 3.06	**<0.01**	2.45	1.69 to 3.55	**<0.01**
Thai	0.33	0.27 to 0.40	**<0.01**	1.77	1.32 to 2.39	**<0.01**	1.68	1.20 to 2.36	**<0.01**
Other	1.12	0.79 to 1.59	0.54	1.03	0.60 to 1.76	0.92	1.03	0.60 to 1.79	0.91
Unknown	–	–	–	–	–	–	–	–	–
Yes, in the past year had an STI test and/or treatment	2.19	1.49 to 3.21	**<0.01**	4.54	2.65 to 7.78	**<0.01**	4.84	2.74 to 8.55	**<0.01**
Yes, aware that if you are undetectable it's virtually impossible to transmit HIV	–	–	–	1.53	1.03 to 2.26	**0.04**	1.98	1.37 to 2.85	**<0.01**
Yes, taking steps to protect yourself from HIV	1.41	1.13 to 1.76	**<0.01**	–	–	–	–	–	–

PrEP, pre-exposure prophylaxis; ART, antiretroviral treatment; UVL, undetectable viral load; STI, sexually transmitted infection; GEE, generalized estimating equation.
GEE models for PrEP use, ART use and UVL fitted for different populations based on available outcomes.

suppression and information about the prevention potential of PrEP and ART. Community efforts in Hornet markets may have influenced findings reported here.

Study participants who reported having had an STI test and/or treatment and reported awareness about the link between viral load and HIV transmissibility were significantly more likely to report ART use and UVL. These findings highlight the critical role sexual health services can play in facilitating access to HIV-related education and services. Moreover, awareness about risk minimalization may play key role in PrEP and ART uptake [34], which may, in turn, consequently influence viral suppression.

4.1 | Study strengths and limitations

Our study had several strengths and limitations that are important to note. The study sample of Hornet users was conveniently recruited, restricting generalization of study findings. Online convenience samples can create a selection bias towards gay and bisexual men who have better access to the Internet [31]. It should also be noted that survey participants who volunteered, reflect Hornet users who are highly motivated to act on their sexual health. In addition, the cross-sectional design prevents the identification of causal relationships. The study findings are nevertheless important, given the sample size and the median age of respondents, which was relatively young.

Another limitation from this study is the missing data from the sexual health outcomes of interest. As mentioned, our analysis was restricted to individuals who provided information about these outcomes. It is possible that this approach has introduced a selection bias toward participants who are more comfortable discussing their sexual health and this group may be different from broader Hornet users who were excluded. In addition, due to the anonymized nature of this study, we are unable to compare our participants with Hornet users who declined to participate. Therefore, we do not know if there are significant differences between our sample, and those who declined to participate. Nevertheless, because our survey invitation was extended via the use of the Hornet app, we speculate that individuals with unlimited data plans and/or have reliable wi-fi access (and potentially have more resources) were more likely to participate in the study. Hence, our findings may likely overestimate self-reported PrEP or ART use and HIV viral suppression among men who have sex with men.

5 | CONCLUSIONS

Study findings underscore the importance of STI testing and treatment sites as entry points for encouraging PrEP and ART use. Information about HIV transmissibility and viral load should be integrated into tailored HIV prevention messages and educational campaigns. Moreover, sexual health programmes should be designed with age disparities in service access and utilization in mind. Structural-level factors like national HIV policies may be influencing availability and utilisation of important prevention tools, like PrEP. As illustrated by this study, gay social networking apps offer important opportunities to rapidly collect data and disseminate tailored prevention messages. Online social networking applications should be better studied and utilized to more fully leverage their contribution to sexual health promotion among men who have sex with men [35]. Specifically, the HIV sector may benefit from the broad-based adoption of agile approaches to programme design used by social networking apps like Hornet [36,37]. Such approaches may lead to more user-friendly programmes, which may encourage better uptake of ART and PrEP use and more finely tailored prevention interventions for men who have sex with men [38].

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COMPETING INTERESTS

Authors have no competing interests to declare.

AUTHORS' CONTRIBUTIONS

GA is the principal investigator of the Blue-Ribbon Boys study and was the lead writer. GMS is a co-principal investigator, led all data analysis and co-wrote the methods and results reported here. SA, AG, KM and SH are co- investigators who assisted with the overall design of the study and offered feedback to the draft manuscript.

ACKNOWLEDGEMENTS

FUNDING

MSMGF staff and consultant time was funded by the Ministry of Foreign Affairs in the Netherlands, through the Bridging the Gaps Programme and U.S. PEPFAR/USAID/LINKAGES. The authors acknowledge the in-kind contribution made by Hornet, which designed the app interface and accompanying information website, and collected data. We acknowledge former MSMGF Senior Communications Officer, Jack Mackenroth, who co-created and led the Blue-Ribbon Boys Initiative.

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Suraratdecha C et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25129
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25129/full | https://doi.org/10.1002/jia2.25129

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

Cost and cost-effectiveness analysis of pre-exposure prophylaxis among men who have sex with men in two hospitals in Thailand

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Clinical Trial Number: NCT02369887.

Abstract

Introduction: In 2014, the Government of Thailand recommended pre-exposure prophylaxis (PrEP) as an additional HIV prevention programme within Thailand's National Guidelines on HIV/AIDS Treatment Prevention. However, to date implementation and uptake of PrEP programmes have been limited, and evidence on the costs and the epidemiological and economic impact is not available.

Methods: We estimated the costs associated with PrEP provision among men having sex with men (MSM) participating in a facility-based, prospective observational cohort study: the Test, Treat and Prevent HIV Programme in Thailand. We created a suite of scenarios to estimate the cost-effectiveness of PrEP and sensitivity of the results to the model input parameters, including PrEP programme effectiveness, PrEP uptake among high-risk and low-risk MSM, baseline and future antiretroviral therapy (ART) coverage, condom use, unit cost of delivering PrEP, and the discount rate.

Results: Drug costs accounted for 82.5% of the total cost of providing PrEP, followed by lab testing (8.2%) and personnel costs (7.8%). The estimated costs of providing the PrEP package in accordance with the national recommendation ranges from US$223 to US$311 per person per year. Based on our modelling results, we estimate that PrEP would be cost-effective when provided to either high-risk or all MSM. However, we found that the programme would be approximately 32% more cost-effective if offered to high-risk MSM than it would be if offered to all MSM, with an incremental cost-effectiveness ratio of US $4,836 per disability-adjusted life years (DALY) averted and US$7,089 per DALY averted respectively. Cost-effectiveness acceptability curves demonstrate that 80% of scenarios would be cost-effective when PrEP is provided solely to higher-risk MSM.

Conclusion: We provide the first estimates on cost and cost-effectiveness of PrEP in the Asia-Pacific region, and offer insights on how to deliver PrEP in combination with ART. While the high drug cost poses a budgeting challenge, incorporating PrEP delivery into an existing ART programme could be a cost-effective strategy to prevent HIV infections among MSM in Thailand.

Keywords: AIDS; cost; cost-effectiveness analysis; HIV; modelling; pre-exposure prophylaxis; Thailand

Received 18 December 2017; **Accepted** 17 May 2018

1 | INTRODUCTION

HIV pre-exposure prophylaxis (PrEP) can reduce sexual and parenteral transmission of HIV. The World Health Organization recommends PrEP as part of a comprehensive HIV prevention package including HIV testing, counselling, condoms, lubricants, antiretroviral therapy (ART) for partners of people living with HIV, voluntary medical male circumcision and harm reduction interventions for people who use drugs [1]. Oral PrEP has been shown to be cost-effective in settings where the HIV incidence is >3 per 100 person-years and in some settings at lower incidence [1-5]. Although the literature suggests that drug costs of oral PrEP are lower than antiretroviral (ARV) drug costs on the basis of cost per dose and duration of use, funding the high cost of PrEP on top of other prevention programmes remains one of the main challenges, especially in resource-constrained settings [6-9].

Thailand included PrEP as an HIV prevention tool within their 2014 national HIV Treatment and Prevention Guidelines [10]. This is to complement key components of their National Operational Plan for Ending AIDS 2015 to 2019 including increasing HIV testing coverage, facilitation of those who test positive to initiate and stay on treatment, and to provide HIV prevention services to those who test negative [11]. In Thailand, PrEP services are either available free of charge or at low-cost at several locations [12]. As of June 2017, an

estimated 1044 men having sex with men (MSM) had received services from the fee-based PrEP-30 demonstration project (1000 Thai Baht (THB) per month, around US$30), implemented by the Thai Red Cross Society [12]. Around 1000 MSM and transgender (TG) women have enrolled in the Princess PrEP project, which started in 2016 under the Thai Royal patronage [12]. Another 100 MSM and TG women were enrolled in PrEP2START, a government-initiated PrEP scale-up programme, which has been implemented in eight HIV high-burden provinces since November 2016, and which aims to strengthen the public health system and to enhance capacity of healthcare professionals in providing PrEP to MSM and TG [13]. Under the PrEP2START programme drugs are provided free of charge, but participants contributed to laboratory services ranging from US$11 to US$28 annually [13].

Evidence suggests that PrEP programmes have experienced both challenges and successes. An assessment of the PrEP-30 project in early 2016 reported no new infections among PrEP users during the first year of project implementation [13]. The Princess PrEP project showed a 52% retention rate at six months with a 97% adherence rate of ≥4 tablets per week (N = 671) [12]. Another study reported willingness to use PrEP among MSM and TG women ranging from 36% to 41%, with 65% willing to pay a maximum of US$21.40 per month for PrEP [13]. However, wider implementation has been limited and evidence on the epidemiological and economic impact, and costs of PrEP implementation is not available. While demonstration projects indicate feasibility of PrEP implementation, significant challenges for scale-up of PrEP services in Thailand will include securing the financial resources to make PrEP more widely available and mobilization of human resources to prescribe PrEP in a timely manner [14].

The objectives of this study were to assess the cost of providing oral PrEP to MSM, and to estimate the epidemiological impact and cost-effectiveness of oral PrEP for this target group. This study adds new evidence to the existing literature by estimating primary costs for delivering PrEP in facility-based settings and investigating the impact of potential parameters, including programme effectiveness, uptake, and condom use on the cost-effectiveness of PrEP provision.

2 | METHODS

This study was approved by the Thailand Ministry of Public Health (MOPH) Ethical Review Committee and as a non-research programme evaluation by the U.S. Centers for Disease Control and Prevention (CDC). All procedures were in compliance with the Helsinki Declaration, the Code of Federal Regulations, Title 45, Part 46 (45 CFR §46), and local ethical and legal requirements. A written enrolment consent form was sought from potential participants in the cohort study. Staff consent was not required.

2.1 | Prospective observational cohort study

In May 2015, the Thailand MOPH in collaboration with the CDC launched the Test, Treat, and Prevent HIV Programme to identify barriers to the immediate initiation of ART and the use of PrEP. Participants were enrolled and followed from 1 May 2015 to 30 April 2018 including 1880 Thai MSM and TG from the Khon Kaen, Lerdsin, Srinagarind University, Thammasat University, and Udon Thani Hospitals across four provinces (Bangkok, Khon Kaen, Pathum Thani and Udon Thani). PrEP was also offered at Lerdsin and Thammasat Hospitals [15].

2.2 | Cost analysis

We conducted a retrospective cost analysis of the Test, Treat and Prevent HIV Programme from 1 June 2015 to 31 May 2016 to derive the cost associated with HIV testing and PrEP services from a provider perspective. Costs of HIV testing and PrEP services were collected by programmatic activity (HIV testing and counselling, PrEP initiation and PrEP visit (adherence counselling, physical check, clinic visit, prescribing drugs and blood draw)), by input type (personnel, drugs and commodities, supplies, test kits, laboratory testing including creatinine, hepatitis B, syphilis screening, biochemistry and haematology), and by source of support (cohort study or MOPH). We used a time and motion analysis to measure the average time health and lab staff spent on each programmatic activity session. To calculate personnel costs, we collected information from facility and project staff on their salaries and allowances, and assumed staff worked eight hours per day for 20 days each month. We based the cost of supplies and equipment associated with laboratory testing on price per test using the quotes from the suppliers of lab reagents multiplied by the number of tests conducted during the study. The price paid per test covers the cost of the laboratory equipment, services, reagents and consumables for the term of the agreement excluding capital expenditures. The cost of drugs and commodities was determined by multiplying the MOPH unit price with the quantities used. The study excluded costs associated with HIV-related morbidity and mortality, as well as morbidities and mortalities stemming from adverse events associated with care and treatment, costs borne by the health system, higher-level overhead costs, and building maintenance and utility costs. Data on beneficiary volume were extracted from the outcomes of the cohort study to derive the unit cost per-person-per-year (ppy) by dividing the total cost of the programme by the number of PrEP participants. Data collection was conducted from October to December 2016. All costs were collected in THB and converted to U.S. dollars (USD) at the market exchange rate (1 USD = 35.42174 THB) for the period the cost was incurred.

2.3 | Impact and cost-effectiveness analysis

To estimate the epidemiological impact of providing PrEP to MSM, we used the Optima HIV tool (v2.6.6, available at hiv.optimamodel.com), which is a compartmental model of HIV transmission and disease progression linked to a programmatic response module for estimating the epidemiological and economic impact of interventions [16,17]. Of the approximately 571,000 MSM in Thailand [18], about one-third are characterized as being high-risk on the basis of having engaged in condomless sex with casual or known HIV-positive partners [19,20]. We created a model of the MSM population in Thailand disaggregated into low-risk and high-risk groups and

populated the model with available country-specific data on population sizes, sexual behaviour, and testing rates, disaggregated by risk group where possible (Table 1). Non-context specific parameters were also used to inform the model as documented in the Optima HIV user guide [21]. We calibrated the model to historical HIV prevalence estimates to produce baseline estimates of the expected number of new HIV infections over the period from the beginning of 2017 to the end of 2022 in the absence of PrEP.

We assumed a five-year implementation period (fiscal period 2017-2018 to 2021-2022) and measured HIV infections and disability-adjusted life years (DALYs) averted under a range of different scenarios around PrEP provision. DALYs were calculated from the onset of infection and cost and effects were discounted at an annual rate ranging from 1.5% to 4.5%. Disability weights were obtained from the literature [21].

A knowledge of the baseline level of ART coverage among MSM is essential in assessing the impact and cost-effectiveness of providing PrEP. In 2014, ART coverage among MSM was reported as 7% [18], but this is likely to be an underestimate as it only includes people who self-reported as MSM. The ART coverage among the total population of Thailand was approximately 60% [24]. To account for the uncertainty surrounding coverage of ART among MSM, we assumed baseline ART coverage of 30% and allowed coverage to vary between the estimates for MSM and for the total population. We further assumed that the scale-up in ART coverage over the five-year PrEP implementation will not exceed 20 percentage points. For example, if the baseline ART coverage is assumed to be 7%, we allowed ART coverage levels in 2021 to 2022 to range between 7% and 27%. With the baseline ART coverage of 60%, we allowed 2021 to 2022 coverage levels to range between 60% and 80%, with the upper range corresponding to the achievement of the UNAIDS 90-90-90 treatment targets.

We considered two core sets of scenarios based on the parameters listed in Table 2, one in which PrEP will be provided to all MSM and one in which PrEP will only be provided to high-risk MSM. The uptake of PrEP in each scenario is linked to ART coverage levels, with PrEP uptake in each scenario ranging from 0% up to the assumed levels of ART coverage in 2021 to 2022. We consider the possible impact of PrEP on sexual disinhibition by modelling the impact of reductions in condom use among MSM. While we do not specifically model the effects of other changes in sexual behaviour (for example, an increase in the number of partners), we expect that the results would be similarly sensitive to other forms of sexual disinhibition [25].

We ran 60,000 model simulations, in which samples of each of the eight parameters listed in Table 2 were drawn from uniform distributions over their allowable ranges, and calculated the total number of new HIV infections and DALYs that were estimated over the implementation period for each simulation.

For the cost-effectiveness analysis, we calculated the cost associated with each scenario by disaggregating the cost of PrEP and ART. To derive the cost of the PrEP intervention, we multiplied the number of HIV-negative MSM by the percentage of MSM receiving PrEP and then by the unit cost ppy of the PrEP programme. We multiplied the number of HIV-positive MSM by the percentage of MSM receiving ART, and then by the unit cost ppy of the ART programme to estimate the cost of ART provision. The median cost per person on ART per year including ARV medicines of US$369.57 was obtained from the Test, Treat and Prevent HIV Programme costing study from the same cohort [26]. We used a cost-effectiveness threshold of US$17,449, equal to three times the gross domestic product (GDP) per capita [27] to determine the cost-effectiveness of PrEP [28].

3 | RESULTS

3.1 | Annual PrEP costs

From 1 June 2015 to 31 May 2016, 366 HIV-negative MSM and TG participants were recruited at Lerdsin and Thammasat University Hospitals to participate in the PrEP sub-study. Of the 366 participants, 163 (44.5%) accepted PrEP free-of-charge for 12 months, and this was used to determine the acceptance rate and to assess costs. Drug costs accounted for 82.5% of the total annual costs

Table 1. Key parameters for the epidemiological model

Parameter	Value	Source and notes
Condom use among MSM with casual partners	82%	2015 [18]
Condom use among MSM with regular partners	66%	Condom use with all male steady partners, value consistent from 2005 and 2007 [22]
Per-act transmission probabilities	Varying	[21]
Efficacy of interventions	Varying	[21]
Percentage MSM tested for HIV in the last 12 months	30.85%	2015 [23]
HIV prevalence among MSM		
High-risk	11.6%	2017 [23]
Low-risk	5.2%	2017 [23]
Population size		
High-risk	155,149	2017 [23]
Low-risk	362,055	2017 [23]

MSM, men having sex with men.

Table 2. Model parameters for PrEP implementation scenarios

Parameter	Value	Range	Notes
PrEP programme effectiveness	75%	50% to 95%	The variation in programme effectiveness reflects uncertainty in both drug efficacy and adherence/retention.
Baseline ART coverage among MSM in 2017/18	30%	7% to 60%	ART coverage among MSM in 2014 was reported at 7% [18] (likely to be underestimated as this only includes ART clients who self-reported as MSM). ART coverage was approximately 60% among the total population [24]. We used a default value of 30% and allowed coverage to vary between the estimates for MSM and for the total population.
ART scale-up relative to baseline	10 ppts increase	0 to 20 ppts increase	We set ART coverage among MSM in 2021/22 relative to the value in 2017/18. Our default assumption is for a slight scale-up relative to baseline; we contrast this with maintenance of baseline levels and a larger increase. Since our baseline ART coverage assumptions range up to 60%, an assumption of a 20 percentage point scale-up encompasses the accomplishment of the UNAIDS 90-90-90 targets.
PrEP uptake among high-risk MSM	10 ppts lower than ART coverage levels	From 0% up to ART coverage levels	As a baseline, we assume that PrEP uptake will be 10 percentage points lower than ART coverage levels. We consider uptake values ranging from 0% up to ART coverage levels.
PrEP uptake among low-risk MSM			
Scenario: PrEP is provided to all HIV-negative MSM	10 ppts lower than ART coverage levels	From 0% up to ART coverage levels	
Scenario: PrEP is provided to HIV-negative high-risk MSM	0%	No range	No uptake among low-risk MSM
Percentage reduction in condom use for those receiving PrEP	10%	0% to 20%	Moderate reduction in condom use in the moderate scenario, no reduction in the ambitious scenario and 20% reduction in the conservative scenario.
PrEP unit cost ppy	US$222.18	US$180 to US$310	
Annual discounting rate	3%	1.5% to 4.5%	

MSM, men having sex with men; PrEP, pre-exposure prophylaxis; ART, antiretroviral therapy; ppy, per-person-per-year; ppts, percentage points.

associated with PrEP provision (Table 3). HIV testing costs were US$824 per year. The unit cost ppy, including HIV testing for all clinic visits and the cost of project staff who provided PrEP was US$129. Project staff were hired to support PrEP services, but if the PrEP programme is implemented, project staff will be replaced by MOPH staff. The average unit cost of providing PrEP ppy without project staff is US$128. We assumed that the unit cost of providing PrEP to MSM will be the same as that derived for MSM/TG from the cohort study.

We projected the cost if each participant took PrEP continuously over the 12-month study period, attended clinic and monitoring visits, and received HIV and lab tests following recommended PrEP programme guidelines [29]. We applied a micro costing approach to estimate the unit cost ppy and quantities for personnel, HIV and lab testing, and drugs for each package (Table 4). We applied a 0.7% proportion of overhead costs from a similar existing study in Thailand [30] to the unit cost. In the cohort study, demand creation activities were included in each counselling session. Personal communications with a programme officer from a pilot PrEP project conducted previously in Thailand indicated that the spending for demand creation activities for both HIV testing and PrEP accounted for approximately 22% of the project budget. Although the amount included demand creation activities for PrEP (inclusive of activities during the counselling session) and for HIV testing, we applied this proportion to the unit cost to reflect additional demand creation activities that may be offered. The cost to implement the PrEP programme ranges from US$222.89 to US$310.99 ppy depending on the package options and demand creation activities chosen.

3.2 | Impact and cost-effectiveness of PrEP

In Table 5 we present results on the number of HIV infections averted, lifetime treatment costs averted, and the incremental cost-effectiveness ratio (ICER) for both HIV infections and DALYs averted over the five-year

implementation period. Results are presented for two core implementation strategies: PrEP for high-risk MSM only and PrEP for all MSM, and are based on the scenarios generated using the parameter values shown in Table 2. Comparing these two strategies, we estimate that providing PrEP to all MSM would have a greater epidemiological and economic impact than providing PrEP to high-risk MSM only, with almost 2.5 as many HIV infections averted (1368 *vs.* 555) and more than twice the discounted lifetime treatment costs averted (US$9.84 million *vs.* US$3.99 million). However, providing PrEP only to high-risk MSM would be approximately 32% more cost-effective than providing it to all MSM, with ICERs of US$4,836 and US$7,089 per DALY averted respectively. Applying the cost-effectiveness threshold of three times GDP per capita of US$17,449, the ICERs per DALY averted for both targeting strategies demonstrate the cost-effectiveness of PrEP services.

3.3 | Sensitivity analysis

Figure 1 presents tornado diagrams summarizing the one-way sensitivity analysis of the ICERs for both HIV infections and DALYs averted based on the model parameters defined in Table 2. The ICERs are particularly sensitive to both baseline ART coverage and the ART scale-up rate. Higher ART baseline coverage and a more rapid scale-up of ART would make the PrEP programme relatively less cost-effective. These results are also sensitive to the PrEP programme unit cost. In scenarios where PrEP was only provided to high-risk MSM with all other parameter values as indicated in Table 2, the ICER for HIV infections averted is estimated to lie between US$58,670 and US$83,587, while the ICER for DALYs averted is estimated to lie between US$3,767 and US$6,946. We estimate that these ranges would increase to US$78,855 to US$142,828 and US$5,266 to US$9,559 respectively if PrEP was provided to all MSM. We also find that the scenario for providing PrEP only to high-risk MSM, if condom use while using PrEP were maintained, would be particularly cost-effective.

Using a cost-effectiveness threshold of three times GDP per capita, an estimated 80% of PrEP implementation scenarios (as constructed using the parameter values from Table 2) are calculated to be cost-effective if the PrEP programme is provided solely to high-risk MSM, compared to 66% for all MSM (Figure 2). The minimum and maximum ICERs for DALYs averted are estimated to be US$702 (assuming a PrEP unit cost of US$180, 95% PrEP programme effectiveness, no reduction in condom usage, ART coverage remaining constant at 7%, and a 1.5% discount rate) and US$218,802 ($310 PrEP unit cost, 55% PrEP programme effectiveness, 20% reduction in condom usage, 60% ART coverage increasing to 80% by 2021 to 2022, and a 4.5% discount rate) respectively.

Table 3. Distribution of total annual costs (USD) associated with PrEP initiation and clinic visits by input type

Input type	Cohort study (including MOPH and project staff)	Projection (MOPH staff only)
Personnel (health and laboratory staff)	$1,452 (8.4%)	$1,337 (7.8%)
Lab supplies and reagents	$1,406 (8.2%)	$1,406 (8.2%)
PrEP drugs	$14,106 (82.0%)	$14,106 (82.5%)
Other supplies	$242 (1.4%)	$242 (1.4%)
Total	$17,206	$17,091

USD, U.S. dollars; PrEP, pre-exposure prophylaxis; MOPH, Ministry of Public Health.

4 | DISCUSSION

There is strong evidence for the safety and efficacy of PrEP among MSM and other high-risk groups [2,31]. However, the evidence on cost-effectiveness of PrEP is mixed, with results varying depending on the unit cost of PrEP, population targeted, and the broader health system context [32]. This suggests that country-specific cost-effectiveness analyses may be needed to inform national policy on PrEP implementation

Table 4. Unit cost (USD) of PrEP recommended package by option per person per year

Cost category	Option 1[a]	Option 2[b]
Personnel (health and laboratory staff) to provide HIV testing and counselling, one visit for initial PrEP counselling and recruitment, six visits of maintenance support (counselling), four additional HIV tests, two creatinine tests, one Hepatitis B surface antigen (HBs Ag) test and two upgraded STIs screenings (option 2 only)	$24.66	$25.63
Supplies (HIV testing and lab testing) for five HIV tests (initiating testing and four additional tests), two creatinine tests, one HBs Ag test and two upgraded STIs screenings (option 2 only)	$10.36	$41.41
Tenofovir/Emtricitabine (TDF/FTC) (12 bottles: 1 pill per day)	$186.33	$186.33
Total unit cost ppy	$221.34	$253.37
Total unit cost ppy with overhead 0.7%	$222.89	$255.14
Total unit cost ppy with overhead 0.7% and 22% demand creation activities	$271.59	$310.88

USD, U.S. dollars; PrEP, pre-exposure prophylaxis; ppy, per-person-per-year.
[a]Option 1 package includes one visit for initial PrEP counselling and recruitment, four additional HIV tests, two tests for creatinine, one HBs Ag test, 12 months TDF/FTC combination (tenofovir disoproxil fumarate/emtricitabine), six visits for maintenance support (counselling); [b]Option 2 package includes the option 1 package plus two times upgraded STIs screening (chlamydia, gonorrhoea, syphilis rapid test, nucleic acid amplification test).

Table 5. Incremental cost-effectiveness ratios (ICERs) for core scenarios, based on the parameter values given in Table 2.

	Cost	Effectiveness			ICERs	
Scenario name	Total five-year programme cost (millions)	DALYs averted	HIV infections averted	Lifetime treatment costs averted (million)	$/DALY averted	$/HIV infection averted
PrEP provided to high-risk MSM	$41.99	7,857	555	$3.99	$4,836.00	$68,468.00
PrEP provided to all MSM	$147.14	19,368	1368	$9.84	$7,089.00	$100,367.00

DALYs, disability-adjusted life years; $, U.S. dollars.

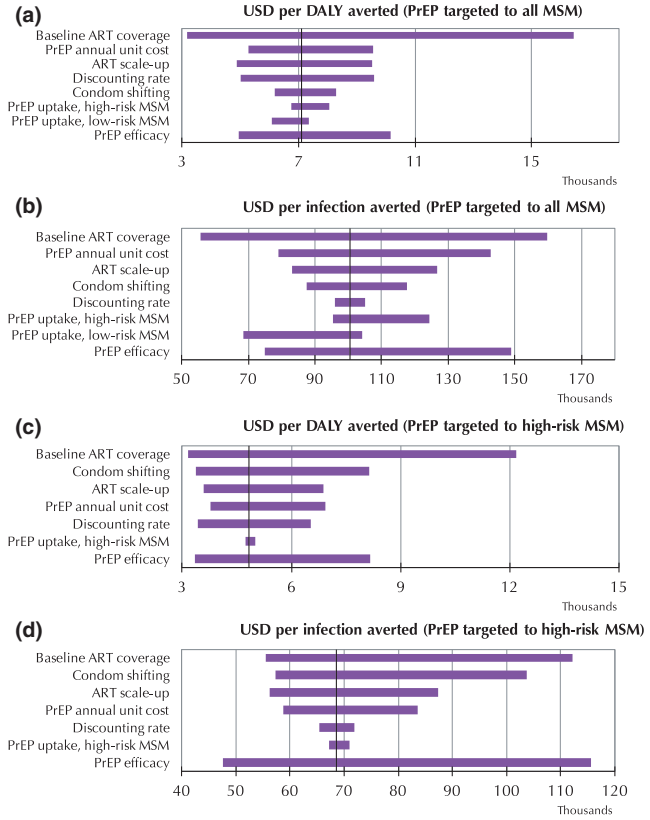

Figure 1. Tornado diagrams of univariate sensitivity analysis.

strategies. Accordingly, a growing number of studies have been published in recent years to fill this gap. We searched PubMed from 1 January 2013 to 11 October 2017 with the terms "HIV" AND ("PrEP" OR "PrEP") AND ("cost" OR "cost-effectiveness") with the goal of identifying any new studies that have appeared since the 2013 meta-analysis of PrEP cost-effectiveness modelling studies [32]. The search retrieved 149 abstracts, of which 21 provided country-specific estimates of the cost-effectiveness of various PrEP implementation strategies [6,8,9,33-49]. This study is not only the first to provide data and evidence on the costs and cost-effectiveness of providing oral PrEP to MSM in Thailand, but is also the first such study from the Asia-Pacific region.

The unit cost of the PrEP programme in the cohort study was lower than that of the recommended package because not all study participants attended clinic visits quarterly and took PrEP continuously, and the visit and testing schedules were different between the cohort study and recommendation. Since PrEP was offered as an integrated service to ART services in the study, the cost difference attributed to project staff was less than US$1 per person-year. Consistent with findings from other countries [32], drug costs represent the majority of PrEP programme costs. If the PrEP programme could be delivered according to the recommended package at a unit cost of US$222.89 ppy and provided to high-risk MSM, we estimate that it would be a very cost-effective package, with an estimated ICER of US$4,836 per DALY averted, lower than Thailand's per-capita GDP of US$5,816. Through a sensitivity analysis we estimate that if the PrEP programme is only provided to high-risk MSM, 80% of the scenarios that we considered would be cost-effective, compared to 66% if the programme is provided to all MSM.

There are several limitations to this study. The cost associated with community-based outreach activities, such as demand creation and peer support groups (e.g. to improve high-risk MSM enrolment or adherence) were not available and were not implemented in the cohort study. We applied the cost of demand creation activities based on the information from another project and included overhead costs obtained from another study as a proxy to define the range of unit costs. The project engaged senior facility staff during implementation, and the cost per person per year may be lower if less senior staff were deployed. Laboratory testing requirements varied among the facilities included in this study. The proportion of lab costs from the recommended PrEP package were much less than the project costs due to the type and quantity of tests used in this study. In our study, most tests were conducted quarterly and other tests, such as biochemical tests were also included. Our analysis did not consider new diagnostics, for example HIV self-testing, which may lead to further reductions in cost. Costs could be reduced if PrEP were offered on demand or for less than 12 months. Due to limited resources, we did not collect data on cost to clients, which would be useful to determine the potential financial barriers and copayment. Our sensitivity analysis attempted to account for cost variation due to outreach activities supporting adherence, drug

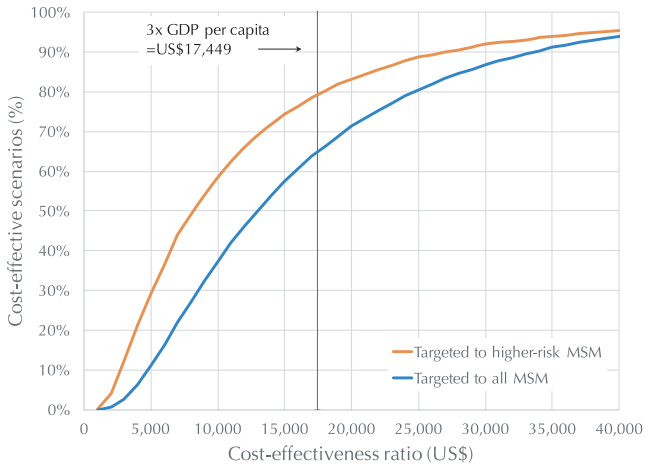

Figure 2. Cost-effectiveness acceptability curve for pre-exposure prophylaxis strategies.

prices, and duration of PrEP uptake. Not all possible factors that may impact the cost-effectiveness of PrEP were included – for example, we did not account for potential cost savings or DALYs averted associated with screening for sexually transmitted infections, nor for the possible changes in the number of partners that might result from PrEP uptake. Instead we opted to model the impact of sexual disinhibition as impacting condom use only. We expect that any additional changes in sexual behaviour would impact the cost-effectiveness of PrEP in a comparable way to the impact of changes in condom use. While we did not consider the budget-impact analysis, which will further guide the resource allocation decision, we have attempted to cost the PrEP programme and have extrapolated the costs of the recommended package.

5 | CONCLUSIONS

This analysis provides insights on various PrEP delivery strategies, as well as an analysis of some of the factors that influence PrEP impact and cost-effectiveness. These findings show that the cost-effectiveness ratios are sensitive to ART coverage and PrEP programme effectiveness. A PrEP strategy targeting high-risk MSM if condom use does not decrease was found to be the most cost-effective intervention. Evidence from both Thailand [13] and from other settings has consistently shown no difference in condom use with uptake of PrEP [31], so there is reason to be hopeful that the best-case scenarios provided in this study would be reflected if PrEP were implemented. While elevated PrEP drug costs will continue to pose a budgeting challenge, our results indicate that providing PrEP to high-risk MSM is likely to be a cost-effective HIV prevention intervention.

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COMPETING INTERESTS

The authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

CM, CL, PP, MM developed the cohort study. CS, DG, CM and MM developed the costing study design. CS, RS and DW developed the cost-effectiveness analysis. CS and RS produced the results and were the lead writers of the manuscript. PV, PM, PT, TK and CK collected the data. All authors reviewed and contributed to the final manuscript and have read and approved the final version.

ACKNOWLEDGEMENTS

This project has been supported by the President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention (CDC), and the Australian National Health and Medical Research Council. We thank the study participants for their contributions to the study, members of the cohort study team, and the hospital staff. We are grateful to the Thailand Ministry of Public Health, Bangkok Metropolitan Authority, Lerdsin Hospital and Thammasat University Hospital whose support made this study possible. The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the funding agencies. Sherrie L. Kelly and Maria Del Mar Quiroga (Burnet Institute) provided useful comments and edits during the review phase.

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RESEARCH ARTICLE

Achieving the first 90 for key populations in sub-Saharan Africa through venue-based outreach: challenges and opportunities for HIV prevention based on PLACE study findings from Malawi and Angola

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Abstract

Introduction: Providing outreach HIV prevention services at venues (i.e. "hotspots") where people meet new sex partners can decrease barriers to HIV testing services (HTS) for key populations (KP) in sub-Saharan Africa (SSA). We offered venue-based HTS as part of bio-behavioural surveys conducted in urban Malawi and Angola to generate regional insights into KP programming gaps and identify opportunities to achieve the "first 90" for KP in SSA.

Methods: From October 2016 to March 2017, we identified and verified 1054 venues in Luanda and Benguela, Angola and Zomba, Malawi and conducted bio-behavioural surveys at 166 using the PLACE method. PLACE interviews community informants to systematically identify public venues where KP can be reached and conducts bio-behavioural surveys at a stratified random sample of venues. We present survey results using summary statistics and multivariable modified Poisson regression modelling to examine associations between receipt of outreach worker-delivered HIV/AIDS education and HTS uptake. We applied sampling weights to estimate numbers of HIV-positive KP unaware of their status at venues.

Results: We surveyed 959 female sex workers (FSW), 836 men who have sex with men (MSM), and 129 transgender women (TGW). An estimated 71% of HIV-positive KP surveyed were not previously aware of their HIV status, receiving a new HIV diagnosis through PLACE venue-based HTS. If venue-based HTS were implemented at all venues, 2022 HIV-positive KP (95% CI: 1649 to 2477) who do not know their status could be reached, including 1666 FSW (95% CI: 1397 to 1987), 274 MSM (95% CI: 160 to 374), and 82 TG (95% CI: 20 to 197). In multivariable analyses, FSW, MSM, and TGW who received outreach worker-delivered HIV/AIDS education were 3.15 (95% CI: 1.99 to 5.01), 3.12 (95% CI: 2.17 to 4.48), and 1.80 (95% CI: 0.67 to 4.87) times as likely, respectively, as those who did not to have undergone HTS within the last six months. Among verified venues, <=68% offered any on-site HIV prevention services.

Conclusions: Availability of HTS and other HIV prevention services was limited at venues. HIV prevention can be delivered at venues, which can increase HTS uptake and HIV diagnosis among individuals not previously aware of their status. Delivering venue-based HTS may represent an effective strategy to reach the "first 90" for KP in SSA.

Keywords: Key and vulnerable populations; HIV testing; HIV prevention; venue-based outreach; hotspots; sub-Saharan Africa; Malawi; Angola

Additional Supporting Information may be found online in the Supporting information tab for this article.

Received 15 December 2017; **Accepted** 18 May 2018

1 | INTRODUCTION

Key populations (KP) face a disproportionate HIV burden in sub-Saharan Africa (SSA) [1]. Driven by stigma, discrimination, limited KP-friendly services, and other structural barriers, the HIV prevention, treatment, and care continuum remains inaccessible for many KP in the region [2,3]. As a result, progress toward ensuring universal access to HIV services for KP, and achieving HIV epidemic control, has been sub-optimal in many SSA countries [1,4].

Although distinct, the HIV epidemics in Malawi and Angola share features reflective of broader regional trends. In

Malawi, the most recent evidence, from 2011 to 2014, indicates that HIV prevalence among the country's estimated 14,505 female sex workers (FSW) [5] is 62% to 69% [5,6], and HIV prevalence among the estimated 38,734 men who have sex with men (MSM) [7,8] is 18% [9]—each substantially higher than the 9.2% prevalence in the 2016 general population [10]. In Angola, while no national KP size estimates have been published, recent data suggest HIV prevalence of 10.5% among FSW in 2016 [11] and 3.7% among MSM in 2011 [12]—both several times higher than the 2016 adult prevalence of 2.0%[13]. In both countries, data for transgender women (TGW) is virtually non-existent, with one report, presenting 2011 to 2012 data, suggesting HIV prevalence among Malawian TGW may be 16% [14].

Across Malawi and Angola, important geographical variations exist in which urban areas report higher HIV prevalence than rural ones. National HIV responses have increasingly focused on reaching populations in urban locales, including KP, to achieve ambitious UNAIDS 90-90-90 targets [15]. Realizing the "first 90" such that 90% of persons living with HIV (PLHIV), including KP, know their HIV status is important both for enabling PLHIV to start anti-retroviral therapy (ART) and for supporting HIV-negative people to access HIV prevention technologies. As demonstrated by recent national surveys from Malawi and other SSA countries, the most glaring challenge for HIV epidemic control remains reaching PLHIV unaware of their HIV status [2,16].

In SSA, national efforts to reach KP with HIV testing services (HTS) and other HIV prevention offerings have traditionally relied upon generalized, facility-based approaches [17-19]. Such approaches have not been tailored to the unique needs and preferences of KP nor sufficiently addressed the myriad barriers that make facility-based services inaccessible for many KP [3,20-22]. While scarce data from SSA describe the uptake and HIV positivity of KP-focused HTS delivered outside facilities [23], data from other regions suggest superior HTS uptake by KP of community- over facility-based approaches [24].

Since 2014, the PEPFAR-funded LINKAGES project has partnered with KP communities throughout SSA, including in five southern African countries, Malawi and Angola among them, to improve KP access to HIV prevention, treatment, and care [25]. Following WHO guidance, LINKAGES and other KP implementing partners have introduced programmes that involve KP as providers, such as KP peer educators and outreach workers, and deliver stigma-free HIV services closer to KP communities [4,26-31]. Emerging evidence suggests KP programmes incorporating such outreach activities may hold promise for engaging HIV-negative KP to prevent HIV acquisition and for accelerating HIV diagnosis and linkage to care for HIV-positive KP [32]. When KP outreach services include venues where people meet new sex partners (i.e. "hotspots"), there may be additional benefits, such as reaching other populations at risk for HIV [33].

To address pressing gaps along the HIV cascade for KP, two LINKAGES-supported countries in southern Africa—Malawi and Angola—requested PLACE (Priorities for Local AIDS Control Efforts) studies to inform LINKAGES programming. Using PLACE bio-behavioural survey data from each country, we aimed to identify outreach strategies to accelerate progress towards the first 90 for KP and to generate new, regionally relevant insights into barriers to HIV prevention faced by KP. In this report, we highlight unmet KP programming needs and opportunities for improved HIV diagnosis and KP engagement in urban outreach settings in Malawi and Angola.

2 | METHODS

2.1 | Ethics statement

The National Health Sciences Research Committee of Malawi (#15/7/1448), National Ethics Committee of the Ministry of Health of Angola, and University of North Carolina IRB (#15-1903, #15-1154) approved the study.

2.2 | PLACE background

PLACE is a research methodology used at the local level to identify where to reach people most likely to acquire and transmit HIV and to assess programming coverage and gaps among those persons. PLACE can be used to estimate key population size, as well as HIV prevalence and HIV cascade indicators for KP and other at-risk populations. PLACE methodology has been described extensively [33-36], and encompasses 5 steps (Figure 1). Programmatically relevant insights can be gained from steps 1 to 3 plus step 5 (data analysis); full PLACE requires completing all 5 steps, including the bio-behavioural survey (step 4). While PLACE is action-oriented and involves KP in implementation, the protocol is designed to produce findings about KP programming gaps and HIV diagnostic yield that are more reflective of the local epidemiology and on-the-ground challenges in outreach settings than specific to the method itself.

2.3 | PLACE geographical areas

In Malawi, six districts were selected for PLACE in response to national stakeholder guidance. One of these, Zomba, was selected for full PLACE based on implementing partner requests to identify pressing gaps along the HIV prevention-to-care continuum amenable to KP programming. In Angola, full PLACE data was available from two urban locales, Luanda and Benguela, selected using similar rationale [12,37].

2.4 | PLACE protocol overview

We implemented full PLACE concurrently in Malawi and Angola between October 2016—March 2017 as part of LINKAGES [38], using the same protocol adapted to each country's local context. Guided by PLACE steps (Figure 1), we first consulted local KP stakeholders through a mapping readiness assessment [39]. Second, field teams systematically identified venues where KP could be reached and where people meet new sex partners through surveys with knowledgeable community informants. Venues included bars, clubs, motels/rest houses, brothels, festivals, and other publically accessible places and events. Third, field teams visited and verified these venues and surveyed site informants to assess HIV prevention service availability. Fourth, trained interviewers and social mobilizers from KP groups returned to a sample of venues to administer the bio-behavioural survey to patrons and workers

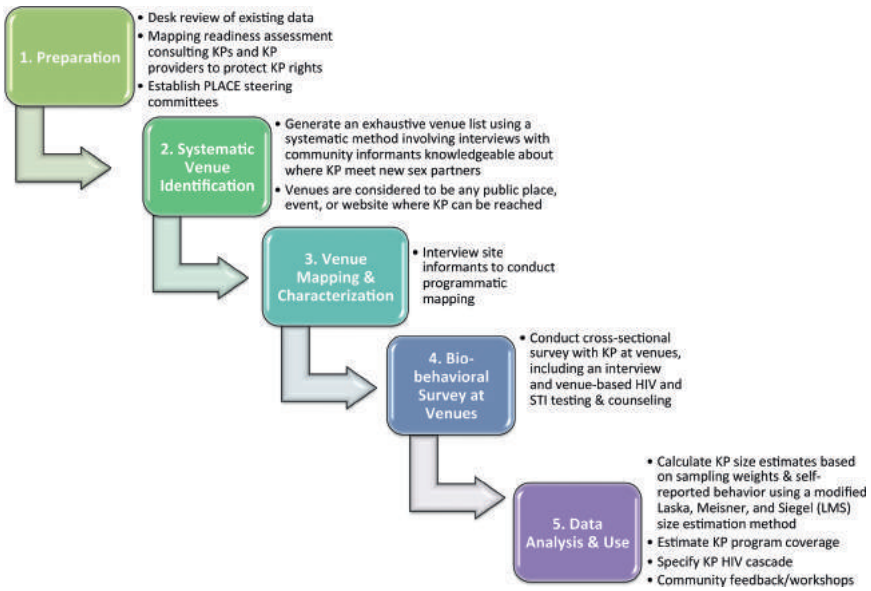

Figure 1. The five steps required for implementing the full PLACE protocol.

without regard to their KP status. We defined "patrons" as individuals socializing at, and "workers" as people employed by, the venue; either could include KP. Further details about PLACE are provided in the accompanying supporting information (Additional File 1).

2.5 | PLACE participants

For step 3, site informants must have been: (1) knowledgeable about the venue; (2) ≥18 years old; and (3) willing to provide informed consent.

For step 4, interviewers first asked patrons and workers several screening questions designed to: be feasible in outreach settings; include all KP and other at-risk populations based on less intrusive, general behavioural questions; avoid stigmatizing KP in public venues; and exclude people who would rarely classify as KP (Table 1). Screening questions were used to identify *potential* KP members only, and not to define participants as members of specific KP for the analysis. A random sample of individuals answering "yes" to ≥1 screening question were invited to participate in the bio-behavioural survey, which included HTS. If the interviewers identified individuals at the site known to be FSW, MSM, or TG, these individuals were also invited to participate. Participant eligibility criteria included people: (1) ≥15 years old (≥18 years in Malawi); (2) willing to provide written informed consent; (3) new to the study; and (4) not intoxicated. After data collection, when analysing participants' responses to sensitive questions exploring established KP behavioural factors, we applied internationally agreed upon definitions post hoc to assign a mutually exclusive KP classification of FSW, MSM, or TGW (Table 2) [4,40,41]. For our FSW definition, we included females who received money for sex in the last six months and those who identified as FSW since both could be reached at venues with HIV prevention services and both reported similar demographic and behavioural characteristics (Additional File 2).

Table 1. Screening questions for PLACE bio-behavioural survey.

Country	Population	Behavioural factors assessed
Angola	Men/TGW	In the past six months, have you: 1 Had anal sex with someone? 2 Met a new sex partner online?
	Women	In the past week, have you had: 1 >2 total sex partners?
Malawi	Men/TGW & Women	In the past three months, have you had: 1 >5 total sex partners? 2 Anal sex with anyone? 3 Sex with someone met online or on a phone app? 4 Missed taking prescribed medicine for a STI, such as HIV?

The following screening questions were used in each country to identify individuals to randomly select for participation in the PLACE bio-behavioural survey; individuals answering "yes" to ≥1 questions passed the screen.
TG, Transgender women; STI, Sexually transmitted infection; HIV, Human immunodeficiency virus.

2.6 | PLACE HTS and linkage to care procedures

All venues selected for full PLACE offered on-site HTS, as part of the bio-behavioural survey, at a discrete location selected in consultation with KP mobilizers and venue management, typically in a private room or project tent situated in a secluded area. All on-site HTS was performed using HIV-1/2 rapid antibody tests according to national guidelines [12,42], and was conducted by trained counsellors who underwent regular proficiency testing for quality assurance purposes. Screening was performed with Determine HIV-1/2 (Alere, Tokyo, Japan) followed by confirmatory testing with Uni-gold HIV-1/2 (Trinity Biotech, Bray, Co. Wicklow, Ireland). In cases

Table 2. Definitions for FSW, MSM, and TGW employed during PLACE data analysis.

Population	Definition for Angola & Malawi
FSW	Assigned female sex at birth and received money for sex in the past six months or identified as a sex worker at time of survey.
MSM	Assigned male sex at birth and identified as male at time of survey; plus had anal sex with a man, paid a man for sex (in last six months), had ≥1 male partner (in last month), or identified as gay or bisexual at time of survey.
TGW	Assigned male sex at birth and identified with female gender or as transgender at time of survey.

Definitions based on behavioural factors identified post hoc through participants' responses to questions in the bio-behavioural survey.
FSW, Female sex worker; MSM, Men who have sex with men; TGW, Transgender women.

of discordant or inconclusive results, repeat testing was done on a new sample: in Malawi, this involved repeat parallel testing and, in Angola, repeat serial testing [12,42].

All bio-behavioural survey participants provided voluntary informed consent for HTS separately. Study staff actively worked to link all participants with a new HIV diagnosis to care and treatment through phone and in-person follow-up and by connecting newly diagnosed individuals to peer health educators, where available. All participants received male condoms; no other reimbursement or incentive was provided.

2.7 | PLACE data collection

For step 2, trained interviewers administered a community informant survey that asked participants to name and characterize sites where people meet new sex partners, and generated a de-duplicated list of venues (Figure 1). For step 3, interviewers visited these venues to verify their existence and location, and to interview approximately one site informant per venue about site characteristics important for HIV prevention. Using this approach, we identified and verified a total of 1054 venues across Luanda, Benguela, and Zomba. Of these, field workers conducted bio-behavioural surveys and offered HTS at 166 sites, including: 57 randomly and purposively selected sites in Zomba; 68 randomly chosen sites plus six events selected purposively in Luanda; and 31 randomly chosen sites plus four purposively selected events in Benguela. Survey data were collected using a tablet. De-identified HIV test results were entered into Excel (Microsoft, Redmond, WA, USA). Survey and HIV testing data were subsequently linked through a unique identification number, and merged onto a secure database.

2.8 | Data analyses

We present frequencies, percentages, and 95% confidence intervals (CI) for categorical variables. For all bio-behavioural survey data, we weighted respondents according to their probability of being sampled following established methodology reported previously [43]. Using this methodology, we assigned people selected randomly or through screening higher weights than those selected purposively. Each venue where participants were interviewed was assigned a venue weight based on the probability of venue selection for Steps 3 to 4. The final sampling weights combined the venue weights with each individual's probability of being selected for an interview [43]. The estimated number of PLHIV unaware of their status at venues was calculated by applying the final sampling weights to the frequency of people with a positive HIV test but who did not self-report being HIV-positive, with CI calculations accounting for clustering by venue.

We estimated the association between outreach worker HIV prevention education and recent HIV testing, stratified by KP type, using bivariable log binomial regression and multivariable modified Poisson regression modelling and robust variance estimators. In our multivariable model, we controlled for age, country/locale and secondary education. We first conducted the analysis for each locale separately (data not shown). We then modelled results for each KP type, combining data from all locales, after demonstrating the homogeneity of the effect direction across the different geographic areas. All analyses were performed, using SAS 9.4 (Cary, NC, USA).

3 | RESULTS

3.1 | Overview

We first present results for 959 FSW, 836 MSM, and 129 TGW surveyed across all locales. We then summarize results from 1054 site informant interviews to contextualize HIV prevention availability.

3.2 | Demographic and behavioural characteristics

In Zomba, Malawi, FSW were mostly >25 years (55%), with 75% noting ≥1 new sex partner in the past four weeks. MSM and TGW were young with 76% and 82% <25 years, respectively. Approximately, 72% and 75% of MSM and TG, respectively, reported ≥1 new sex partner in the past four weeks.

In Angola, 55% of FSW were >25 years, and 89% had ≥1 new sex partner in the past four weeks. Angolan MSM and TGW were older than their Malawian counterparts with 59% and 67%, respectively, being >25 years. Approximately, 85% and 91% of MSM and TGW, respectively, reported ≥1 new sex partner in the past four weeks.

3.3 | HIV prevalence and testing

HIV prevalence ranged from 2% (95% CI: 1% to 5%) to 62% (95% CI: 54% to 72%) depending on KP group and locale (Table 3). In Zomba, most FSW, MSM, and TGW had received HTS within the last six months, whereas in Angola, <25% of KP reported HTS in the past six months. Based on the weighted population prevalence, we estimated that 71% of KP living with HIV (KPLHIV) across all locales were not previously aware of their HIV status and received a new HIV diagnosis through PLACE venue-based HTS. The proportion of KPLHIV newly HIV diagnosed through venue-based HTS was highest

Table 3. HIV prevalence and HIV testing practices among KP who socialize at venues.

	Total Sample[a]			Population Prevalence[b]								
	FSW (N = 954)	MSM (N = 832)	TGW (N = 126)	Zomba, Malawi[a]			Luanda, Angola			Benguela, Angola		
	n	n	n	FSW n = 106	MSM n = 119	TGW n = 53	FSW n = 505	MSM n = 457	TGW n = 46	FSW n = 343	MSM n = 256	TGW n = 27
Total HIV-positive	118	22	9	62%	2%	20%	8%	2%	9%	5%	3%	6%
Self-Reported	43	4	2	60%	50%	77%	20%	28%	57%	4%	7%	0%
Newly diagnosed by Venue-based Outreach HTS	75	18	7	40%	50%	23%	80%	72%	43%	96%	93%	100%
Ever tested for HIV and received test results	550	393	80	88%	75%	72%	53%	47%	65%	58%	36%	41%
In the last six months, tested for HIV and received test results	187	164	50	75%	54%	65%	16%	17%	24%	9%	6%	21%

FSW, Female sex worker; MSM, Men who have sex with men; TGW, Transgender women; HTS, HIV testing services; HIV, human immunodeficiency virus.
[a]5 FSW, 4 MSM and 3 TGW did not test for HIV or had invalid results.
[b]Population prevalence is weighted based on venue-based sampling strategy.

among TGW, ranging from 23% (Zomba) to 100% (Benguela). We estimate that a combined 2022 HIV-positive KP (95% CI: 1649 to 2477) who currently do not know their status could be newly diagnosed via venue-based HTS should HTS be taken to scale in all study locales, including 1666 FSW (95% CI: 1397 to 1987), 274 MSM (95% CI: 160 to 374), and 82 TGW (95% CI: 20 to 197).

3.4 | Access to basic HIV prevention

KP respondents frequently reported recent condomless penile-vaginal and anal sex (Table 4). Despite the prevalence of high-risk sex, few respondents reported having a condom on their person or recently obtaining free lubricant. Similarly, in Zomba and Luanda, ≤50% of all participants reported receiving health information on site from an outreach worker. In Benguela, availability of this service was only slightly more common.

Across locales, receiving HIV/AIDS information from an outreach worker was significantly associated with having undergone HIV testing in the past six months for FSW and MSM, but not for TGW (Table 5). The association observed among FSW and MSM remained statistically significant after controlling for age, education, and country/locale. In the multivariable model, FSW, MSM, and TG who received HIV/AIDS education from an outreach worker were 3.15 (95% CI: 1.99 to 5.01), 3.12 (95% CI: 2.17 to 4.48), and 1.80 (95% CI: 0.67 to 4.87) times as likely, respectively, as those who did not to have undergone HTS within the last six months.

3.5 | Access to other prevention

A clinically meaningful proportion of respondents reported a recent genital sore (Table 6). Despite this, <50% of participants reported having undergone a STI evaluation by a medical provider within the last year.

High symptom prevalence was also reported for tuberculosis (TB) (Table 6). Across locales, 15% to 38% of respondents endorsed ≥1 current TB symptom [44], but only 0% to 11% of participants reported providing a sputum sample for TB testing within the last year.

3.6 | Outreach HIV prevention service availability

Across locales, venue-based outreach services were infrequently available, with ≤68% of site informants reporting any on-site HIV prevention service availability (Table 7). On-site HTS and outreach worker-led prevention education were uncommonly reported.

4 | DISCUSSION

We report a high proportion of KPLHIV who were previously unaware of their HIV status before being newly diagnosed through venue-based HTS, including one of the first accounts of HIV prevalence and testing histories among TGW from Angola or Malawi. Despite the number of new HIV diagnoses

Table 4. Unmet needs for basic HIV prevention services among KP who socialize at venues.

Unmet Needs	Total Sample			Population Prevalence[a]								
	FSW (N = 959)	MSM (N = 836)	TGW (N = 129)	Zomba, Malawi			Luanda, Angola			Benguela, Angola		
	n	n	n	FSW n = 111	MSM n = 123	TGW n = 56	FSW n = 505	MSM n = 457	TGW n = 46	FSW n = 343	MSM n = 256	TGW n = 27
Recent penile-vaginal sex[b]	915	645	60	88%	77%	72%	95%	72%	17%	100%	95%	59%
Recent condom-less penile-vaginal sex[b]	655	490	44	67%	62%	52%	73%	79%	91%	70%	71%	86%
Recent anal sex with a man[b]	383	756	117	19%	75%	79%	57%	94%	94%	23%	89%	67%
Recent anal sex without a condom[b]	273	455	69	98%	70%	72%	71%	55%	46%	62%	67%	56%
Has condom on person at time of interview	263	237	42	46%	18%	19%	33%	42%	56%	12%	14%	16%
Obtained free lubricant in the past six months	155	163	36	34%	15%	10%	21%	24%	34%	5%	15%	18%
Received information about HIV/AIDS from outreach worker at venue in last 12 months	428	298	46	50%	23%	31%	36%	30%	31%	60%	52%	57%

FSW, Female sex worker; MSM, Men who have sex with men; TGW, Transgender women; HIV, human immunodeficiency virus; AIDS, Acquired immune deficiency syndrome.
[a]Population prevalence is weighted based on venue-based sampling strategy.
[b]"Recent" refers to a period within three months of survey administration in Malawi, and six months of survey administration in Angola.

Table 5. Estimated effects of HIV/AIDS education delivered by outreach workers on HIV testing uptake within the past six months.

Participant Type	Received information about HIV/AIDS from an outreach worker at the venue in last 12 months?	Unadjusted		Adjusted[a]	
		PR 95% CI	*p*-value	PR 95% CI	*p*-value
FSW	Yes	3.23 (2.01, 5.17)	<0.01	3.15 (1.99, 5.01)	<0.01
	No	1.00		1.00	
MSM	Yes	3.05 (2.10, 4.43)	<0.01	3.12 (2.17, 4.48)	<0.01
	No	1.00		1.00	
TGW	Yes	0.80 (0.18, 3.58)	0.78	1.80 (0.67, 4.87)	0.25
	No	1.00		1.00	

PR, Prevalence ratio; CI, Confidence interval; FSW, Female sex worker; MSM, Men who have sex with men; TGW: Transgender women.
[a]Adjusted for age, country/locale, and education level.

made through PLACE, KP and site informants reported limited access to HTS and other venue-based prevention services. We note that HTS can be delivered at venues, enabling new HIV diagnoses in individuals not previously aware of their HIV status. Venue-based HTS may be particularly impactful for KP who socialize at venues, many of whom report not having received HTS in the past six months, but who may potentially be more likely to undergo HTS if they receive HIV/AIDS information from an outreach worker. Delivering outreach HTS alongside other HIV prevention services may represent an

Table 6. Opportunities for outreach screening and treatment for STIs and TB per KP who socialize at venues.

	Total Sample			Population Prevalence[a]								
	FSW (N = 959)	MSM (N = 836)	TGW (N = 129)	Zomba, Malawi			Luanda, Angola			Benguela, Angola		
Symptom/Service	n	n	n	FSW n = 111	MSM n = 123	TGW n = 56	FSW n = 505	MSM n = 457	TGW n = 46	FSW n = 343	MSM n = 256	TGW n = 27
In past four weeks, had genital sore	118	119	16	13%	7%	13%	11%	13%	16%	12%	22%	10%
In past 12 months, examined/tested by a medical provider for STI (other than HIV)	251	235	30	36%	21%	27%	27%	28%	24%	25%	38%	34%
With symptoms compatible with possible TB (cough, fever, night sweats, weight loss)[b]	188	165	25	15%	18%	21%	21%	18%	38%	18%	24%	15%
In the past 12 months, provided a sputum sample for TB diagnostic test	37	57	7	9%	4%	10%	2%	4%	1%	4%	11%	0%

FSW, Female sex worker; MSM, Men who have sex with men; TGW, Transgender women; STI, Sexually transmitted infection; HIV, human immunodeficiency syndrome; TB, tuberculosis.
[a]Population prevalence is weighted based on venue-based sampling strategy.
[b]Adapted from the World Health Organization 4-symptom TB screen for persons living with HIV [44].

Table 7. Availability of any outreach HIV prevention services at venues per community site informants.

	Zomba, Malawi % (n = 166)	Luanda, Angola % (n = 536)	Benguela, Angola % (n = 352)
Any HIV/AIDS prevention service available on site within the past six months?[a]	68%	57%	24%
Any on-site HIV testing service within the past six months?	2%	6%	1%
Any availability of male condoms (free or for sale) in the past six months?	61%	51%	21%
Any availability of lubricant (free or for sale) in the past six months?	2%	27%	3%
Any safe sex education offered by an outreach worker within the past six months?	7%	12%	4%
Any visits by a mobile clinic within the past six months?	1%	3%	0%

HIV, human immunodeficiency virus; AIDS, Acquired immune deficiency syndrome.
[a]Any prevention" encompasses ≥1 of the following services: male condoms, lubricant, HIV testing, outreach/peer worker services, mobile clinic or needle exchange.

effective strategy to accelerate progress towards the first 90 for KP in SSA.

Our study demonstrated that more than 70% of HIV-positive KP were not previously aware of their HIV status and received a new HIV diagnosis through venue-based HTS. These new diagnoses were made even though most participants reported having previously tested for HIV. These data align with recent evidence from Malawi where relatively few MSM and FSW living with HIV were previously aware of their HIV status [6,9,45]. We estimate that over 2000 KPLHIV who do not currently know their status could be newly diagnosed if venue-based HTS were expanded to all venues in the studied locales. Providing HIV/AIDS information via an outreach strategy could help facilitate such scale up based on our

finding that outreach worker-led education was associated with increased recent HIV testing for FSW and MSM—an observation among the first of its kind from SSA. The fact that this association was not observed among TGW people warrants further study, and may reflect the scarcity of TGW-tailored outreach services in SSA [14,46].

Venue-based HTS may also provide opportunities to serve other at-risk populations unaware of their HIV status. For example, among 720 non-MSM, cisgender men tested across study locales, 3% were found to be HIV positive, and of these, 76% were newly diagnosed. Similarly, HIV prevalence among all 380 non-FSW female respondents was 2%, and 84% of these were newly diagnosed. These results suggest venue-based HTS may be an underutilized strategy to improve testing coverage among men, single adults, and other populations not currently served by more traditional HTS approaches [47].

Beyond HTS, the high proportion of disclosed high-risk behaviours, including condomless sex, suggest a large unmet need for HIV prevention services. Indeed, inconsistent condom use among MSM has previously been identified as a risk factor for prevalent HIV infection in Malawi [3]. Despite the documented need and obvious public health importance, free condom and lubricant provision was infrequently reported at venues. Limited access to free condoms and condom-compatible lubricant is particularly problematic for MSM and FSW who must overcome multiple structural barriers to purchase or carry these commodities [48,49]. It is not surprising, then, that prevalence of self-reported recent genital sore was relatively high in our study, exceeding 10%. Such genital sores and STIs are easily amenable to syndromic management or point-of-care diagnosis and tailored treatment, either of which could be reliably provided in an outreach setting by a trained provider.

To improve access to these services, new approaches are urgently needed that involve KP leaders and serve as a bridge between communities and traditional service delivery platforms [32,50]. Hybrid models that link HIV prevention services provided by KP community groups with treatment offered through national ART programmes may be one such approach [30]. In the hybrid model, outreach HTS can serve as an entry point to ART offered through government clinics or community-based drop-in-centres. For such an approach to succeed, HTS entry points must be expanded and facilitated linkage to care strengthened [23,51].

Given the preponderance of high-risk behaviours, limited STI screening, and substantial HIV diagnostic yield reported here, our study provides evidence to support greater focus on delivering venue-based outreach services in SSA. A basic service package could include: HTS, outreach HIV prevention education, free condoms and lubricant, STI and TB screening and treatment, and peer navigator support to help newly HIV-diagnosed KP link to care and initiate ART [52,53]. Such a package echoes ongoing efforts to reach KP in SSA [27,28,32]. While the cost-effectiveness of such services requires further investigation, modelling data suggest that simply focusing HIV prevention interventions on the places and populations with highest risk could advert thousands of new infections without requiring additional resourcing [54].

Due to the cross-sectional nature of our study, we could not infer causality nor evaluate the effects of venue-based HTS, or other outreach services, on longitudinal HIV-related outcomes, including successful linkage to care for newly HIV-diagnosed KP. In addition, the low HIV prevalence identified among MSM in Zomba, compared to prior Malawi estimates [9,55], raises the possibility that some sites where MSM socialize were missed, or that some PLHIV who already knew their status declined participation because HTS was a required study procedure. Finally, our pragmatic approach precluded us from carrying out more time-intensive study procedures, such as in-depth interviews, to fully assess KP attitudes and preferences regarding venue-based HIV services.

For any service delivery model to succeed, KP constituency engagement and support for model design, implementation, and monitoring is essential [30,50], as is involving public-sector partners to ensure universally accessible HIV, STI, and TB prevention, treatment, and care. With greater resourcing, hybrid models providing venue-based outreach services could expand to include mobile clinics employing trained health workers and peer navigators to provide a comprehensive suite of health services aligned with international normative guidance [4,31].

5 | CONCLUSIONS

If efforts to promote KP human rights and achieve epidemic control in SSA are to be realized, service providers must take advantage of all opportunities to expand access to HTS, and other HIV prevention services, for KP and other at-risk groups. Venue-based outreach may be one such opportunity to serve these populations at the sites where they socialize. While the capacity of many providers may be insufficient to offer a full HIV service delivery package in outreach settings, this need not be an excuse for inaction. Rather, offering on-site HTS and a basic suite of HIV prevention services can be an important initial step towards reaching the "first 90" and increasing access to HIV services for those who need them most.

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ACKNOWLEDGEMENTS

FUNDING

This project was funded with the generous support of the American people through the United States Agency for International Development (USAID) cooperative agreement #AID-OAA-A-14-00045. The contents of this manuscript are the sole responsibility of the study authors and do not necessarily reflect the views of USAID or the United States government. Funding agencies had no role in the study design, data collection or analysis, manuscript writing, or the decision to submit for publication. We acknowledge the contributions of Ernest Mlenga, John Chapola, and Risa Teresky in overseeing PLACE activities in Zomba, Malawi. We thank Ana Diaz and Melchiade Ruberintwari for their in-country leadership on LINKAGES and support of PLACE implementation in Angola and Malawi, respectively.

AUTHORS' CONTRIBUTIONS

MEH, WMM and SSW had overall responsibility for implementing the study, and conceived and designed the study, analysed the data, and led the manuscript writing. MEH, WMM, AB, JKE, KEL, IM and SSW contributed to developing the study concept and design. AB, PS, WMM and SSW contributed to data collection. WMM, JEL and SSW assisted with data analysis and results interpretation. MEH, WM and SSW contributed to drafting the manuscript. All authors reviewed the manuscript critically for intellectual content. All authors read and approved the final draft of the submitted manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:
Additional file 1: Angola PLACE protocol
Additional file 2: Table S1. Demographic and behavioural characteristics of women identifying as FSWs and women reporting receiving money for sex in the last six months.

Kan M et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25139
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25139/full | https://doi.org/10.1002/jia2.25139

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

Social network methods for HIV case-finding among people who inject drugs in Tajikistan

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Abstract

Introduction: HIV testing programmes have struggled to reach the most marginalized populations at risk for HIV. Social network methods such as respondent-driven sampling (RDS) and peer-based active case-finding (ACF) may be effective in overcoming barriers to reaching these populations. We compared the client characteristics, proportion testing HIV positive (yield), and number of new cases found through two RDS strategies and an ACF approach to HIV case-finding among people who inject drugs (PWID) in Tajikistan.

Methods: Routine programme data from adult PWID recruited to testing under the HIV Flagship Project in Tajikistan were analysed to compare client demographic and clinical characteristics across the three approaches. We also compared the number of previously untested clients, the number of new HIV cases found, and the yield across the case-finding strategies, and evaluated predictors of new HIV diagnosis using fixed-effects logistic regression.

Results: From 24 October 2016 to 30 June 2017, Flagship tested 10,300 PWID for HIV, including 2143 under RDS with unrestricted waves (RDS1, yield: 1.5%), 3517 under restricted RDS (RDS2, yield: 2.6%), and 4640 under ACF (yield: 1.5%). Clients recruited under ACF were similar in age (35.8 vs. 36.8) and gender (91% vs. 90% male) to those recruited through RDS, though ACF clients were more likely to report being a first-time tester (85.1% vs. 68.3%, $p < 0.001$). After controlling for age, sex, previous testing history and accounting for clustering at the site level, we found that clients tested under both RDS1 (aOR: 1.74, 95% CI: 1.04 to 2.90) and RDS2 (aOR: 1.54, 95% CI: 1.11 to 2.15) had higher odds of testing newly positive for HIV relative to clients recruited through ACF. We did not find significant differences in the odds of new HIV infection between those recruited from RDS1 versus RDS2 (aOR: 1.12, 95% CI: 0.67 to 1.86).

Conclusions: RDS-based interventions resulted in higher yields and overall case-finding, especially when recruitment was restricted. However, ACF identified a higher proportion of first-time testers. To find at least 90% of PWID living with HIV in Tajikistan, it may be necessary to implement multiple case-finding approaches concurrently to maximize testing coverage.

Keywords: HIV; AIDS; Central Asia; Tajikistan; case-finding; network; respondent driven sampling

Additional Supporting Information may be found online in the Supporting information tab for this article.

Received 13 December 2017; **Accepted** 22 May 2018

1 | INTRODUCTION

While national HIV prevalence in Tajikistan is 0.3%, prevalence among the estimated 23,000 people who inject drugs (PWID) in the country is 13.5% [1]. Though PWID represent <0.3% of the total population in Tajikistan, they make up approximately 19% of all PLHIV in the country [2]. Data also suggest that HIV testing coverage among PWID remains inadequate [3] to meet the UNAIDS 90-90-90 goals. There is an urgent need to expand testing services and treatment among PWID in Tajikistan, who are disproportionately impacted by HIV.

To improve HIV case-finding among PWID in Tajikistan, the USAID Central Asia HIV Flagship Project (Flagship) aims to rapidly scale-up HIV case-finding and linkage to care using two methods: respondent driven sampling (RDS) and active case-finding (ACF). RDS was originally designed as a technique for generating a representative sample in hidden or hard-to-reach populations for which a sampling frame is not available [4]. RDS uses a snowball-sampling approach [5] in which initial "seeds" are recruited and provided with coupons to distribute to their peers. Seeds typically receive an incentive for each peer recruited, who are in turn provided with a small, primary incentive, and given additional coupons to recruit their peers. When these coupons are returned, a small secondary incentive is provided to the recruiter. Recruitment continues as such until the required sample size is reached [6].

As a recruitment technique, RDS is susceptible to bias [7], in part because recruiters tend to recruit others like themselves [7,8]. Researchers have hypothesized that these biases could be leveraged to over-recruit from high-risk networks, thereby using RDS as an effective HIV case-finding technique [9,10]. Because "like recruits like," RDS may be used to find new cases of HIV by having PLHIV recruit others from their social network, who themselves are more likely to be PLHIV. Previous research with PWID in Mexico tested this idea and found HIV-infected PWID were more likely to recruit other PLHIV than their HIV-uninfected peers [9].

While the potential of RDS for HIV case-finding has been explored [11], less is understood about the optimal approach to implementation under programmatic conditions, including the number of waves of recruitment that should be undertaken and the number of coupons that should be distributed to HIV-negative and positive recruits. To better understand the optimal strategy at scale, Flagship deployed two RDS strategies, as well as a peer-based ACF intervention, during the first nine months of programme implementation. Under the first approach (RDS1), recruitment could continue indefinitely, with each PWID tested receiving additional coupons to recruit members of his/her social network. Under the second approach (RDS2), recruitment was stopped after two HIV-negative waves (e.g. if two successive individuals were recruited who were HIV-negative, no coupons were provided for further recruitment). Under the ACF intervention, "Peer Navigators" (PN) – individuals who were themselves living with HIV, on treatment, or who were current/former PWID – recruited their peers for HIV testing services (HTS) through direct outreach. These same PNs also recruited seeds for the RDS interventions and provided case-management services to PLHIV identified by the project (Additional file 1).

Using routine programmatic data from the Flagship Project's monitoring information system (MIS), we evaluated the yield, number of new HIV cases found, and the demographic characteristics (age, sex, HIV testing history, etc.) of those tested under each approach. The findings are intended to inform the scale-up of social network interventions for HIV case-finding among PWID in Tajikistan, and the implementation of other social-network based interventions targeting hard-to-reach populations.

2 | METHODS

2.1 | Programme population

We analysed routine programmatic Flagship data from three sub-national units (Dushanbe City, Districts of Republican Subordination (DRS), and Sughd Oblast) in Tajikistan from 24 October 2016 to 30 June 2017. Subjects included seeds and recruits identified through RDS1, RDS2, and ACF. Eligibility criteria under the project included age ≥18, self-report of injecting drugs in the preceding six months and/or evidence of injection drug use (e.g. track-marks), and no self-reported HIV testing in the preceding six months.

All clients recruited to the programme were screened for eligibility and basic demographic data (e.g. age, sex, previous HIV testing and results) were collected using a paper-based programme intake form from which de-identified data were entered into the project MIS. Clients were tracked using a unique identifier code (UIC), and no personal client identifiers (e.g. name, phone number, address) were included in the database. Data were collected as a part of routine service delivery, and the Population Services International Research Ethics Board granted a non-research determination for this analysis. Flagship clients provided verbal consent for HIV testing and the collection of health-related data.

2.2 | Project design and procedures

Under both RDS1 and RDS2, PNs were instructed to select seeds with large social networks who would be committed to coupon distribution. Seeds were primarily PWID living with HIV and were selected to reflect underlying population diversity in terms of residence, age, sex, and duration of injecting behaviour. Seeds were provided with three coupons to distribute to PWID in their networks. Seeds were instructed to recruit those who had not had a recent HIV test (defined as not having tested within the preceding six months).

Recruits were escorted for HTS at AIDS Centers or underwent rapid-testing in the community. Recruits received a small non-cash incentive (equivalent to $3 USD) after testing, as well as three recruitment coupons, and instructions on who to recruit and how to do so. Recruiters received an additional non-cash incentive (equivalent to $1.50 USD) for each additional member of their networks who redeemed a coupon and underwent testing. RDS1 recruitment could continue indefinitely, and no limits were placed on the number of successive waves. RDS2 recruitment ceased after two HIV-negative waves but could continue in chains where a recruit tested HIV-positive.

The ACF approach was based on the concept of continuously sourcing new networks of PWID and offering them HIV testing. PWID working as ACF PNs offered HTS to other PWID through community outreach, prioritizing communities with large numbers of PWID and low HIV testing coverage. PNs were given weekly targets for new PWID tested and new HIV cases found, with targets managed closely through supportive supervision. Clients recruited through ACF also received a small, non-cash incentive (equivalent to $3 USD) after testing.

Any PWID testing positive were linked to confirmatory HTS at the government AIDS Center. Those confirmed HIV-positive were enrolled into Flagship's case management programme and linked to public sector care and treatment. Clients testing HIV-negative were provided with referrals to prevention services, including opioid substitution therapy (OST) and needle and syringe programmes (NSPs).

2.3 | HIV testing

HTS occurred through two channels: referrals to AIDS centres (from October 2016 to June 2017) and rapid testing at non-governmental organizations (NGOs) or in the community (since April 2017). Prior to introducing rapid testing, clients were referred to AIDS centres for testing conducted according to the national algorithm [12]. After rapid tests were introduced, trained PNs tested clients using OraQuick HIV ½ Rapid Antibody test kits, (OraSure Technologies, Inc., Bethlehem, PA, USA). Rapid tests were performed at implementing NGOs under RDS and by trained PNs in the field for ACF. All clients testing positive on a rapid test were escorted to an

AIDS centre for confirmatory testing according to the national algorithm [12]. Clients diagnosed with HIV were traced in the national treatment database by AIDS centre staff at the time of confirmatory testing to identify clients already on pre-antiretroviral therapy (ART)/ART. Clients not already registered in the national database were considered "newly diagnosed." Identifiable data used for tracing were not collected by the Flagship project, and were not entered into the project MIS.

2.4 | Statistical analysis

We compared the number of participants tested, the number/proportion of new testers, the number/proportion of women tested, the age of recruits, the number of new HIV cases found, and the yield across the three approaches using Pearson's χ^2 test or Fisher's exact test (for binary variables) and t-tests or Wilcoxon rank sum tests (for continuous variables). Yield was defined as the proportion of clients who were HIV-positive on their first test, divided by the total number of respondents tested (excluding seeds). We also evaluated the characteristics of recruitment effectiveness by comparing HIV-positive and HIV-negative recruits. To ensure comparability across approaches, we analysed all programme data from 4 to 5 months of implementation for each of the three approaches.

Predictors of new HIV diagnosis were evaluated using fixed-effects logistic regression [13], with a term to account for clustering at site level. A univariate model comparing odds of new HIV infection across the three recruitment strategies was fitted, and demographic factors were added based on univariate significance of <0.10 and/or programmatic or epidemiological importance. Model fit was compared using Bayesian information criterion, and variance inflation factors were evaluated to check for multicollinearity. All analyses were performed using STATA 13.0 (Stata Corporation, College Station, TX, USA).

3 | RESULTS

3.1 | Description of recruits across methods

Flagship tested a total of 10,300 PWID for HIV in Tajikistan between 24 October 2016 and 30 June 2017 (Table 1). Altogether 181 seeds and 2143 (20.8%) PWID recruits were tested under RDS1, compared to 264 seeds and 3517 (34.1%) recruits under RDS2. A total of 4640 (45.0%) PWID were tested under the ACF approach. Flagship diagnosed 190 preliminary positive HIV cases, for an overall yield of 1.8%. Of these, Flagship PNs escorted 152 (80%) new preliminary positive HIV cases to confirmatory testing, and 133 of these (87.5%) were initiated onto treatment. Most PWID were recruited from Sughd Oblast (4399, 42.7%), with another 3211 (31.2%) from the DRS, and 2690 (26.1%) from Dushanbe City. Most HIV cases were from Sughd Oblast (117/190, 61.6%), with a smaller proportion from the DRS (42, 22.1%) and Dushanbe City (31, 16.3%). Overall yield ranged from 1.2% in Dushanbe City to 2.7% in Sughd Oblast.

RDS1 was conducted between 24 October 2016 to 21 February 2017, recruiting an average of 17.9 clients daily (Figure 1A). Altogether 32 (1.5%) RDS1 clients were newly diagnosed with HIV. RDS2 ran from 22 February 2017 to 30 June 2017, with an average daily recruitment rate of 27.5 clients (Figure 1B). A total of 90 (2.6%) RDS2 clients were newly diagnosed with HIV. ACF ran from 9 January 2017 to 30 June 2017 and tested an average of 27 clients per day. The ACF approach identified 68 (1.5%) newly diagnosed HIV cases (Figure 1C). Yield was similar between RDS1 and ACF (1.54% vs. 1.47%, $p = 0.414$), but was slightly higher under RDS2 compared to ACF (2.6% vs. 1.5%, $p < 0.001$).

Most Flagship clients were male (87.6%) (Table 1), though the proportion of females was higher among those tested under RDS1 (13.0%) compared to ACF (8.9%) and RDS2 (8.8%) ($p < 0.001$). Clients averaged 36.3 years of age. Clients recruited through ACF were slightly younger on average (35.8 years) than those recruited through RDS (RDS1: 37.9; RDS2: 36.1, $p < 0.001$). Approximately, 68% of clients reached through RDS were self-reported first-time testers, compared to 85% of ACF clients ($p < 0.001$).

3.2 | Yield across approaches

Yield among females was higher than among males for both RDS (4.6% for females vs. 1.9% for males, $p < 0.001$) and ACF (4.4% vs. 1.2%, $p < 0.001$) (Table 2). Among self-reported new testers, testing yield was higher under RDS than ACF (2.4% vs. 1.4%, $p = 0.002$), though no differences were observed in yields between ACF and RDS among those who had previously tested (1.7% vs. 1.7%, $p = 0.910$).

Yield was higher among RDS clients who reported having had sex with their recruiter (6.5% vs. 2.0%, $p = 0.001$) or sharing a needle with their recruiter (3.7% vs. 1.5%, $p = 0.009$). Yield was higher among clients testing under RDS2 versus RDS1 across most demographic groups (Table 3), including men and previous testers. HIV-positive recruiters had a higher overall yield among those they directly recruited than HIV-negative recruiters (5.3% vs. 2.6%, $p = 0.002$).

3.3 | Seed characteristics

Altogether 445 seeds were recruited for RDS, including 181 (40.7%) under RDS1 and 264 (59.3%) under RDS2 (Table 4). Seeds were majority HIV positive (94.8%), male (84.0%), and averaged 40.2 years old. Most seeds were married (51%) and recruited through community networks (64.9%) or referred by the AIDS Centre (32.7%). Altogether 200 (44.9%) seeds were launched in Sughd Oblast, 95 (21.4%) in DRS, and 150 (33.7%) in Dushanbe City. PLHIV seeds had smaller average self-reported network sizes compared to HIV-negative seeds (11.1 vs. 20.8, $p < 0.001$). Coupon redemption did not differ significantly between HIV-positive seeds and HIV-negative seeds (mean coupon redemption: 0.97 vs. 0.94, $p = 0.579$). Yield within HIV positive seed chains was 2.6% compared to 3.3% for chains started by HIV-negative seeds ($p = 0.571$).

3.4 | Predictors of new HIV infection

On univariate analysis, recruitment through RDS1 or RDS2 (compared to ACF) was associated with increased odds of new HIV diagnosis (OR: 1.57, 95% CI: 1.15 to 2.16) (Table 5). Older age (OR: 1.03, 95% CI: 1.01 to 1.04) and female sex (OR: 3.37, 95% CI: 2.36 to 4.81) were also associated with increased odds of HIV infection. In the adjusted models,

Table 1. Demographic and clinical characteristics of people who inject drugs recruited to HIV testing in Tajikistan

Variable	Total (N = 10,300) N (%)	RDS1 (n = 2143, 20.8%) n (%)	RDS2 (n = 3517, 34.2%) n (%)	ACF (n = 4640, 45.1%) n (%)	*p*-value
Female	1001 (10.4)	279 (13.0)	311 (8.8)	411 (8.9)	<0.001
Geography					<0.001
Dushanbe City	2690 (26.1)	739 (34.5)	1011 (28.8)	940 (20.3)	
Districts of Republican Subordination	3211 (31.2)	434 (20.3)	681 (19.4)	2096 (45.2)	
Sughd Oblast	4399 (42.7)	970 (45.3)	1825 (51.9)	1604 (34.6)	
Age (mean, standard deviation (SD))	36.4 (8.8)	37.9 (9.2)	36.1 (8.5)	35.8 (8.7)	<0.001
Non-government organization					<0.001
Bovari	552 (5.4)	552 (25.8)	0 (0.0)	0 (0.0)	
Marvorid	937 (9.1)	336 (16.2)	188 (5.4)	403 (8.7)	
Nasli Javoni	651 (6.3)	651 (30.4)	0 (0.0)	0 (0.0)	
Spin Plus	2138 (20.8)	187 (8.7)	1011 (28.8)	940 (20.3)	
Dina	2328 (22.6)	209 (9.8)	1016 (28.9)	1103 (23.8)	
Buzurg	534 (5.2)	22 (1.0)	329 (9.4)	183 (3.9)	
Guli Surkh	1631 (15.8)	45 (2.1)	249 (7.1)	1337 (28.8)	
Rokhi Zindagi	886 (8.6)	88 (4.1)	480 (13.7)	318 (6.9)	
Tajikistan Network	643 (6.2)	43 (2.0)	2440 (6.9)	356 (7.7)	
Recruitment wave					<0.001
1	1275 (22.5)	406 (19.0)	869 (24.7)	–	
2	3264 (57.3)	823 (38.4)	2441 (69.4)	–	
3	599 (10.6)	410 (19.1)	189 (5.4)	–	
4	305 (5.4)	287 (13.4)	18 (0.5)	–	
5	137 (2.4)	137 (6.4)	0 (0.0)	–	
6	58 (1.0)	58 (2.7)	0 (0.0)	–	
7	13 (0.2)	13 (0.6)	0 (0.0)	–	
8	5 (0.1)	5 (0.2)	0 (0.0)	–	
9	4 (0.1)	4 (0.2)	0 (0.0)	–	
Never tested for HIV	7818 (75.9)	1448 (67.6)	2420 (68.8)	3950 (85.1)	<0.001
Shared needles with recruiter	1398 (24.7)	620 (28.9)	778 (22.1)	–	<0.001
Had sex with recruiter	123 (2.2)	58 (2.7)	65 (1.9)	–	0.032
Migration experience	5374 (52.2)	923 (43.0)	1743 (49.6)	2706 (58.3)	<0.001
Network size (mean, SD)	7.7 (6.4)	7.5 (6.4)	7.8 (6.5)	–	0.034
HIV positive	190 (1.8)	32 (1.5)	90 (2.6)	68 (1.5)	0.001

RDS1, respondent-driven sampling with unrestricted recruitment; RDS2, RDS with restricted recruitment (in which recruitment is stopped after two HIV-negative waves, but allowed to proceed otherwise); ACF, active case-finding (peer-led, community-based HIV case-finding).

previous HIV testing (Model 2 aOR: 0.61, 95% CI: 0.42 to 0.90) and female sex (Model 2 aOR: 2.82, 95% CI: 1.72 to 4.64) were associated with odds of new HIV infection. Odds of a new HIV diagnosis did not differ significantly between those recruited through RDS1 versus RDS2 in any of the models.

4 | DISCUSSION

Strategies leveraging the social networks of PLHIV may improve the efficiency and effectiveness of HIV case-finding programmes. Approaches such as index testing and assisted partner notification [14], as well as RDS methods [12] have shown high yields under programmatic conditions, and may be effective ways to close the testing gap, especially for hidden and hard-to-reach populations. Testing programmes also serve as important entry points for prevention services. Recent research suggests that interventions that link PWID to services such as OST and NSPs are likely to be very cost-effective, if not cost-saving, in Central Asian contexts, in addition to having a significant impact on HIV transmission and injecting behaviour [15].

The two variations on RDS-based case-finding presented here leveraged social networks in an effort to increase HIV case-finding and linkages to treatment and prevention among PWID in Tajikistan. Together these approaches identified a total of 190 preliminary positive cases of HIV, linked 152 of these (80%) to confirmatory testing, and put 133 (87.5%) new clients on treatment. This represented a substantial proportion of all HIV tests conducted and new HIV cases found in the programme areas. Coupon generation, incentive delivery and

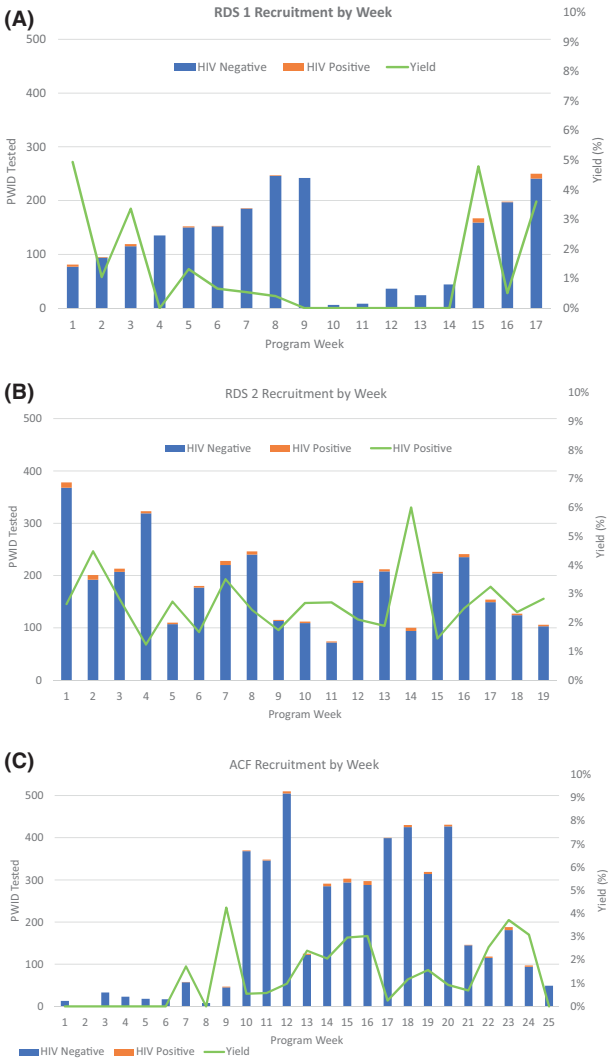

Figure 1. (A-C) Recruitment across three approaches to HIV case-finding amongst people who inject drugs in Tajikistan. RDS, respondent driven sampling; RDS1, RDS with unrestricted recruitment; RDS2, RDS with restricted recruitment (in which recruitment is stopped after two HIV-negative waves, but allowed to proceed otherwise); ACF, active case-finding (peer-led, community-based HIV case-finding approach). Figures show the number of clients recruited to testing each week of intervention implementation. The weekly yield of case-finding activities (the number of clients testing positive for HIV divided by the number of clients tested) is shown in green.

tracking, and recruitment management were implemented by local NGOs, with recruitment and case-management being performed by PNs who were themselves PLHIV or current/former PWID. Flagship experience demonstrates that RDS-based methods are feasible approaches to HIV case-finding among PWID in Tajikistan, and may be appropriate for other Central Asian countries and beyond. While yield and case-finding varied across approaches, regular analysis of project data and timely adjustment of project strategies was crucial to maximize intervention impacts. Flagship is currently conducting analogous programmes in the Kyrgyz Republic, suggesting the scalability of this approach.

Table 2. Comparison of HIV testing yield[a] between respondent-driven sampling and active case-finding among people who inject drugs in Tajikistan

Variable	RDS[b] % (n) N = 5660	ACF[c] % (n) N = 4640	*p*-value
Total	2.2 (122)	1.5 (68)	0.009
Male	1.9 (95)	1.2 (50)	0.007
Female	4.6 (27)	4.4 (18)	0.883
Age 18 to 30 years	1. 3 (19)	1.3 (17)	0.962
Age >30 years	1.5 (51)	2.4 (103)	0.004
District of Republican Subordination	1.9 (21)	1.0 (21)	0.036
Dushanbe City	1.3 (23)	0.9 (8)	0.283
Sughd Oblast	2.8 (78)	2.4 (39)	0.476
Never tested for HIV	2.4 (92)	1.4 (56)	0.002
History of migration	2.1 (57)	1.4 (38)	0.042

[a]Yield was defined as the proportion of clients testing positive on their first HIV test out of all clients tested for HIV;
[b]RDS includes the aggregate results from respondent driven sampling approach 1 (RDS1) with unrestricted waves, and RDS2 (in which recruitment was stopped after 2 HIV-negative waves);
[c]ACF, active case-finding approach (utilized peer-outreach workers to perform community-based HIV case-finding).

Table 3. Comparison of HIV testing yield[a] between respondent-driven sampling with restricted and unrestricted recruitment waves among people who inject drugs in Tajikistan

Variable	RDS1 N = 2143 % (n)	RDS2 N = 3517 % (n)	*p*-value
Total	1.5 (32)	2.6 (90)	0.007
Male	1.3 (24)	2.2 (71)	0.019
Female	2.9 (8)	6.1 (19)	0.060
Sughd Oblast	1.4 (14)	3.5 (64)	0.002
Dushanbe City	8 (110)	1.5 (15)	0.467
District of Republican Subordination	2.3 (10)	1.6 (11)	0.409
Ever tested for HIV	0.9 (6)	2.2 (24)	0.033
Never tested for HIV	1.8 (26)	2.7 (66)	0.066
Shared needle with recruiter	1.5 (9)	3.7 (29)	0.009
Had sex with recruiter	0.0 (0)	12.3 (8)	0.006
Never had sex with recruiter	1.5 (32)	2.4 (81)	0.038
No history of migration	1.2 (15)	2.8 (50)	0.003

RDS1, respondent-driven sampling with unrestricted recruitment; RDS2, RDS with restricted recruitment (in which recruitment is stopped after two HIV-negative waves, but allowed to proceed otherwise).
[a]Yield was defined as the proportion of clients testing positive on their first HIV test out of all clients tested for HIV.

Similar HIV case-finding projects have been conducted for key population testing programmes among MSM and PWID in India [16], high-risk heterosexuals in the US [10] and PWID in Ukraine [17] and Vietnam [12]. While some projects achieved testing yields of >10%, our yields ranged from 1.5% to 2.6%,

Table 4. Seed demographics, by HIV status and recruitment approach among people who inject drugs in Tajikistan

Variable	HIV-negative seeds (n = 23, 5.2%) n (%)	HIV+ seeds (n = 422, 94.8%) n (%)	RDS1 (n = 181, 40.7%) n (%)	RDS2 (n = 264, 59.3%) n (%)	*p*-value[a]
Female	1 (4.4)	70 (16.6)	29 (16.0)	42 (15.9)	0.010
Geography					0.060
Dushanbe City	0 (0.0)	150 (35.6)	61 (33.7)	89 (33.7)	
District of Republican Subordination	0 (0.0)	95 (22.5)	48 (26.5)	47 (17.8)	
Sughd Oblast	23 (100.0)	177 (41.9)	72 (39.8)	128 (48.5)	
Age (mean, standard deviation (SD))	38.1 (6.6)	40.4 (7.9)	40.8 (7.6)	39.9 (8.1)	0.240
Married	–	215 (51.0)	81 (44.8)	134 (55.6)	0.029
Migration experience	10 (43.5)	197 (46.7)	95 (52.5)	112 (42.4)	0.037
Network size (mean, SD)	11.1 (8.0)	20.8 (6.5)	9.4 (6.8)	18.7 (8.0)	<0.001
HIV positive	–	–	181 (100.0)	241 (91.3)	<0.001
Coupons redeemed (mean, SD)	0.94 (0.3)	0.97 (0.1)	0.94 (0.2)	0.95 (0.2)	0.579

RDS1, respondent-driven sampling with unrestricted recruitment; RDS2, RDS with restricted recruitment (in which recruitment is stopped after two HIV-negative waves, but allowed to proceed otherwise).
[a]*p*-value compares the values between RDS1 and RDS.

well below the estimated PWID HIV prevalence in Tajikistan [1]. It is unclear whether this was due to limitations in the case-finding approach itself, declines in underlying prevalence of undiagnosed HIV among PWID (as the ART programme in Tajikistan has expanded), inaccurate HIV prevalence or size estimation data, or some other factor. Regardless, efforts to boost Flagship yields are underway, including differential provision of coupons to recruiters based on HIV risk characteristics (i.e. needle sharing, younger PWID, long-term injectors, females, etc.), which may help boost enrolment of these subpopulations. Further analysis of effective recruiters (e.g. those who recruited ≥1 HIV-positive recruits) could inform differential targeting of coupon distribution. However, while yield rates were lower than expected, it should be noted that Flagship's case-finding represented a substantial proportion of total new HIV cases diagnosed (and linked to treatment) in the programme areas, and these absolute numbers of new HIV cases found are vital to Tajikistan's reaching the ambitious 90-90-90 targets.

Our results suggest that recruits testing through RDS-based case-finding may differ in important ways from clients recruited through strategies like peer-led ACF, including age, HIV testing history, and sex. While yield was lower under ACF compared to RDS2, ACF reached PWID clients more quickly than RDS1, did not require incentive payments for recruitment (though PWID received testing incentives), and reached a higher proportion of new testers. To work at maximum effectiveness, it may be necessary to implement multiple case-finding approaches concurrently, such as assisted partner notification and RDS or ACF, or to conduct staggered RDS "campaigns" alongside other forms of case-finding.

While approaches restricting recruitment of HIV-negative recruits may increase yield (relative to unrestricted RDS), this increase in testing efficiency may require additional investments in seed recruitment, since recruitment chains are ended more quickly under this approach. At the time of analysis, RDS2 was beginning to exhaust its pool of PWID living with HIV available as new seeds, and there was some concern

Table 5. Fixed-effects logistic regression model for HIV infection by recruitment strategy

Variable	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)[a]
Model 1[a]		
Strategy		
RDS1	1.74 (1.04 to 2.90)	1.77 (1.05 to 2.98)
RDS2	1.54 (1.11 to 2.15)	1.67 (1.19 to 2.34)
Active case-finding	Ref	Ref
Age	1.03 (1.01 to 1.04)	1.03 (1.01 to 1.05)
Female	3.37 (2.36 to 4.81)	3.58 (2.50 to 5.13)
Tested for HIV previously	0.72 (0.50 to 1.05)	0.61 (0.42 to 0.90)
Model 2[b]		
Strategy		
RDS1	1.12 (0.67 to 1.86)	1.12 (0.67 to 1.86)
RDS2	Ref	Ref
Age	1.02 (1.00 to 1.04)	1.03 (1.01 to 1.05)
Female	3.01 (1.91 to 4.76)	2.82 (1.72 to 4.64)
Tested for HIV previously	0.54 (0.34 to 0.85)	0.49 (0.31 to 0.79)
Had sex with recruiter	3.13 (1.44 to 6.80)	1.95 (0.85 to 4.46)
Shared needles with recruiter	1.26 (0.79 to 1.99)	1.25 (0.78 to 2.00)
History of migration	0.90 (0.61 to 1.35)	1.03 (0.68 to 1.56)

RDS1, respondent-driven sampling with unrestricted recruitment; RDS2, RDS with restricted recruitment (in which recruitment is stopped after two HIV negative waves, but allowed to proceed otherwise).
[a]Model 1 adjusts for recruitment strategy (RDS1, RDS2, and ACF), age, sex, and HIV testing history and clustering at the non-governmental organization (NGO) level.
[b]Model 2 adjusts for recruitment strategy (RDS1 and RDS2), age, sex, HIV testing history, history of sex with the recruiter, history of needle sharing with the recruiter and a history of migration, in addition to clustering at the NGO level.

about continuing the pace of recruitment under this model. Further, after adjusting for site of recruitment and other demographic factors, we did not find a statistically significant difference in odds of new HIV infection between clients recruited through the two RDS approaches. However, we did find that RDS2 provided a more consistent flow of new clients over time, compared to the "boom and bust" of RDS1, allowing for more predictable allocation of staffing/resources. Regardless of the RDS method, additional seed recruitment requires considerable effort, and may slow down recruitment over time. Recruitment of high-risk HIV-negative seeds, especially for RDS2, may help to reduce this burden. The cost of seed recruitment between these approaches should be considered in future cost-effectiveness research.

Strikingly, all three methods recruited insufficient numbers of female PWID, despite a high prevalence of undiagnosed HIV in this population. Female PWID, and female partners of male PWID, in Central Asia face multiple, intersecting HIV risks, and may be less able to negotiate consistent condom use, or to persuade a partner to go for couples HIV testing [18]. Such women are also at high risk of gender-based violence, and experience more HIV and drug-related stigma and discrimination than their male counterparts [18]. Given these risks, more efforts to reach female PWID with HTS, such as recruiting additional female seeds and PNs, are warranted. Similarly, efforts that successfully reach older and previously untested PWID appear likely to yield more HIV infections. Additional interventions, such as assisted partner notification [14], may further expand HIV case-finding originating from network-based methods. Finally, extension of these methods into other key populations, such as MSM, may help increase HIV testing coverage among other hard-to-reach populations with high HIV risks and low test coverage [19].

This analysis is subject to important limitations. Interventions were conducted concurrently in the same programme areas. Thus, differences across strategies may have been obscured, and outcomes may have varied if interventions had been implemented separately. While we did not find evidence of this, it is also possible that some respondents were tested multiple times in an effort to receive additional incentives. However, the World Health Organization (WHO) recommends at least annual testing for key populations, including PWID [20], and we judged the risk of any individual being tested multiple times within a six-month period to be relatively low. The risk was minimized through use of a UIC. PNs, who were themselves members of the beneficiary populations, were also trained to spot clients coming for testing more than once semi-annually. Such clients were provided HIV testing but did not receive an incentive.

Because RDS2 was conducted after RDS1, it is possible that the higher yield was driven partly by programmatic improvements independent of the RDS approach. While implementing partners were extensively trained and closely monitored, it is possible that actual implementation varied across organizations and time. We attempted to account for clustering at the organization level in our final model, but this analysis was limited by the small number of clusters. However, if these issues did have an effect, the authors feel the impacts likely bias findings towards the null. Because yield was calculated based on the first HIV test result (rather than confirmatory testing), yield may have been over-estimated. Finally, this analysis was based on routine programmatic data, and some important covariates (e.g. years of injecting) were not collected.

Despite these limitations, this analysis contributes to a growing body of evidence about using RDS methods for HIV case-finding among key populations. Other studies have explored strategies to improve the efficiency of these social network methods for HIV case-finding [16], including the use of recency testing to identify newly HIV-infected seeds [21] who may be indicative of risk networks in which HIV transmission is ongoing [17]. While these studies have demonstrated the efficacy of network-based approaches to case-finding among key populations, ours is one of the few that has looked at the effectiveness of RDS-based case-finding at scale under programmatic conditions.

5 | CONCLUSION

To reach the UNAIDS ambitious 90-90-90 targets by 2020, programmes worldwide need to find more effective ways of reaching those at highest risk of infection with testing. Flagship demonstrated the feasibility of conducting RDS for HIV case-finding among PWID at scale, testing >5600 PWID in just eight months. While the yield from RDS-based approaches was greater than that of the ACF approach, client profiles differed between the strategies, suggesting that multiple case-finding approaches may be needed to ensure the first 90 target is met. Variations on RDS implementation, such as differential distribution of coupons, limiting recruitment after a number of HIV-negative waves, or utilizing technologies like recency assays may increase testing yields, and should be considered by programme implementers. Decisions to scale-up network-based methods for HIV case-finding depends on both the impact and cost-effectiveness of these approaches. Future research should explore cost per case-detected and cost-effectiveness to better inform programmatic decision-making. Future studies may also consider the ideal frequency of RDS-based methods over time, comparing costs and health impact of an ongoing versus campaign-style approach.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHORS' CONTRIBUTIONS

MK cleaned the dataset and contributed to the analysis and manuscript writing. DG contributed to the data analysis, outlining of the manuscript, and technical editing. RG contributed to manuscript writing and, along with OS, provided technical inputs. KL contributed to analysis design, manuscript writing and editing.

ACKNOWLEDGEMENTS

The authors acknowledge the staff of all Flagship local NGO implementing partners, as well as the PN and PWID in Tajikistan who play a critical role in the described intervention, and who expend tremendous efforts to reach the

members of their communities with HIV testing and linkages to care, treatment, and prevention. Special acknowledgement goes to Rashid Shaimerden, who developed the online MIS database and consistently improved monitoring and data quality. We acknowledge the hard work and dedication of all Flagship Tajikistan staff, specifically Khursheda Rakhmatova, Azamjon Mirzoev, Firuza Kurbanova, Shodiya Mirkhaidarova, Faridun Iskhokov, Artyom Bdoyan, Iskandar Akhmedov and others. The funding for this analysis came from the USAID Central Asia HIV Flagship Project, under which PSI is the prime.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Additional file 1. Includes additional information about the Flagship Peer Navigators, including their demographics, subnational units where employed, and training/instructions.

Tun W et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25124
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25124/full | https://doi.org/10.1002/jia2.25124

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

Uptake of HIV self-testing and linkage to treatment among men who have sex with men (MSM) in Nigeria: A pilot programme using key opinion leaders to reach MSM

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Abstract

Introduction: HIV self-testing (HIVST) offers an alternative to facility-based HIV testing services, particularly for populations such as men who have sex with men (MSM) who may fear accessing testing due to stigma, discrimination and criminalization. Innovative HIV testing approaches are needed to meet the goal of 90% of people living with HIV being diagnosed. This study piloted an intervention to distribute oral HIVST kits to MSM through key opinion leaders (KOLs) in Lagos, Nigeria and assessed the feasibility, acceptability, uptake of HIVST and linkage to HIV treatment.

Methods: A cohort study was conducted (May through September 2017) with 319 participants who were recruited by 12 KOLs through their networks. A baseline survey was conducted at the time of the oral HIVST kit (OraQuick® HIV antibody test) distribution to eligible MSM followed by a 3-month follow-up survey to assess usage of and experience with the HIVST kits. Each participant was given two kits.

Results: The median age of the participants was 25 years, 88.7% were literate and 17.9% were first-time testers. Of the 257 participants (80.7% retention) who completed the three-month follow-up interview, 97.7% reported using the HIVST kit and 14 (5.6%) self-reported an HIV positive result. A quarter (22.7%) tested themselves the same day they received the kit, and 49.4% tested within one week. Almost all participants reported that the HIVST kit instructions were easy or somewhat easy to understand (99.6%) and perform the test (98.0%). The most common reasons they liked the test were ease of use (87.3%), confidentiality/privacy (82.1%), convenience (74.1%) and absence of needle pricks (64.9%). All 14 participants who tested positive had sought confirmatory testing and initiated HIV treatment by the time of the three-month survey.

Conclusions: HIVST distribution through KOLs was feasible and oral self-testing was highly acceptable among this urban MSM population. Despite concerns about linkage to treatment when implementing self-testing, this study showed that linkage to treatment can be achieved with active follow-up and access to a trusted MSM-friendly community clinic that offers HIV treatment. HIVST should be considered as an additional option to standard HIV testing models for MSM.

Keywords: HIV; self-testing; MSM; feasibility; HIV positivity rate; linkage to treatment; Nigeria

Received 15 December 2017; **Accepted** 16 May 2018

1 | INTRODUCTION

HIV testing is critical in reaching the UNAID's 90-90-90 goals of having 90% of people living with HIV diagnosed, 90% of them on antiretroviral therapy (ART) and 90% of them virally suppressed [1]. However, for key population groups including men who have sex with men (MSM), uptake of HIV testing services is often low due to multilevel factors such as stigma and discrimination, criminalization, and fear of having trouble with law enforcement authorities [2-7]. In Nigeria, not only is same-sex sexual activity illegal, but the passage of the Same Sex Marriage (Prohibition) Act of 2013 has ushered in more violence against the LGBT community and has greatly restricted activities of nongovernmental organizations providing services to LGBT people, including any kind of health services. In Nigeria, the estimated HIV prevalence among MSM is 23% to 55% [8-10]. Furthermore, only 65% of MSM have ever had an HIV test, and HIV testing rate during the past 12 months is less than 25% [10, 11]. To overcome barriers to HIV testing uptake, the World Health Organization (WHO) developed HIV guidelines recommending HIV self-testing (HIVST) be offered in addition to existing facility-testing modalities (2016) [12]. HIVST does not require presence of a health provider, thus ensuring privacy and enabling convenience that are particularly important to MSM.

Oral HIVST involves the client obtaining an oral specimen by swiping the gums with the test swab, performing the test and interpreting the test result him/herself in private. It is

considered a screening test and does not provide a definitive diagnosis; thus, it requires confirmatory testing. HIVST is considered particularly important for MSM who are reluctant to access static or mobile testing services or MSM concerned about disclosure of sexual orientation when seeking HIV services with health providers [13-15]. Globally, studies have found consistently high levels of HIVST acceptability among the general population and higher-risk subgroups (including MSM) who may not access other testing services [14,16-31]. In addition, several studies have shown HIVST increases test coverage for both first-time and repeat testers [14,18-20,32,33]. Citing this early evidence, the 2016 WHO HIVST guidelines recommend HIVST and specifically call for implementation pilots to understand the effect and operational aspects HIVST distribution in a real-world setting [12]. This is more important as national policy makers are hesitant to endorse HIVST without sufficient evidence that it is feasible, cost-effective, safe, and leads to acceptable levels of linkage to post-test services (i.e. confirmatory testing and HIV care and treatment).

We conducted an implementation science research (IS) project, assessing the acceptability, feasibility and operationalization of a distribution model whereby key opinion leaders (KOLs) distribute self-test kits to MSM in Lagos. Specifically, we examined HIVST uptake (usage), HIV positivity rate, linkage to confirmatory testing and HIV treatment, and perceived benefits and potential harms. This project is the first of its kind being implemented in Nigeria, and is the first implementation science research project to examine HIVST among MSM in sub-Saharan Africa.

2 | METHODS

2.1 | Study design

A cohort study was conducted (May to September 2017) in Lagos. A baseline survey was conducted at the time of the kit distribution to eligible MSM followed by a three-month follow-up survey with baseline participants to assess usage of and experience with the HIVST kits and access to confirmatory testing and HIV treatment (among those who tested positive).

2.2 | Study population

Eligible participants were biological males aged 17 to 59 years, reporting anal intercourse with a man in the past 6 months, self-reporting HIV negative or unknown status, having no recent HIV test (<3 months), having lived in the city of Lagos for the three months prior to the interview, and planning to stay in Lagos for the next four months.

2.3 | Description of the distribution model

Twelve KOLs were trained to recruit MSM from their own personal networks. These KOLs were selected from a pool of KOLs who had been trained as HIV counselors for the Population Council's MSM-friendly community-based health center (CHC) in Lagos. KOLs were selected by the CHC management staff to work for the CHC services because they were highly respected and endorsed by their peers (i.e. were recommended by other MSM clients of the CHC) and influential (i.e. successful in referring many of their peers to the CHC), showed great enthusiasm and motivation to serve as KOLs, and had real-time information about their MSM community and hotspots (physical and virtual), which were corroborated by other KOLs and the CHC's programmatic staff. KOLs had to be at least 18 years of age, self-identify as MSM or gay, have completed secondary education and good interpersonal skills, and be able to mention at least ten hotspots where MSM meet. KOLs were diversified in age and professional and educational status: six were older than 25 years and six were younger; three had some or had completed secondary schooling, six were currently in or had completed tertiary education, and three had completed certificate or trade school; and their current professional status was current students (4), part-time employed (3), full-time employed (2) and self-employed (3). KOLs mobilized potential participants at hotspots considered to be safe, such as football fields, gyms and cafes. Virtual mobilization was done via mobile applications (primarily WhatsApp). We also received assistance from another local NGO working with MSM to help introduce their MSM constituents to the study KOLs. This NGO is located in another part of Lagos and tends to attract older and more educated professional MSM. KOLs informed potential participants about the study and provided them with information or referral cards to either meet at the Population Council's CHC or another convenient and safe space for the interview and distribution. MSM who wanted to be part of the study and receive the self-test kits were then formally screened for eligibility by a research assistant or the KOL in a private place; if eligible, the candidate gave consent and was interviewed by the research assistant. After the baseline interview, all participants were provided with: (1) two HIVST kits (OraQuick Rapid HIV ½ Antibody, OraSure Technologies), a rapid oral fluid test kit approved by FDA to detect HIV antibodies, (2) a referral voucher to access free HIV testing at the CHC, and (3) HIV prevention an HIVST information, and condoms and lubricant. At the time of the distribution, the research assistant explained how OraQuick works without providing detailed instruction or demonstrating how to perform the test. Participants were sent a video demonstration of OraQuick on their phones. It should be noted that KOLs accompanied the research assistants during all baseline study visits as their introduction of the research assistants to the potential participants was necessary to gain the trust of the participant in the research assistant.

Due to mental health concerns and at the request of the ethical review boards, a phone hotline was set up and managed by a certified HTS counsellor for four months to provide information on HIVST kit use, counselling, and referrals for HIV care and treatment and other support services. The hotline information was included in the package given to participants. In addition, the HTS counsellor followed-up with participants by calling participants at five, 30 and 80 days after participants received the HIVST kits to provide support for usage and facilitate referrals for HIV treatment for those testing positive. In order to ensure that the follow-up calls did not bias our research (i.e. the follow-up call may motivate people to use the test), the counsellor was instructed to simply assess the participant's psychological well-being and not promote the use of the test kit. In the event that the counsellor deemed the participant needed further counselling and

support, the counsellor advised the participant to come into CHC to meet with the counsellor for further counselling.

2.4 | Baseline survey

The baseline interview covered demographic profile, HIV-related risk behaviours, HIV testing history, reasons for not having tested, and self-perceived HIV risk. Each interview lasted 35 to 45 minutes. At baseline, the names (or nicknames) and contact information (mobile number) of the participants were collected to ensure successful follow-up with participants for the three-month survey. The baseline data collection and HIVST kit distribution was completed within 32 days.

2.5 | Three-month follow-up interviews

A follow-up interview was conducted after three months to determine whether participants had used the HIVST kits provided and their experience with it, their self-reported test result, potential harms, confirmatory testing (if positive), linkage to ART, and willingness to pay. Follow-up interviews took place at the CHC or at a convenient safe location. All participants provided written informed consent and were reimbursed 1500 Nigerian Nairas (approximately USD 4.15) for each the baseline and follow-up interviews.

2.6 | Data analysis

Descriptive statistics of the quantitative survey data were computed using STATA Software (Version 14.1, College Station, Texas). Univariate data analysis was used to describe the characteristics of the study population and their perceptions and behaviours related to self-testing.

2.7 | Ethical considerations

Ethical approval for the study was obtained from the Population Council Institutional Review Board and the College of Medicine of the University of Lagos Health Research and Ethical Committee.

3 | RESULTS

3.1 | Participant characteristics

A total of 686 MSM were reached by KOLs (i.e. made contact via face-to-face, phone, text messaging or social media app whereby self-testing was introduced) of whom 388 were referred to the study for the initial study screening visit. Of those, 307 (79.1%) were referred through a one-on-one meeting with a KOL, 27 (7.0%) through one-on-one social media contact (e.g. WhatsApp) with a KOL, 24 (6.2%) were referred by a friend or boyfriend, 30 (7.7%) through other means. Of the 388 referred to the study, 63 were deemed ineligible (multiple reasons possible): 25 had not had sex with a man in the previous six months, six had not lived in Lagos the preceding three months or were planning to move from Lagos in the next three months, 15 had tested for HIV in the last three months, 15 had previously tested HIV positive, and 14 were on ARV drugs, and one had previously received a self-test kit prior to the study. Five people did not provide consent, and one was dropped due to multiple enrolment yielding a sample of 319 participants. A total of 177 (55.5%) were reached for the 5-day follow-up call by the counsellor, 218 (68.3%) for the 30-day call, and 77 (24.1%) for the 80-day call. Of the 319 participants,

The characteristics of the baseline participants are reported in Table 1. The median age was 25 years and 86.8% were never married. Almost all participants had completed secondary education or higher; 27.9% had completed tertiary

Table 1. Characteristics and behaviours of baseline participants (N = 319).

Characteristics	n (%)
Median age (IQR)	25 (21, 32)
Marital status	
Never married/single	277 (86.8)
Single but living with male partner	18 (5.6)
Married to a woman	24 (7.5)
Education	
Some secondary or less	14 (4.4)
Completed secondary	133 (41.7)
Some tertiary	83 (26.0)
Completed tertiary	89 (27.9)
Currently in school/university	
Full-time	74 (23.2)
Part-time	12 (3.8)
Not enrolled	233 (73.0)
Literacy	
Illiterate	13 (4.1)
Partially literate	23 (7.2)
Literate	283 (88.7)
Sexual self-identity	
Homosexual	99 (31.0)
Bi-sexual	215 (67.4)
Straight/heterosexual	4 (1.3)
Not sure	1 (0.3)
Previously HIV tested and received result	
Never	57 (17.9)
More than 1 year ago	115 (36.1)
Tested in last 7 to 12 months	91 (28.5)
Tested within last 6 months	56 (17.5)
Median number of male sex partners in the last six months (IQR)	3 (2, 6)
Type of partner last male partner	
Regular steady partner	180 (56.3)
Casual partner	121 (37.8)
Paying partner	19 (5.9)
Did not use a condom at last sex with a man	84 (26.3)
Self-perceived likelihood of being HIV positive	
Very likely	26 (8.2)
Somewhat likely	67 (21.0)
Unlikely	107 (33.5)
Very unlikely	119 (37.3)

education. About one-quarter (27.0%) were currently enrolled in school or university, and the majority (88.7%) were literate. Most participants self-identified as bi-sexual (67.4%) or homosexual (31.0%). Most of the participants had previously tested for HIV; 17.9% had never previously tested for HIV.

Participants reported a median of three male sex partners in the last six months; 56.3% reported their last male partner was a regular partner and 37.8% reported a casual partner. A quarter (26.3%) had not used a condom at last sex with a man. A high proportion (29.2%) felt they were very likely or somewhat likely to be HIV positive.

3.2 | Lost to follow-up

A total of 257 participants (80.6%) completed the follow-up interview. In comparing the characteristics of participants, there were no significant differences between the 62 participants lost to follow-up and those retained in the study with regard to education, sexual identity, HIV testing history, condom use at last sex with a man, and self-perceived HIV risk. [Data not shown] However, those lost to follow-up were slightly younger than those retained in the study (<25 years: 64.5% vs 50.6%; $p < 0.05$) and had a higher score on the Beck Depression Inventory (3.8 vs 2.4; $p < 0.05$) [34]. Of the 62 participants who were lost to follow-up, 43 were not reachable by the counsellor on the 80-day follow-up call, 10 were reached but did not show up for the interview, four were wrong number or person denied being the participant, two no longer wanted to participate of could not attend the endline visit, and three had missing data on follow-up calls. Although the 62 participants did not participate in the endline survey, data from the counsellor follow-up log from the five-day or 30-day calls indicates that 40 of them reported having used the test kit; usage was unknown for the remaining.

3.3 | Use of HIV self-testing

Each participant received two HIVST kits at baseline. Table 2 describes the self-reported HIVST behaviour of participants at the three-month study visit (N = 257). The majority (97.7%) reported having used the kit on themselves. With the second test kit, 36.2% reported testing themselves again, 33.1% kept it for future use, 21.4% gave it to a friend or a family member, and 8.2% gave it to a sex partner. There was no statistical difference in use of second test kit by HIVST test result, HIV testing history, condom use at last sex, and sexual identification. A quarter (22.7%) tested themselves the same day they received the kit, and 49.4% tested within one week. About a quarter (23.5%) reported that they had someone else present while they tested (55.0% with a friend, 21.7% with a family member, 16.7% with a sex partner and 6.7% with a KOL).

3.4 | Perceptions of HIV self-testing

Table 3 describes the perceptions of HIVST among participants who used the kit (N = 251). Almost all reported that the instructions were easy (92.4%) or somewhat easy to understand (7.2%) and it was easy (90.0%) or somewhat easy (8.0%) to perform the test. Users were asked to indicate what they liked about the HIVST kit. The most common reasons they liked the test were ease of use (87.3%), confidentiality/privacy (82.1%), convenience (74.1%), and absence of needle pricks (64.9%). The majority of users (88.5%) indicated that there was nothing they did not like about the test. Reasons for not liking the test among users (from open-ended questions of the questionnaire) included: *"The liquid content might pour if one is not careful, something should be done about it"*; *"Just because anyone that sees it eventually during the testing process will know ones result"*; *"A physical counsellor should be attached during the distribution so that the respondents could have access to him; this will help check against suicide tendency"* and *"On the pack it was directly stated that it's for HIV, other mild terms can be used that won't arouse any discriminatory suspicion."*

The majority (91.2%) were very satisfied with the self-testing experience, almost all the participants reported that they would use the kit again in the future (99.6%), and would recommend the HIVST kit to others (96.4%). They also were very confident that they could use the test (87.2%) and read the result (84.9%) correctly in the future.

Table 2. Self-reported HIV self-testing (HIVST) behaviour of participants at the 3-month follow-up study visit (N = 257)

Variable	n (%)
What they did with the first HIVST kit	
Tested using HIVST kit	251 (97.7)
Kept it for my future use	4 (1.5)
Gave it to a friend	2 (0.8)
What they did with second HIVST kit	
Tested self again	93 (36.2)
Kept it for future use	85 (33.1)
Gave to friend/family member	55 (21.4)
Gave it to sex partner	21 (8.2)
Other	3 (1.2)
Self-tested how soon after receiving HIVST kit (n = 251)	
Same day	57 (22.7)
Within 1 week	124 (49.4)
Between 1 to 2 weeks	41 (16.3)
More than 2 weeks	29 (11.6)
Someone else present while testing	59 (23.5)
Person present while testing (n = 60)	
Friend	33 (55.0)
Sex partner/spouse	10 (16.7)
Family member	13 (21.7)
Peer educator	4 (6.7)

3.5 | Linkage to HIV care and treatment

Table 4 describes the result of the self-tests and linkages to care and treatment among the 251 users of the test. A total of 14 participants (5.6%) self-reported that they tested positive using the HIVST kit, 7 (2.8%) had indeterminate or invalid results, and four (1.6%) were not sure of their result. Of the seven who reported indeterminate or invalid result, two sought HIV testing and of the four who were unsure of their result, one sought HIV testing afterwards. Over one-half (60.2%) told someone else the test result (friend 43.1%, sex

Table 3. Perceptions of HIV self-testing (HIVST) among participants who used the test kit (N = 251)

Variables	n (%)
Ease of understanding HIVST instructions	
Easy	232 (92.4)
Somewhat easy	18 (7.2)
Somewhat difficult	1 (0.4)
Difficult	0
Performing the HIVST was:	
Easy	226 (90.0)
Somewhat easy	20 (8.0)
Somewhat difficult	4 (1.6)
Difficult	1 (0.4)
What participants liked about the HIVST kit	
Easy to use	219 (87.3)
Guarantees confidentiality/privacy	206 (82.1)
Convenient to use	186 (74.1)
No need for needle prick	163 (64.9)
Learn test result quickly	145 (57.8)
Easy to understand instructions	138 (55.0)
Easy to interpret results	140 (55.8)
Do not have to go to facility/Do at home	137 (54.6)
Saves time	126 (50.2)
Can test at home with friend/partner	108 (43.0)
Do not have to talk to health provider	96 (38.3)
What participants disliked about the HIVST kit	
Nothing	222 (88.5)
Satisfaction with HIVST experience	
Very satisfied	229 (91.2)
Somewhat satisfied	18 (7.2)
Not satisfied	4 (1.6)
Would use the HIVST kit again in the future	250 (99.6)
Confidence in using the HIVST correctly in the future	
Very confident	219 (87.2)
Confident	30 (12.0)
Somewhat confident	2 (0.8)
Confidence in reading the HIVST result correctly in the future	
Very confident	213 (84.9)
Confident	36 (14.3)
Somewhat confident	2 (0.8)
Would recommend HIVST kit to others	242 (96.4)

partner 23.8%, counsellor 20.5%, family member 14.6%, KOL 13.9%, health worker 3.3%).

Among the 226 participants who tested negative, 11.1% sought HIV counselling and testing after self-testing. The reasons given for not seeking post-test counselling were that they were negative and did not see the need for counselling (85.7%) and they knew how to maintain their negative status (38.6%). Among the 14 who tested positive, all sought post-test counselling and had their test results confirmed at the CHC following the national testing algorithm, that is, all 14 were confirmed HIV positive and all accepted and have initiated HIV treatment. This information was confirmed through the CHC.

Table 4. Result of HIV self-testing (HIVST) and linkage to HIV care and treatment among participants who used the HIVST kit (N = 251)

Variable	n (%)
Result of HIVST	
Negative	226 (90.0)
Positive	14 (5.6)
Indeterminate/Invalid	7 (2.8)
Not sure	4 (1.6)
Told someone the test result	151 (60.2)
Who participant told of HIVST result (n = 151)	
Friend	65 (43.1)
Sex partner	36 (23.8)
Counsellor	31 (20.5)
Family member	22 (14.6)
Peer educator	21 (13.9)
Health worker	5 (3.3)
Sought HIV counselling after learning:	
HIV negative result (n = 226)	25 (11.1)
HIV positive result [a](n = 14)	14 (100.0)
Indeterminate/Invalid (n = 7)	2 (28.6)
Not sure (n = 4)	1 (25.0)
Thought of harming self due to positive result (n = 14)	1 (7.1)
Confirmed registered for HIV treatment (n = 14) [a]	14 (100.0)
Confirmed started HIV treatment (n = 14)[a]	14 (100.0)

[a]Post-test counselling, and registration and initiation of HIV treatment was based on the counsellor's follow-up with the HIV positive participants and confirmation against the Community Health Centre's patient records.

Only nine participants called into the helpline; five of the nine callers had tested positive and were seeking support.

3.6 | Preference for where to obtain HIV self-testing kits

Figure 1 describes places where participants at baseline indicated they would be willing to obtain HIVST kits. The most acceptable place was community-based organization (CBO)/NGO (96.2%) followed closely by peer educators or KOLs (86.2%) and private health facilities (82.8%). When participants were asked to select the one place where they would like to obtain the self-test kits, CBOs/NGOs (55.9%) was the most commonly selected response followed by private (12.5%) and government (11.6%) health facilities. Reasons proffered for selecting CBOs (from open-ended questions of the questionnaire) included: "*They understand my sexuality*", "*No stigma*"; "*This is the only place I can be myself*"; "*I will not be judged for being homosexual*," and "*They also offer good counselling.*"

3.7 | Willingness to pay for HIV self-testing

The majority (85.6%) of participants who received the test kits were willing to pay for the kit. The median maximum participants were willing to pay was N2000 Nigerian Naira (approximately USD 5.50) [Data not shown].

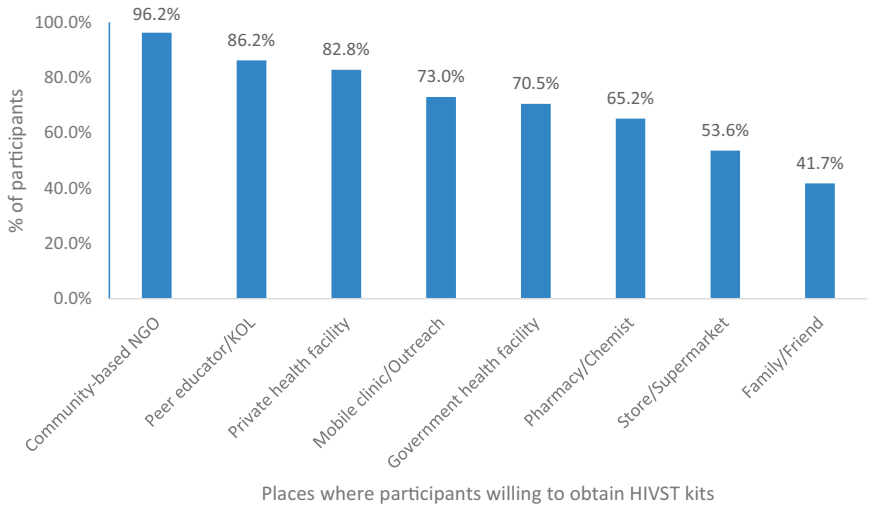

Figure 1. Places where participants were willing to obtain HIV self-testing (HIVST) kits (N = 319)

4 | DISCUSSION

While previous studies have reported on the HIVST acceptability among the general population and MSM [14,16-31], this is one of the first studies to report on actual HIVST usage, positivity rate, and linkage to HIV treatment among MSM in Africa. This study showed that distribution of oral HIVST kits to MSM through networks of KOLs is feasible. The high usage rate of the oral HIVST kit clearly highlights the importance and the need for alternative strategies to HIV testing among MSM in Nigeria. It was encouraging that we observed almost universal uptake of the test kits, including 17.9% who were first-time testers. Lastly, this study showed a high rate of linkage to HIV treatment among this population. The findings from this study are directly responsive to the WHO's 2016 Guidelines on HIVST that calls for furthering the evidence base of HIVST among key populations, especially MSM and groups that have sub-optimal rate of HIV testing in Sub-Saharan Africa [12]. This initial evidence will help guide the Ministry of Health of Nigeria in introducing and scaling up HIVST as another official testing modality to increase uptake of HIV testing among MSM and potentially other high-risk and marginalized populations, among whom HIV testing rates are often low.

The distribution of HIVST kits through KOLs was efficient in reaching MSM for self-testing. A total of 12 KOLs managed to reach a high number of MSM within a fairly short time period (32 days). Feedback from KOLs indicated that it was easy to reach their closest peers, however, it became harder to recruit once they saturated their networks, which is a common occurrence with network sampling [35]. KOLs indicated that they were able to recruit additional MSM by relying on their peers to help recruit other peers. The population reached is a fairly high-risk population (high number of sex partners, type of sex partner, unprotected sex, and high self-perceived risk of HIV). This study managed to recruit MSM who were first-time testers (17.9%), which is noteworthy given the intensity of HIV testing programmes targeting MSM by various NGOs in Lagos. This rate is similar to the CHC's community-based HIV testing activity. While it is indeed important to attract first-time testers, self-testing is also an important option for the MSM population, particularly those at continued risk for HIV among whom retesting is critical.

While studies globally, including countries in Africa, have shown high acceptability of HIVST using hypothetical scenarios in different populations [16-22,24,25,29-31,36,37], this study showed high acceptability with usage with the actual test kit. However, it is important to consider other potential explanations for the high uptake. First, the uptake rate may have been high because those who were interested in using the test likely self-selected to participate in the study. While intention to use the HIVST kit was not a requirement for participation, it is likely that those who agreed to meet with the KOLs and participate in the study were already intending to use the kit and those who did not want to use the test kit declined to even meet with the KOLs. Despite the potential self-selection into the study of those who intended to self-test, this study's high uptake of HIVST as well as the high level of willingness to pay for it provides important insight into the need for this alternative method of testing. In addition, the follow-up calls made by the counsellor to the participants may have encouraged some to use the test kits. However, this may be minimal as nearly three-quarter of the participants had used the kit within their first week of receipt. Future HIVST implementation programs should keep this cost in mind during the planning stages.

To date, no other studies have reported HIV positivity rates from HIVST among MSM in Africa. This study found an HIV positivity rate of 5.6%. It should be noted that this does not represent the HIV prevalence in this population as we specifically recruited people who had HIV negative or unknown status. The sample is a fairly young sample, which may explain the relatively low positivity rate. Another reason for the low positivity rate may be that the proportion who had a paying partner in this study was lower than the 24%-55% reported in other studies with MSM in Lagos [8,38]. This positivity rate, however, is similar to the positivity rate (5%) seen among MSM tested through the community-based HIV testing programme in Lagos from April to September 2017. Thus, HIVST distributed through KOLs appears to reach a similar

population with similar positivity rate as community-based HIV testing; thus, it offers MSM an alternative option for testing. To improve HIV positivity rate, future studies should examine more targeted HIVST distribution such as distribution within the networks of HIV-positive MSM.

Invalid test results are generally higher among self-testers. Recent literature has identified several steps in which errors could happen, causing an invalid test result, including sample collection using the swab, handling of the sample swab, and following the procedures [39,40]. In our observation of 16 participants as part of the formative assessment before the distribution of the kits, common errors include not collecting sample correctly, not putting the swab into the bottle correctly, and not waiting enough time (20 minutes) before reading the result [data not shown]. In this current study, we found a fairly high rate of indeterminate or invalid results or uncertainty of result (4.4%), which is higher than what has been reported when subjects performed supervised oral HST after a demonstration of the test kit usage in a rural community in rural Mozambique (5/496 = 1.7%) [41]. However, one of the first HIVST validation studies conducted in Kenya in 2013 reported a higher rate of invalid HIV results (37/239 = 15.5%) [40]. These findings suggest that directly assisted HST may reduce invalid test result, and the need to have a 24-hour hotline, or mobile app to better assist testers. It is also important to highlight the need for HIVST testers to seek post-test counselling when they obtain an indeterminate or invalid result.

In addition to distributing HIVST directly through KOLs, community-based MSM-friendly HIV prevention and treatment facilities such as the CHC may be a potential distribution outlet. NGOs were highly preferred as a place for accessing HIVST kits by study participants due to the safe non-judgmental environment with good quality services. In this study, we gave participants the option to pick up the HIVST kits at the CHC or at an alternate safe and convenient location. This study showed that referral for pick-up of HIVST kits at a facility is an acceptable option with equally high usage as the directly distributed approach; a high percentage (42.2%) chose to come to the CHC for the HIVST kits. A randomized trial in Zambia (the ZEST study) among female sex workers (FSW) which compared a peer educator direct distribution to coupon referral for pick up at a health facility found that FSWs randomized to the referral arm had similar HIVST usage and linkage to care and ART initiation rates as the direct distribution arm (assessed after four months) [42]. Thus, future research and implementation should include health facilities as a distribution site as it may be a less costly model of distribution than using KOLs/peer educators. In addition, future research should be conducted to understand potential differences in risk profiles, HIVST uptake, HIV positivity rate, and linkage to HIV care and treatment among those receiving HIVST through different distribution.

Although the helpline was available, only a few participants called into the helpline. This is not surprising as most people found the test instructions easy to understand and the test easy to perform. Other studies have also reported low usage of the helpline [43,44]. Despite low usage, this feature may be worth retaining as it appeared to be most useful for study participants who tested positive in order to obtain support – over half the callers were those who tested positive, and it presents an important opportunity for referral to HIV treatment.

A key concern with self-testing is whether self-testers would seek HIV treatment [45,46]. This study demonstrated a noteworthy 100% linkage to HIV treatment; the national linkage rate is 31% [47]. The high linkage to treatment in this study is likely due to follow-up calls by the counsellor after HIVST distribution, the participant's access to their KOLs, and most importantly, the linkage to a well-trusted MSM-friendly facility that offers not only HIV prevention services but also HIV treatment. Studies in low-resource settings among MSM have reported both fairly low [48,49] and high [50,51] linkage to HIV care and treatment after self-testing.

The study has several limitations. First, key outcomes including HIVST uptake and test result were self-reported. Participants may have over-reported HIVST uptake and may also be reluctant in reporting a positive test result and thus overestimate the uptake and underestimate HIV positivity rates. However, it is important to note that for those who reported a positive result, we were able to confirm their HIV positive status with confirmatory testing and their linkage to ART by the CHC programme staff. Second, we lost about 20% of the original cohort and key outcomes may be different between those retained in and those lost from the cohort. However, uptake of HIVST among those lost to follow-up was also fairly high – a minimum of 64.5% used it. A comparison of those lost to follow-up and those retained in the cohort revealed that while the two groups were comparable regarding demographic and risk characteristics, those lost to follow-up were younger and scored worse on the depression scale. This should be kept in mind for future implementation as those lost to follow-up may have been more likely to have experienced harm or psychological distress. Furthermore, regardless of our effort to diversify the profiles of the 12 KOLs, our sample was quite young and educated; therefore, findings may not be generalizable to other segments of the MSM population. It is likely that a young population would underestimate the positive rate among MSM. In addition, the findings may not be generalizable to other settings; for example, the HIVST uptake, ease of use, and linkage to care may be lower in a rural setting, among participants with lower education level or those who do not identify as homosexual or bisexual. Lastly, given that the test kits were provided for free and that there was financial compensation for study participation, it is possible that participants may have participated more than once. However, this is highly unlikely as the small team of interviewers and KOLs would have recognized repeat participants during the short data collection period.

5 | CONCLUSION

This pilot study has shown that HIVST is highly acceptable to urban MSM, the majority of whom are mostly educated and self-identified homosexual or bi-sexual, and distribution through KOLs is feasible. Furthermore, linkage to HIV treatment can be achieved given active follow-up and access to MSM-friendly HIV treatment facilities. While further research is needed to compare outcomes of testing uptake, frequency of re-testing, HIV-positive rate, and linkage to care between

different HIVST distribution models as well as in comparison to standard HIV testing strategies, this study supports the feasibility and acceptability of HIVST among MSM. HIVST should be considered as an additional option to standard HIV testing models.

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ACKNOWLEDGEMENTS

The authors thank the dedicated staff of the Community Health Center and in particular, the key opinion leaders and the research assistants who helped with the implementation of this study. We thank Innocent Agbo for programming the survey and ensuring data quality; Lanre Osakue, Efe Ekperigin, Ebunoluwa Taiwo for overseeing the smooth implementation of data collection and managing staff; and Angela Salomon for assisting with survey programming and performing data checks. Most importantly, we thank the participants without whom this study would not have been possible.

FUNDING

The research reported in this publication was supported by the U.S. National Institutes of Health under award number 1R21AI124409-01.

DISCLAIMER

The content is solely the responsibility of the authors and does not necessarily represent the official views of the U.S. National Institutes of Health.

AUTHORS' CONTRIBUTIONS

WT, SA and LV conceptualized the study design. LV assisted with protocol and tool development, quantitative data analysis and contributed to manuscript writing. JN assisted with implementation oversight and manuscript review. ES managed day-to-day implementation of the intervention and data collection, and contributed to the manuscript writing and review. OD trained study staff and KOLs, supervised data collection and contributed to the manuscript writing and review. AS contributed to the protocol development, training of study staff, manuscript writing. WT trained study staff and KOLs, conducted the data analysis and led the manuscript writing.

COMPETING INTERESTS

All authors report no competing interests.

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Green KE et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25127
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25127/full | https://doi.org/10.1002/jia2.25127

JIAS JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

From conventional to disruptive: upturning the HIV testing status quo among men who have sex with men in Vietnam

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Abstract

Introduction: HIV prevalence among men who have sex with men (MSM) in Vietnam is increasing, while annual HIV testing uptake has remained consistently low, posing a significant challenge to reaching the 90-90-90 goals. Barriers to MSM seeking HIV testing include concerns regarding confidentiality and lack of convenient testing options. Two new HIV testing strategies —HIV lay provider and HIV self-testing (HIVST)—were piloted alongside intensive social media outreach to increase access to and uptake of HIV testing among MSM not actively engaged in services.

Methods: We measured the proportion of first-time MSM HIV testers opting for HIV lay or self-testing, and factors that were associated with first-time testing, as part of a larger HIV lay and self-testing study among key populations in Vietnam. We also assessed MSM satisfaction with HIV lay or self-testing, and testing location and provider preferences. Finally, we calculated linkage to care cascade among MSM that were diagnosed and enrolled in anti-retroviral therapy (ART) services.

Results: Among MSM that sought HIV lay and self-testing, 57.9% (n = 320) and 51.3% (n = 412) were first-time testers respectively. In the final adjusted models, the odds of being a first-time tester and opting for HIV lay testing were higher among MSM who were young, had lower levels of income and had never exchanged sex for money; for HIVST, the odds of being a first-time HIV tester were higher among MSM that had attained lower levels of education. HIV lay and self-testing resulted in higher detection of new HIV cases (6.8%) compared to conventional HIV testing among key populations (estimated at 1.6% in 2016), while MSM linked to testing through social media interventions presented with even higher HIV-positivity (11%). Combined, 1655 HIV cases were diagnosed and more than 90% were registered for ART services.

Conclusions: Our findings suggest that MSM-delivered HIV testing and self-testing, promoted through online or face-to-face interactions, offer important additions to MSM HIV testing services in Vietnam, and could significantly contribute to epidemic control by increasing HIV testing among harder-to-reach and higher-risk MSM, effectively enrolling them in ART, and reducing onward transmission.

Keywords: MSM; HIV testing; community; HIV self-testing; HIV lay provider testing; HIV cascade; social media; Vietnam

Additional Supporting Information may be found online in the Supporting information tab for this article.

Received 15 December 2017; **Accepted** 17 May 2018

1 | INTRODUCTION

Since 2002, the Vietnam Ministry of Health (MOH) has led a large-scale HIV prevention, testing, and treatment programme primarily focused on reaching people who inject drugs (PWID), female sex workers (FSW), and, only more recently, men who have sex with men (MSM) [1]. HIV prevalence among PWID and FSW has declined significantly over the past decade [2,3]. Among MSM, however, HIV prevalence has increased, from 4% in 2011 to 7.4% in 2016, with the highest HIV prevalence (13%) in Ho Chi Minh City (HCMC) [2].

Until recently, HIV testing was solely available in clinical settings, with a focus on client- and provider-initiated facility-based modalities. In addition, confirmation of HIV diagnosis was only allowed in MOH-certified reference laboratories, which contributed to significant time delays in treatment enrolment [4].

Although the number of HIV testing sites has increased significantly, annual HIV testing uptake has remained low in MSM [5]. Reported annual HIV testing among MSM was 30.2% in 2011, 28.2% in 2013 and 32% in 2015 [6,7]. A national internet-based survey among MSM found that 76.5%

had never tested for HIV [8]. The study revealed that common reasons for MSM not seeking an HIV test included feeling ashamed, fear of receiving a positive result and self-perception of not being at risk of HIV. A representative cross-sectional study in four high-prevalence provinces reported that the primary features that MSM preferred in HIV testing were confidentiality and convenience [9]. This same study measured acceptability of HIV self-testing (HIVST) if it were available; 64% of MSM responded that they would opt for it, with privacy, confidentiality, speed and convenience being its primary advantages over conventional HIV testing [9]. A qualitative study with MSM in HCMC also described a strong preference for HIV testing services offered in an MSM-friendly environment [10]. Meta-analyses of HIV lay and self-testing have found that, when compared to conventional HIV testing, these strategies can significantly increase uptake of HIV testing among new testers, boost frequency of testing, and better reach those that are at risk of HIV [11-13].

Another barrier to MSM HIV testing in Vietnam involves the limitations of face-to-face peer outreach. There are an estimated 330,000 MSM in Vietnam, of whom some 26% are considered reachable through traditional peer interventions [14]. Studies measuring MSM online behaviour, social media consumption and service utilization suggest that a much larger population could be reached through online interactions [8,15,16]. In a representative sample of MSM across four cities, 88.9% of MSM reported owning a smart phone, 97.6% had a social media account and 80% used Facebook regularly [9]. Likewise, from an online descriptive cross-sectional study among MSM in Hanoi, 66.2% of respondents stated they already used the Internet to seek HIV prevention information, and 73.4% said they sought sex partners online [16]. Studies in Ghana, Thailand and the United States have demonstrated that online MSM peer outreach can result in increased use of HIV testing, particularly among those that are new to HIV services and not already in contact with HIV outreach interventions [17-19].

In 2015, shortly after adopting the global 90-90-90 goals, the Vietnam MOH embraced new strategies to increase HIV testing uptake and linkages to treatment among MSM and other key populations (KP). These new HIV testing modalities focused on community-based organization (CBO) delivered lay provider testing and HIVST promoted through online and face-to-face peer outreach. The interventions were implemented as part of the USAID/PATH Healthy Markets project funded by the US President's Emergency Plan for AIDS Relief (PEPFAR) through the US Agency for International Development (USAID). This paper describes the methods, results, and implications of these new HIV testing approaches reaching MSM in two major cities of Vietnam.

2 | METHODS

2.1 | Intervention description

In November 2015, staff from seven MSM-led CBOs in HCMC and five in Hanoi were trained to offer HIV lay provider testing, and began offering services to MSM from December 2015. The three-day training course equipped MSM lay testers to use and interpret a rapid blood-based professional use test (Alere Determine™ HIV-1/2), and in steps to follow if a test was HIV-reactive or invalid. Lay testers subsequently received supportive supervision and were assisted to master testing offered in a community setting (at CBO offices or community-based events).

Staff from the same 12 MSM CBOs were trained in May 2016 to offer HIVST information and support to clients, where needed, and what steps to take if the self-test was HIV-reactive. CBOs offered clients a choice of either a blood-based (Alere Determine™ HIV-1/2) or oral fluid (OraQuick® Rapid HIV-1/2 Antibody) assay. Both tests were made available in the CBO office and clients could opt to test privately without guidance or communication with staff, or could request help in specific steps of self-testing. Vietnamese language test inserts, pamphlets and tutorial videos were developed to support self-test performance. MSM with an HIV-reactive result from peer testing or self-testing (for those that disclosed their results) were accompanied by CBO staff for confirmatory testing at the closest district health centre, and those that were HIV diagnosed were helped with ART enrolment.

An intensive branded promotional campaign accompanied these new services, utilizing Facebook, Grindr, and MTV. A Facebook page, Rainbow Village, with 230,000 followers as of December 2017, is an open space for MSM to connect and exchange information on HIV, sexuality and wellbeing. The majority of fans are young (88% between 13 and 24) MSM and live in urban areas [20]. In March 2016, eight MSM social network influencers were identified and trained to communicate directly with Rainbow Village followers and provide HIV risk screenings and referrals for HIV lay or self-testing. To further increase ease of HIV testing uptake, a service booking application, I Reserve, was launched in February 2017. With I Reserve, MSM can quickly select where and when to test; and receive a test voucher with a unique identifier. The CBO receives an automatic booking notification and can then track test results and ART enrolment.

2.2 | Study design

We conducted a descriptive analysis of MSM first-time HIV testers seeking HIV lay or self-testing as part of a larger implementation science study in Vietnam that assessed the acceptability, feasibility and effectiveness of linkages to care of HIV lay and self-testing among KP (MSM, PWID, FSW) and their sex partners in four provinces (HCMC, Hanoi, Dien Bien and Nghe An) from December 2015 to September 2017. The larger study involved: observation and validation of lay-provider testing performance; validation of HIV self-test result interpretation; one cross-sectional survey among KP that used HIV lay-testing (n = 918) and one for KP that self-tested (n = 936); analysis of linkage to care (test-diagnose-enroll) HIV cascade monitoring data; and focus group discussions with health managers, lay providers and testers. Preliminary results from the overall study including lay-provider and self-tester performance, HIV testing uptake and preferences, and aggregate linkage to care results have been published elsewhere [21,22].

The primary outcome of interest for our analysis was the proportion of MSM first-time HIV testers opting for HIV lay or self-testing and factors that were associated with first-time testing. We also assessed MSM satisfaction with HIV lay or self-testing, and testing location and provider preferences and

Table 1. Outcome measure definitions and data source

1. First-time testers	MSM that report HIV testing for the first time ever	Cross-sectional survey
2. HIV testing preferences	MSM preferences related to HIV testing type, location and provider	Cross-sectional survey
3. Linkage to care	MSM who test HIV-reactive that are diagnosed and enrolled in ART services	Quarterly service monitoring data

how they had heard of lay-testing. Finally, we calculated linkage to care: the HIV positivity rate of MSM seeking HIV lay or self-testing, and the number and proportion of those diagnosed that were enrolled in ART services. We also assessed linkage to care specifically for MSM that HIV lay or self-tested through a social media-based referral or booking (Table 1).

2.3 | Participants, recruitment and data collection

Men aged 18 and above, who had sex with a man in the last 12 months, were HIV-negative or status-unknown, and opted for HIV lay or self-testing were eligible for the HIV lay-tester or self-tester cross-sectional study.

MSM cross-sectional survey participants were selected during two rounds of observation of MSM lay-provider testing performance. Each MSM tester was observed at two separate time points one week and one month after completing training. MSM were informed of the study through CBO and social media promotion. Those that were interested in coming for testing during the two observation sessions were informed about the study, its purpose and that it would involve an observer who would evaluate the performance of their lay tester and a short survey on their testing experience. After being briefed, MSM that opted to participate in the study and presented at the CBO for testing completed the informed consent process where the study's purpose, process, and potential risks and benefits were discussed. Trained research staff conducted the interviews using computer-assisted personal interviewing (CAPI).

For the HIVST survey, a "take all" method was applied where every client who met the above mentioned criteria, accepted HIV self-testing and opted to participate in the study were invited to join and then completed a paper-based self-administered survey. The HIV lay and self-testing cross sectional survey included socio-demographical information, HIV risk behaviours, HIV testing history, satisfaction with the testing approach; willingness to pay; and preferences related to type of HIV test, HIV tester and location of HIV testing.

The study was approved by the Institute of Social and Medical Studies IRB in Hanoi, Vietnam. PATH's research determination committee also reviewed the protocol and determined it as non-research. Oral informed consent was obtained from all participants.

2.4 | Analysis

The Kobo Toolbox application that hosts Open Data Kit programme (ODK) was used for the HIV lay testing CAPI survey data entry. Data were analysed using SPSS Version 22.0. The paper-based HIVST surveys were entered using EpiData Version 3.1 and then converted to SPSS for analysis.

The main outcome of interest was the proportion of MSM first-time HIV testers opting for HIV lay or self-testing and factors that were associated with first-time testing. Univariable logistic regressions were conducted to identify socio-behavioural factors independently associated with first-time HIV testers, and analysed separately for MSM selecting HIV lay provider testing and self-testing. Variables found to be statistically associated with a p-value of <0.05 were included in the multivariable logistic regression model. The final model was generated using backward elimination of variables with a p-value of <0.05. Socio-behavioural characteristics and HIV testing satisfaction of MSM opting for HIV lay or self-testing were explored and compared using the Wald Test.

Data to determine linkage to care were drawn from quarterly PEPFAR direct service delivery monitoring reports and included the period of December 2015 to September 2017 for lay testing, and May 2016 to September 2017 for self-testing. We used aggregated individual tester data to assess the number and proportion of HIV-reactive cases among those tested, the number and proportion of those that were newly diagnosed, and the number and proportion of those diagnosed that were enrolled in ART services. As part of the linkage to care cascade analysis, we explored direct referrals from MSM online influencers and MSM who booked an HIV test using the I Reserve app. The linkage to care cascade data were analysed and visualized applying the 2015 LINKAGES guide [23].

3 | RESULTS

3.1 | Enrolment

A total of 548 MSM accessing HIV lay provider testing and 803 MSM seeking HIVST opted to participate in the study. Survey completion rate was high among respondents, although in the HIVST survey there were a significant number of missing responses (343/803, 42.7% missing) to the income level question. Chi-square analysis was conducted between first time and non-first time testers, and respondents with and without income data and no associations were found (p = 0.998).

3.2 | HIV testing uptake and frequency

Among MSM that sought HIV lay testing and HIVST, 57.9% (n = 320) and 51.3% (n = 412) were first-time testers respectively (Table 2). For MSM that had reported ever HIV testing, the majority had tested in the previous 12 months (n = 151, 64.8% and n = 303, 77.5% respectively). Median age of MSM seeking lay and HIVST were 23 and 24 respectively.

The top three sources of information where MSM had first heard of lay testing were: peer outreach workers (70.6%), friends (62.5%) and Facebook (55.1%).

3.3 | HIV testing satisfaction and preferences

Nearly all MSM reported being satisfied with HIVST (94.8%; n = 761/803) and lay provider testing (98.2%; n = 538/548). Among MSM that sought HIV lay provider testing, 85.4%

Table 2. Number and proportion of new and infrequent MSM HIV lay and self-testers

	MSM	
Characteristics	**Self-testing (n = 803)**	**Lay-testing (n = 548)**
Ever been HIV tested		
No, this is first time	51.3%	57.9%
Yes	48.7%	42.1%
HIV tested in	(n = 391)	(n = 233)
past 12 month		
No	22.5%	35.2%
Yes	77.5%	64.8%

(n = 468/548) said they would opt for this form of testing in the future, while 11.5% (n = 63/548) had no preference in type of future HIV testing. For MSM that chose HIVST, 57.2% (n = 459/803) stated they would prefer CBO staff assisted self-testing, 21% (n = 169/803) reported wanting to self-test alone in the CBO office, and 16.6% (n = 133/803) said that their preference was to self-test at home.

3.4 | Factors associated with being a first-time HIV tester opting for HIV lay provider or self-testing

In the univariable regression for MSM selecting HIV lay testing, being a new HIV tester was associated with younger age, no sex exchanged for money, and lower income ($p < 0.05$). These associations remained statistically significant in the multivariable analysis (Table 3).

In the final adjusted model, the odds of being a first-time tester were higher among MSM who had never exchanged sex for money (aOR 2.3; 95% CI: 1.35 to 2.9) or who had income below the mean level (aOR 1.6; 95% CI: 1.1 to 2.3).

In the univariable regression for MSM seeking HIVST, a lower level of attained education was associated with being a new HIV tester at $p < 0.05$ (Table 4). The odds of being a new HIV self-tester and having attained a lower level of education remained high in the multivariable logistic regression analysis (aOR 1.8; 95% CI: 1.3 to 2.5).

3.5 | Linkage to care cascade results

From December 2015 to September 2017, 23,180 MSM received HIV lay testing. There were 1582 HIV-reactive cases

Table 3. Factors associated with being a first-time HIV tester and opting for lay provider testing

				Univariable logistic regression		Multivariable logistic regression	
Socio-demographics	**Total (n = 548)**	**First-time testing (n = 316)**	**Ever tested (n = 232)**	**OR (95% CI)**	***p*-value**	**aOR (95% CI)**	***p*-value**
Age in years				1.04 (1.008 to 1.06)	**0.012**	1.03 (1.003 to 1.07)	**0.029**
Education							
High school and below	35%	108 34.2%	84 36.2%	0.91 (0.64 to 1.3)	0.623	1.05 (0.69 to 1.6)	0.8
To College and university	65%	208 65.8%	148 63.8%	1		1	
Sex exchange for money							
No	86.7%	285 90.2%	190 81.9%	2.1 (1.27 to 2.47)	**0.004**	2.3 (1.35 to 2.9)	**0.002**
Yes	13.1%	30 9.5%	42 18.1%	1		1	
Ever injected drugs							
No	95.6%	301 95.3%	223 96.1%	1		1	
Yes	4.0%	14 4.4%	8 3.4%	1.29 (0.53 to 3.14)	0.566	1.86 (0.71 to 4.87)	0.2
Income							
Below mean	55.3%	189 59.8%	114 49.1%	1.7 (1.2 to 2.4)	**0.003**	1.6 (1.1 to 2.3)	**0.013**
Above mean	38.5%	104 32.9%	107 46.1%	1		1	
Residence							
Hanoi	34.5%	110 34.8%	79 34.1%	1		1	
Ho Chi Minh City	65.5%	206 65.2%	153 65.9%	0.96 (0.67 to 1.38)	0.854	1.25 (0.82 to 1.9)	0.29

Bold denotes *p*-value <0.05.

(6.8%), of which 1386 were HIV-diagnosed (87.6%) and 1290 (93.1%) were enrolled in ART (Figure S1).

There were an additional 4220 MSM that opted for HIVST from May 2016 to September 2017. Among those, 297 (7%) tested HIV-reactive and 269 (90.6%) were confirmed HIV-positive. Of those diagnosed, 243 (90.3%) were registered for treatment (Figure S2).

As part of these linkage to care cascades, 2067 MSM were counselled and screened for HIV risk by social media influencers, 1429 (69.1%) were referred for an HIV test based on their HIV risk profile, 1419 tested (99.3%) and 10.9% (n = 155) were HIV diagnosed. A total of 387 MSM used the newly launched I Reserve app, 367 were HIV tested (94.8%), and 11.1% (n = 43) were HIV diagnosed. All 198 of those diagnosed were enrolled in ART services (Figures 1 and 2).

4 | DISCUSSION

Despite Vietnam MOH recommendations that MSM and other key populations test for HIV at minimum annually, uptake has been consistently poor. Our results demonstrate substantial use of and preference for HIV lay-provider and self-testing among MSM, particularly in young, and new or infrequent HIV testers. In a 22-month period, 12 MSM-led CBOs in two cities successfully tested 27,000 peers, identified 1655 HIV cases and linked the majority (>90%) of them into treatment. Peer-delivered HIV testing and self-testing also resulted in higher detection of new HIV cases (6.8% to 11%) compared to the national rate among KP testing in conventional governmental facilities (estimated at 1.6% in 2016) in Vietnam [24]. This was the first time that MSM-led CBOs were allowed to offer such services to peers, and play an active role in the 90-90-90 cascade in Vietnam.

The authors are not aware of any other study that has described such a high volume of peer delivered HIV testing uptake with MSM. One study from Thailand describes a similar model to ours, where MSM were trained to offer HIV testing through five CBOs in four localities. While the scale was much smaller—in 16 months, the CBOs tested 1680 individuals—the HIV diagnosis and ART enrolment rates were similarly high [25,26].

We found that HIV lay and self-testing were very effective at reaching new MSM HIV testers (more than 50% for both testing modalities). While we were not able to identify studies that measured impact of MSM-delivered HIV testing on new tester uptake, a pooled analysis of 12 studies that measured the impact of HIVST on new HIV testing, reported that 18.7% of MSM were first-time testers (9.9% in higher-income

Table 4. Factors associated with being a first-time HIV tester and opting for self-testing

Socio-demographics	Total (n = 803)	First-time testing (n = 412)	Ever tested (n = 391)	Univariable logistic regression		Multivariable logistic regression	
				OR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
Age in years				0.99 (0.996 to 1.03)	0.87	0.98 (0.95 to 1.02)	0.45
Education							
High school and below	41.1%	201 (48.8%)	129 (33.0%)	1.9 (1.4 to 2.3)	**0.000**	1.8 (1.3 to 2.5)	**0.001**
College and university	58.9%	211 (51.2%)	262 (67.0%)	1		1	
Sex exchanged for money							
No	70.6%	277 (67.2%)	290 (74.2%)	0.72 (0.5 to 1.0)	0.081	0.83 (0.57 to 1.2)	0.34
Yes	19.3%	88 (21.4%)	67 (17.1%)	1		1	
No response	10.1%	47 (11.4%)	34 (8.7%)	1.05 (0.61 to 1.8)	0.85	1.0 (0.57 to 1.8)	0.9
Ever injected drugs							
No	94.8%	383 (93.0%)	378 (96.7%)	1		1	
Yes	1.6%	9 (2.2%)	4 (1.0%)	2.22 (0.67 to 7.27)	0.187	2.2 (0.69 to 7.6)	0.17
No response	3.6%)	20 (4.9%)	9 (2.3%)				
Income							
Below mean	41.0%	167 40.5%	162 41.4%	0.92 (0.61 to 1.3)	0.711	0.78 (0.51 to 1.2)	0.27
Above mean	16.3%	69 16.7%	62 15.9%	1		1	
No response	42.7%	176 42.7%	167 42.7%	0.94 (0.63 to 1.4)	0.79	0.84 (0.55 to 1.2)	0.42
Residence							
Hanoi	35.7%	139 33.7%	148 37.9%	1		1	
Ho Chi Minh City	64.3%	273 66.3%	243 62.1%	1.19 (0.89 to 1.59)	0.224	0.99 (0.72 to 1.3)	0.9

Bold denotes *p*-value <0.05.

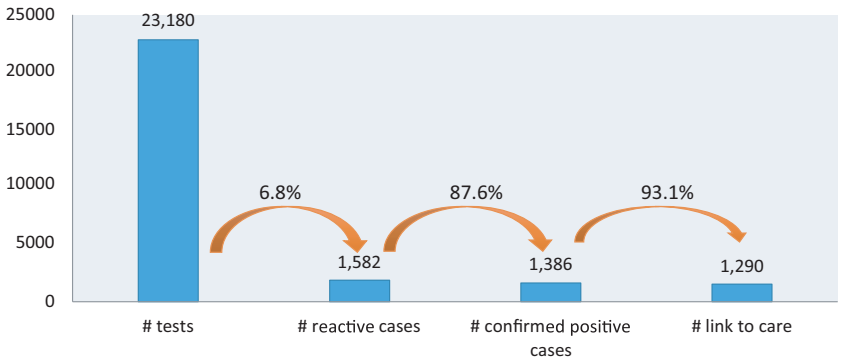

Figure 1. HIV lay-testing cascade among men who have sex with men, January 2016 to September 2017

countries; 32.9% in lower-income countries) [27]. The proportion of new HIV self-testers in our study was more than twice the pooled average, and nearly double that of lower income countries reported in this meta-analysis. Combined, new MSM testers that opted for HIV lay and self-testing were more likely to be young, have a lower income, not have exchanged sex for money, and have attached lower levels of education. Studies in higher and lower-income countries have identified younger age and lower education attainment with never HIV testing [28-30]. This suggests that HIV lay and self-testing are reaching at-risk MSM in a way that traditional HIV testing services are not equipped to.

In our study, we found that young MSM were more likely to select HIV lay provider testing or self-testing; the majority were under 30 years of age. This may be in part due to the blend of online and traditional promotion of the services. Although the number of MSM reached online and linked to testing were minimal (6.6% of total), more than half of lay-testers stated that they were informed of the service through Facebook. Importantly, online outreach and use of I Reserve HIV service booking app resulted in a near doubling of HIV-positivity in MSM testers. The HIV positivity yield derived from these approaches was almost the same, but I Reserve may be easier to scale given it is an individually driven tool, and no or minimal peer interaction is required. While our results suggest online reach as an important strategy for identifying newer, higher-risk or otherwise "hidden" populations, moving forward, experimental studies measuring the effectiveness of social media interventions on MSM uptake and frequency of HIV testing in Vietnam should be conducted.

MSM testers reported a high degree of satisfaction with these new models of CBO-delivered testing, and intent to re-test and refer peers. Given the range of MSM HIVST-delivery preference we found in our study, from CBO-assisted, to unassisted home testing, it will be important to continue to offer a range of options that maximize acceptability and uptake. While the majority of respondents stated preference for CBO-assisted HIVST, it is possible this will shift to greater interest in unassisted HIVST as these modals become more widely available and as MSM in Vietnam become more familiar with HIV self-tests and how they work.

There are several limitations associated with the data presented in this paper. First, as a descriptive study, we were not able to directly compare MSM using HIV lay and self-testing to facility-based testing, and assess differences in the proportion of first-time HIV testers, HIV positivity yield and linkage to care between the two. Second, our study was not based on a probability sample, and was not necessarily representative of MSM in HCMC and Hanoi. Third, in a bid to keep the self-administered HIVST survey short and encourage data completion we limited variables and did not include questions on whether it was social media content, face-to-face interactions or both that prompted HIVST uptake.

Despite these limitations, the large number of MSM that were new to HIV testing that actively sought out HIV lay and self-testing from MSM-led CBOs is encouraging. These findings suggest that HIV lay and self-testing should be scaled to

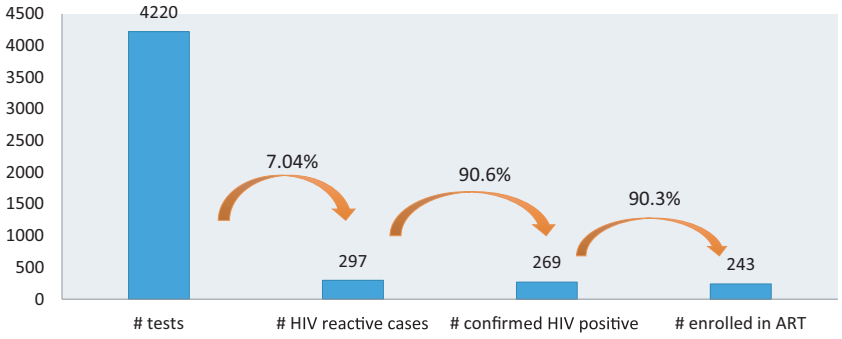

Figure 2. HIV self-testing cascade among men who have sex with men, May 2016 to September 2017

other geographies in Vietnam, while continuing to evaluate and refine newer approaches to reach high risk MSM that are still reluctant to seek HIV testing, such as older MSM. This could include assessing preferences for and uptake of unassisted HIVST through online, pharmacy and partner distribution models; and measuring the acceptability and impact of partner notification and index testing among the sex and drug using partners of newly HIV-diagnosed MSM. Although not measured in this study, linkages to HIV prevention services, particularly pre-exposure prophylaxis (PrEP), is a critical component of HIV testing services for those at high risk testing HIV-negative. With it now available in Vietnam [31], strength of linkages between HIV lay and self-testing and PrEP should be evaluated.

The results from our study have important public health implications and suggest that if Vietnam were to scale MSM peer delivered HIV testing and self-testing, it could accelerate progress towards epidemic control by more effectively identifying new HIV infections, more rapidly linking them to treatment, and critically, reducing onward transmission. Given the demonstrated ability of MSM CBOs in Vietnam to offer quality, convenient and confidential HIV testing services, we feel that this approach could be applied in other countries with similar contexts where MSM HIV testing-uptake is static and/or low.

5 | CONCLUSIONS

HIV lay provider and self-testing, promoted through social media and traditional outreach, resulted in significant uptake among young, previously HIV testing naïve MSM in two major cities in Vietnam. These community-delivered HIV testing approaches should be included in national HIV testing guidelines in Vietnam and substantially scaled to increase MSM use of HIV testing, and early access to treatment and PrEP. Without MSM-led and acceptable HIV testing approaches such as these, it is unlikely that Vietnam will achieve 90-90-90 by 2020 and epidemic control by 2030.

AUTHORS' AFFILIATIONS

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHORS' CONTRIBUTIONS

KEG, BVU, HTTP and MHT were study co-principal investigators. KEG, BVU and MHT drafted the manuscript with input from the co-authors. SHV and TMN provided advice and guidance on the intervention design. HVN, AHD, AB, TTT, TNNN and LTXH provided intervention oversight, training and quality assurance. MHT, TML and TTD provided data collection oversight. MHT, LHD and GTTH conducted data analysis. All authors have read and approved the final manuscript.

ACKNOWLEDGEMENTS

The authors acknowledge the significant contributions of participating MSM CBOs (G-Link, Lighthouse, G3VN, Aloboy, M4M, Color of Life, Smile, Vuot Song, Real Life, The Boy, V-Smile, SHP, Ruby, Suc Moi), Life Center, and the Ho Chi Minh City and Hanoi Provincial AIDS Centers that pioneered HIV lay provider and self-testing in Vietnam. We thank USAID for their support and funds for the HIV testing pilots, and Dr. Van Thi Thuy Nguyen from the World Health Organization in Vietnam for her insights and advice. Finally, a thank you to Susan Perez and Louise Cotrel-Gibbons for editing the manuscript.

FUNDING

USAID funded the HIV testing interventions and study.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Figure S1. Age distribution among men who have sex with men who opted for lay provider testing.

Figure S2. Age distribution among men who have sex with men who opted for self-testing.

Phanuphak N et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25118
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25118/full | https://doi.org/10.1002/jia2.25118

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

What would you choose: Online or Offline or Mixed services? Feasibility of online HIV counselling and testing among Thai men who have sex with men and transgender women and factors associated with service uptake

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Abstract

Introduction: HIV testing coverage remains low among men who have sex with men (MSM) and transgender women (TGW). We studied characteristics of Thai MSM and TGW who chose online and/or offline platforms for HIV counselling and testing and the feasibility of integrating online technologies and HIV self-testing to create service options.

Methods: From December 2015 to June 2017, MSM and TGW enrolled from Bangkok Metropolitan Region and Pattaya could choose between: [1] offline HIV counselling and testing (Offline group), [2] online pre-test counselling and offline HIV testing (Mixed group), and [3] online counselling and online, supervised, HIV self-testing (Online group). Sociodemographic data, risk behaviour and social network use characteristics were collected by self-administered questionnaires. Logistic regression models identified covariates for service preferences.

Results: Of 472 MSM and 99 TGW enrolled, 202 self-selected the Offline group, 158 preferred the Mixed group, and 211 chose the Online group. The Online group had the highest proportion of first-time testers (47.3% *vs.* 42.4% *vs.* 18.1%, $p < 0.001$) and reported highest HIV prevalence (15.9% *vs.* 13.0% *vs.* 3.4%, $p = 0.001$) as compared to Offline and Mixed groups, respectively. Having tested for HIV twice or more (OR 2.57, 95% CI 1.03 to 6.41, $p = 0.04$) increased the likelihood to choose online pre-test counselling. Being TGW (OR 6.66, 95% CI 2.91 to 15.25, $p < 0.001$) and using social media from four to eight hours (OR 2.82, 95% CI 1.48 to 5.37, $p = 0.002$) or >8 hours (OR 2.33, 95% CI 1.05 to 5.16, $p = 0.04$) increased selection of online, supervised, HIV self-testing. Providers primarily used smartphones (79.2%) and laptops (37.5%) to deliver online services. Self-testing strip image sharpness and colour quality were rated "good" to "excellent" by all providers. Most participants (95.1%) agreed that online supervision and HIV self-testing guidance offered were satisfactory and well delivered.

Conclusions: Online HIV services among MSM and TGW are feasible in Thailand and have the potential to engage high proportions of first-time testers and those with high HIV prevalence. When designing public health interventions, integrating varied levels of online HIV services are vital to engage specific sections of MSM and TGW populations in HIV services.

Clinical Trial Number: NCT03203265

Keywords: Online; HIV testing; counselling; men who have sex with men; transgender women

Received 15 December 2017; **Accepted** 12 May 2018

1 | INTRODUCTION

HIV testing is the first critical entry point into HIV prevention and treatment cascades. However, scaling-up HIV testing among key populations (KPs), including men who have sex with men (MSM), transgender women (TGW), sex workers and people who inject drugs, remains a global challenge [1]. In Thailand, MSM and TGW contribute to more than half of new HIV cases annually [2]. Recent estimate demonstrated that only 29% of MSM had received an HIV test in the past 12 months [3]. Although country data for TGW is limited, HIV testing coverage was reported at only 34% in 2014 [3].

A survey conducted among 4639 Thai MSM and TGW during 2010 to 2011 identified fear of testing (60%), not recognizing risk exposure (40%), and unavailability of friendly testing services (15%) as main reasons for never testing for

HIV [4]. In response, Thailand with support from the USAID has implemented the Key Population-Led Health Services (KPLHS) model led by community-based organizations (CBOs) serving MSM and/or TGW. KPLHS are a defined set of HIV-related health services delivered by trained KP community health workers in partnership with other health sector entities. This KPLHS model has proved extremely successful in engaging MSM and TGW who are at high-risk for HIV infection into early diagnosis, early antiretroviral treatment (ART) linkage, and high pre-exposure prophylaxis (PrEP) uptake [5]. In 2017 alone, KP community health workers contributed to 38% of the 41,386 HIV counseling and testing services and 26% of 4840 new HIV diagnoses among MSM and TGW in Thailand [6].

Given the heterogeneity in psychosocial context and health and digital literacy among MSM and TGW, multiple HIV testing options are needed to ensure that certain sub-populations are not excluded [7]. Motivation and education-based interventions through peer mobilizers and mass media campaigns could help tackle fear of testing. New technologies including online communication platforms and HIV self-testing have shown potential to overcome structural barriers and increase access to HIV counselling and testing among KPs [8,9].

A systematic review revealed that supervised HIV self-testing (conducted with real-time support from a healthcare provider) and unsupervised HIV self-testing were highly acceptable and preferred among people at risk for HIV infection, although lower sensitivity was found when self-testing was unsupervised [10] Online support to perform HIV self-testing has shown advantage over unsupervised HIV self-testing by the ability to address certain concerns such as lack of pre- and post-test counseling [11]. Thai MSM and TGW who lead the region in Internet and technology adoption and utilization have shown consistently high preferences for online HIV service delivery [12,13]. Online supervised self-testing with special emphasis on individual-level counselling could help address barriers to self-testing uptake among Thai MSM, such as fear of receiving self-testing kit at home, fear of one's own lack of understanding of self-testing and receiving results alone [14].

We leveraged Online, Offline and Mixed HIV counselling and testing, three distinct service delivery models by integrating online and HIV self-testing technologies, KPLHS and public healthcare services. In this paper, we specifically explored characteristics of Thai MSM and TGW as well as key factors they took into account when choosing service options. In addition, we studied providers' technology skills and utilization levels and their feasibility of delivering online HIV services as well as satisfaction among MSM and TGW clients receiving services.

2 | METHODS

From December 2015 to June 2017, Thai MSM and TGW were consecutively recruited and enrolled into a 12-month cohort study, with six-monthly visits to assess the preferences and feasibility of online and offline HIV counselling and testing strategies (NCT03203265). The Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, and the Bangkok Metropolitan Administration Ethics Committee approved this study. Inclusion criteria included Thai national, aged >18 years, being men or TGW, engaged in unprotected anal sex with men at least once in the past 6 months, living in Bangkok Metropolitan Region or Pattaya, and not known to be HIV positive. The study was supported by amfAR GMT Initiative grant and conducted by the Thai Red Cross AIDS Research Centre (TRCARC), Service Workers IN Group (SWING) Foundation, Rainbow Sky Association of Thailand (RSAT), and Sisters Foundation. SWING, RSAT and Sisters were CBOs serving MSM and TGW. SWING had two community health centres in Bangkok and Pattaya, RSAT had one community health centre in Bangkok, and Sisters had one in Pattaya. We reported baseline data from this study.

2.1 | Recruitment strategies and informed consent process

Online recruitment strategies included dissemination of study recruitment posters, text-based messages, and an online HIV self-testing video promoted through organizations' websites, banners on popular websites, and platforms commonly used by MSM and TGW such as Facebook, LINE chat groups, Camfrog video chat rooms, Hornet, and Jack'D. Offline recruitment was conducted by CBOs at hot spots using study posters and flyers. Participants interested in joining the study were scheduled for either online or offline informed consent process, based on individual preference. The online informed consent process was conducted using a real-time video chatting platform enabling the participant information sheet to be reviewed via shared screen.

2.2 | HIV counselling and testing via online and/or offline strategies

To understand the types of service delivery models that appeal to various sub-groups of MSM and TGW participants, the study allowed participants to self-select from three distinct strategies (Figure 1) including: (1) conventional offline HIV counselling and testing (Offline group), (2) online pre-test counselling and offline HIV testing (Mixed group), and (3) completely online counselling and supervised HIV self-testing (Online group). Services in the Offline group were delivered by staff at TRCARC and the four community health centres. In the Mixed group, pre-test counselling was conducted online by study staff and participants were scheduled to receive HIV testing and post-test counselling at a by-appointment-only clinic in Bangkok operated by TRCARC. Online group participants received totally online pre-test counselling, HIV testing, and post-test counselling. Study staff provided linkage to care and ART initiation support to all HIV-positive participants, regardless of CD4 count as per the Thailand National Guidelines [15].

2.3 | HIV testing and other services provided in Online, Mixed and Offline groups

Blood samples were collected by venipuncture in the Offline group for HIV testing. Other sexually transmitted infection testing were conducted based on provider's judgment. HIV testing was conducted according to Thailand National

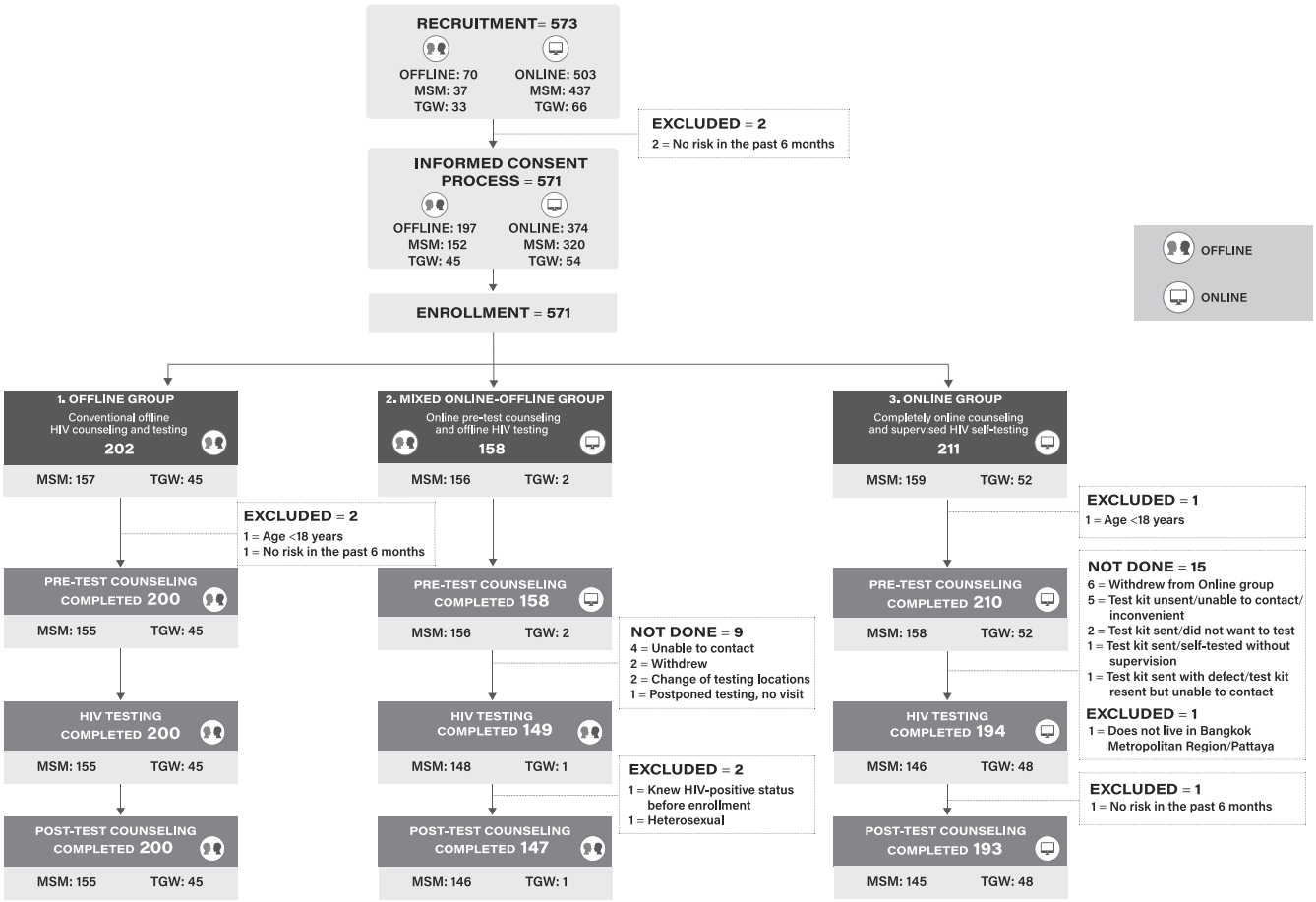

Figure 1. Flow of recruitment and enrolment of men who have sex with men (MSM) and transgender women (TGW) participants.

Guidelines [15], starting with either machine-based 4th generation (at TRCARC) or rapid third generation assay (at the community health centers) with confirmation of reactive result made by another two assays. Confirmed HIV status was available within one to two hours. To identify acute HIV infection cases, all non-reactive samples were also sent for nucleic acid testing (NAT) by Aptima HIV-1 RNA qualitative assay (Gen-Probe Inc., San Diego, CA, USA).

Participants in the Mixed group were scheduled to receive fingerprick blood collection at the clinic. Rapid third generation assay was performed with confirmation of reactive result by another two assays which confirmed HIV status within one to two hours.

In the Online group, participants had an HIV self-testing package and an online HIV self-testing video URL link [16] sent to them on a pre-scheduled date. Study staff contacted the participants to ensure package delivery and scheduled date and time for the online, supervised, HIV self-testing process. Step-by-step, real-time guidance was provided through a video chatting platform preferred by the participants. For self-testing, we used a rapid third generation assay (Alere Determine™ HIV 1/2, Alere Medical Co., Ltd., Matsuhidal, Matsudoshi, Chiba, Japan) and fingerprick blood sample which allowed for 15 minutes diagnosis result. Post-test counselling for participants with reactive results emphasized immediate linkage to confirmation and ART initiation at preferred hospitals or clinics.

PrEP and post-exposure prophylaxis (PEP) were offered to all participants and assistance to access PrEP and PEP services offline was given by study staff. Participants in the Mixed and the Online groups were also provided access to the Adam's Love Electronic health record (EHR) system which enabled secure access to laboratory results, post-test summaries and appointment scheduling for HIV test, as previously described [17].

2.4 | Data collection and questionnaires

A self-administered questionnaire was used at baseline visit to collect sociodemographic, risk behaviour, social network use characteristics, perceived barriers and facilitators for HIV testing, and experiences around stigma and discrimination. Online group participants also completed a questionnaire assessing their decision-making and reasons for choosing online, supervised, HIV self-testing, over clinic-based testing, and feelings post-service utilization. Study staff delivering online services completed a questionnaire that assessed their technology skills and utilization, and the feasibility and acceptability of delivering online HIV services.

2.5 | Statistical analysis

Data from the questionnaires were reported overall and by self-selected groups and by gender as frequency and

proportion for categorical parameters and mean (standard deviation, SD) and median (interquartile range, IQR) for continuous parameters. Comparison of continuous variables between groups was made by Two-sample *t* test, ANOVA techniques or non-parametric tests. Chi-square or Fisher's exact test was used for comparison of proportion of characteristics between groups.

The associations of covariates with a preference for online *vs.* offline pre-test counselling service and online *vs.* offline HIV testing and post-test counselling services were modelled using binary logistic regression, adjusting for confounders as appropriate. Factors showing significant level of 0.10 in the univariate model were adjusted in the multivariate model.

3 | RESULTS

The study recruited 437 MSM and 66 TGW through online and 37 MSM and 33 TGW via offline channels (Figure 1). Informed consent process was conducted online with 320 MSM and 54 TGW and offline with 152 MSM and 45 TGW. Of 571 participants enrolled, 202 selected the Offline group, 158 chose the Mixed group, and 211 preferred Online group. Seven individuals were further excluded (Figure 1) and data analyses were subsequently performed on 564 participants (Table 1). Mean (SD) age was 27.9 (7.2) years. In the past six months, 68.3% had multiple sex partners, 77.4% inconsistently used condoms, 6.2% used amphetamine-type stimulants, and 18.2% engaged in group sex. Basic characteristics of MSM and TGW participants are summarized in Table 1.

3.1 | First-time tester rate and HIV prevalence by self-selected groups

All participants in the Offline group completed HIV testing process although proportions were lower in the Mixed group (94.3%) and Online group (92.4%) (Figure 1). Nine participants in the Mixed group and 11 in the Online group did not show up for the offline or the online scheduled visit, and four could not complete online, supervised, self-testing process.

First-time testing rate was 42.4% in the Offline group, 18.1% in the Mixed group, and 47.3% in the Online group, $p < 0.001$. HIV prevalence was lowest in the Mixed group followed by the Offline and Online groups (3.4% *vs.* 13% *vs.* 15.9%, $p = 0.001$). One HIV-positive case was diagnosed by NAT in the Offline group. The Mixed group also had lowest proportion of TGW when compared to the Offline and Online groups (1.3% *vs.* 22.5 *vs.* 25.0%, $p < 0.001$).

3.2 | Factors associated with selecting "online pre-test counselling" (Table 2)

In a logistic regression model, having a bachelor degree or higher (OR 2.02, 95% CI 1.02 to 4, $p = 0.045$), having monthly income between 429 and 857 USD (OR 2.31, 95% CI 1.02 to 5.21, $p = 0.04$), and having had HIV tested twice or more (OR 2.57, 95% CI 1.03 to 6.41, $p = 0.04$) increased online pre-test counselling selection chances. Identifying inconvenient service hours as a barrier to HIV testing (OR 2.92, 95% CI 1.32 to 6.45, $p = 0.008$) influenced MSM to choose online pre-test counselling. Among TGW, positive attitude towards HIV testing (OR 8.75, 95% CI 1.56 to 49.01, $p = 0.01$) was associated with a higher chance to select online pre-test counselling, although prioritizing NAT-based HIV testing (OR 0.13, 95% CI 0.02 to 0.76, $p = 0.02$) decreased such chances.

3.3 | Factors associated with selecting "online HIV testing and online post-test counseling" (Table 3)

Being TGW (OR 6.66, 95% CI 2.91 to 15.25, $p < 0.001$), spending 4 to 8 hours (OR 2.82, 95% CI 1.48 to 5.37, $p = 0.002$) or >8 hours (OR 2.33, 95% CI 1.05 to 5.16, $p = 0.04$) on social media per day, and having preference towards online services (OR 5.73, 95% CI 2.99 to 10.98, $p < 0.001$) and home-based HIV testing (OR 6.00, 95% CI 3.1 to 11.63, $p < 0.001$) increased participant's likelihood to choose online HIV testing and post-test counselling. However, having preference for immediate confirmatory HIV test and ART initiation (OR 0.32, 95% CI 0.15 to 0.67, $p = 0.003$), wanting an HIV testing technology to detect infection soonest post-exposure (OR 0.30, 95% CI 0.16 to 0.57, $p < 0.001$), and having concerns around quality (OR 0.42, 95% CI 0.22 to 0.81, $p = 0.01$) or clinic hygiene (OR 0.31, 95% CI 0.16 to 0.6, $p < 0.001$) reduced selection chances.

3.4 | Factors associated with selecting "Offline" and "Mixed" groups

Having a bachelor degree or higher (OR 0.5, 95% CI 0.25 to 0.98, $p = 0.045$), monthly income between 429 and 857 USD (OR 0.43, 95% CI 0.19 to 0.98, $p = 0.04$), and having tested for HIV twice or more (OR 0.39, 95% CI 0.16 to 0.97, $p = 0.04$) reduced the chance to select the Offline group. Being TGW (OR 0.03, 95% CI 0 to 0.26, $p < 0.001$) negatively influenced Mixed group selection, while having bachelor degree or higher (OR 3.10, 95% CI 1.48 to 6.46, $p < 0.001$), having had HIV tested twice or more (OR 5.90, 95% CI 2.09 to 16.64, $p < 0.001$), and high HIV prevention knowledge (OR 2.81, 95% CI 1.39 to 5.69, $p < 0.001$) positively influenced this selection.

3.5 | Other factors associated with the decision to join the Online group and feelings post service-utilization

Of the 208 participants who joined the Online group, 160 responded to the survey. For most (87.5%), it was an easy decision to choose online, supervised, HIV self-testing. Preference for joining was guided by logistic/time convenience (46.9%), privacy and confidentiality (19.4%), altruism (16.9%), and scheduling flexibility (15.6%). Positive perceptions ("it's good and convenient", "it's amazing", "I'm glad to join HIV self-testing") increased from 67% before the process to 82% after. Negative perceptions ("fear of fingerprick", "I feel anxious", "I am nervous with the procedure") decreased from 23.2% to 8.8%. Most agreed that the HIV self-test kit mailed to them was complete (95%), the video and study brochure helped them comprehend the procedure (92.9%), and online

Table 1. Characteristics of men who have sex with men (MSM) and transgender women (TGW) participants

Characteristics	Overall (N = 564)	MSM (n = 465)	TGW (n = 99)	*p*-value
1. Demographic data				
Age (years)				
Mean (SD)	27.9 (7.2)	28.1 (7.2)	26.8 (7.2)	0.11[a]
Age 18 to 25	235 (41.7)	192 (41.3)	43 (43.4)	0.69[c]
Age >25	329 (58.3)	273 (58.7)	56 (56.6)	
Education				<0.001[c]
Less than Bachelor degree	221 (47.3)	163 (42.7)	58 (68.2)	
Bachelor degree/above	246 (52.7)	219 (57.3)	27 (31.8)	
Main occupation				<0.001[c]
Unemployed/Student	121 (26)	102 (26.8)	19 (22.6)	
Employed	294 (63.2)	256 (67.2)	38 (45.2)	
Service worker	50 (10.8)	23 (6)	27 (32.1)	
Income (USD)				<0.001[d]
<429	171 (37.6)	127 (34.2)	44 (52.4)	
429 to 857	192 (42.2)	156 (42.1)	36 (42.9)	
858 to 1429	59 (13)	57 (15.4)	2 (2.4)	
1430 to 2857	28 (6.2)	27 (7.3)	1 (1.2)	
≥2858	5 (1.1)	4 (1.1)	1 (1.2)	
2. Using social media				
Do you always use social media?				>0.99[d]
No	23 (5)	19 (5)	4 (4.8)	
Yes	437 (95)	358 (95)	79 (95.2)	
Which social media do you always use? (can select more than one choice)				
Facebook	431 (91.7)	351 (91.2)	80 (94.1)	0.37[c]
Line	427 (90.9)	355 (92.2)	72 (84.7)	0.03[c]
WhatsApp	55 (11.7)	38 (9.9)	17 (20)	0.009[c]
Instagram	225 (47.9)	186 (48.3)	39 (45.9)	0.69[c]
YouTube	325 (69.2)	272 (70.7)	53 (62.4)	0.13[c]
Twitter	172 (36.6)	148 (38.4)	24 (28.2)	0.08[c]
Skype/FaceTime	52 (11.1)	38 (9.9)	14 (16.5)	0.08[c]
Google	101 (21.5)	87 (22.6)	14 (16.5)	0.21[c]
How long do you spend time on social media daily? (excluding playing game)				
Weekday				0.02[c]
less than 2 hours	36 (7.8)	27 (7.1)	9 (10.8)	
2 to 4 hours	141 (30.5)	126 (33.2)	15 (18.1)	
4 to 8 hours	195 (42.1)	150 (39.5)	45 (54.2)	
8 to 24 hours	91 (19.7)	77 (20.3)	14 (16.9)	
Weekend				0.18[c]
less than 2 hours	25 (5.5)	18 (4.8)	7 (9)	
2 to 4 hours	111 (24.5)	98 (26.1)	13 (16.7)	
4 to 8 hours	212 (46.7)	175 (46.5)	37 (47.4)	
8 to 24 hours	106 (23.4)	85 (22.6)	21 (26.9)	
How do you rate your social media skills?				0.08[d]
Excellent	111 (24)	97 (25.5)	14 (16.9)	
Good	198 (42.8)	166 (43.7)	32 (38.6)	
Intermediate	144 (31.1)	110 (29)	34 (41)	
Poor	8 (1.7)	5 (1.3)	3 (3.6)	
No ability	2 (0.4)	2 (0.5)	0 (0)	
Have you ever sought sexual partner on social media?				0.08[c]
No	52 (11.1)	38 (10)	14 (16.5)	
Yes	415 (88.9)	344 (90.1)	71 (83.5)	

Table 1. (*Continued*)

Characteristics	Overall (N = 564)	MSM (n = 465)	TGW (n = 99)	*p*-value
If yes, which social media have you used for seeking sexual partner? n = 415				
Facebook	236 (50.2)	183 (47.5)	53 (62.4)	0.01[c]
Applications, e.g., Grindr, Jack'D, Hornet	285 (60.6)	266 (69.1)	19 (22.4)	<0.001[c]
Camfrog	92 (19.6)	75 (19.5)	17 (20)	0.91[c]
Instagram	41 (8.7)	35 (9.1)	6 (7.1)	0.55[c]
Others	10 (2.1)	5 (1.3)	5 (5.9)	–
What device(s) do you use for social media?				
Mobile phone	417 (88.7)	346 (89.9)	71 (83.5)	0.09[c]
Tablet	86 (18.3)	81 (21)	5 (5.9)	0.001[c]
Personal computer (PC)	109 (23.2)	97 (25.2)	12 (14.1)	0.03[c]
Notebook/laptop	148 (31.5)	136 (35.3)	12 (14.1)	<0.001[c]
3. Risk behaviour at baseline				
Age at first sex (years)				
Median (IQR)	17 (15 to 19)	18 (16 to 20)	15 (14 to 18)	<0.001[b]
Perceived HIV risk in the past 6 months				0.44[c]
No risk	50 (10.4)	39 (9.8)	11 (13.3)	
Mild	183 (37.9)	157 (39.3)	26 (31.3)	
Moderate	179 (37.1)	148 (37)	31 (37.4)	
High	71 (14.7)	56 (14)	15 (18.1)	
Median (IQR) number of sexual partners in the past 6 months	4 (2 to 6)	3 (2 to 6)	5.5 (2 to 15)	<0.001[b]
Condom use in the past 6 months				0.61[c]
Never	46 (9.8)	37 (9.5)	9 (11.1)	
Sometime	317 (67.6)	260 (67)	57 (70.4)	
Always	106 (22.6)	91 (23.5)	15 (18.5)	
Drug use in the past 6 months				>0.99[c]
No	304 (64.7)	249 (64.7)	55 (64.7)	
Yes	166 (35.3)	136 (35.3)	30 (35.3)	
Amphetamine-type stimulants used	29 (6.2)	25 (6.5)	4 (4.7)	0.54[c]
Had group sex in the past 6 months				0.057[c]
No	396 (81.8)	322 (80.3)	74 (89.2)	
Yes	88 (18.2)	79 (19.7)	9 (10.8)	
Yes, median (IQR) times of group sex	2 (1 to 3)	2 (1 to 3)	2 (1 to 3)	–
Yes, median (IQR) number of partners during each group sex	3 (3 to 4)	3 (3 to 4)	3 (3 to 3.5)	–
4. Perceived barriers and facilitators for HIV testing				
Have you ever been tested for HIV before participating in the study?				0.30[c]
No	172 (36.8)	137 (35.7)	35 (41.7)	
Yes	296 (63.3)	247 (64.3)	49 (58.3)	
If yes, median (IQR) times of HIV testing, n = 296	2 (1 to 4)	2 (1 to 4)	1 (1 to 2)	<0.001[b]
Does Nucleic Acid Testing (NAT) influence your decision to test for HIV this time?				0.67[c]
No	139 (30.1)	115 (30.4)	24 (28.6)	
Yes	177 (38.3)	147 (38.9)	30 (35.7)	
Not sure	146 (31.6)	116 (30.7)	30 (35.7)	
What is/are the barrier(s) to HIV testing?				
Inconvenience in travelling to get the service	149 (31.8)	131 (34.1)	18 (21.4)	0.02[c]
Unattractive/not beautiful place	23 (4.9)	17 (4.4)	6 (7.1)	0.30[c]
Inconvenient service hours	140 (29.9)	119 (31)	21 (25)	0.28[c]
Unfriendly staff	51 (10.9)	47 (12.2)	4 (4.8)	0.046[c]
Concern about confidentiality of HIV result	112 (23.9)	96 (25)	16 (19.1)	0.25[c]
Afraid of getting HIV-positive result	144 (30.8)	113 (29.4)	31 (36.9)	0.18[c]
Never think about HIV testing before	67 (14.3)	62 (16.2)	5 (6)	0.02[c]
Afraid of meeting people you may know	97 (20.7)	89 (23.2)	8 (9.5)	0.005[c]

Table 1. (*Continued*)

Characteristics	Overall (N = 564)	MSM (n = 465)	TGW (n = 99)	*p*-value
What is/are facilitator(s) for HIV testing?				
Quality standard of HIV testing service	266 (56.8)	238 (62)	28 (33.3)	<0.001[c]
Clinic hygiene	208 (44.4)	184 (47.9)	24 (28.6)	0.001[c]
Friendly staff	296 (63.3)	254 (66.2)	42 (50)	0.005[c]
Free HIV testing	303 (64.7)	266 (69.3)	37 (44.1)	<0.001[c]
Souvenir after HIV testing	134 (28.6)	122 (31.8)	12 (14.3)	0.001[c]
Online HIV testing	177 (37.8)	153 (39.8)	24 (28.6)	0.054[c]
HIV acquisition knowledge score (9 points)				
Mean (SD)	7.9 (1.3)	8.0 (1.2)	7.6 (1.6)	
Median (IQR)	8 (7 to 9)	8 (7 to 9)	8 (6 to 9)	0.12[b]
HIV prevention knowledge score (8 points)				
Mean (SD)	5.1 (1.5)	5.2 (1.4)	4.9 (1.8)	
Median (IQR)	5 (4 to 6)	5 (4 to 6)	5 (3 to 7)	0.13[b]
Have you ever known someone close to you who is HIV-positive?				0.62[c]
No	234 (53.6)	200 (54.1)	34 (50.8)	
Yes	148 (33.9)	122 (33)	26 (38.8)	
Not sure/do not know	55 (12.6)	48 (13)	7 (10.5)	
What is/are your attitude(s) about HIV testing?				
I am afraid of needles.	64 (13.7)	55 (14.3)	9 (10.7)	0.38[c]
I am concerned about confidentiality.	169 (36.1)	143 (37.2)	26 (31)	0.28[c]
I think there is less benefit than harm of knowing HIV status.	69 (14.7)	56 (14.6)	13 (15.5)	0.83[c]
I want a test which will detect HIV soonest after the exposure.	255 (54.5)	224 (58.3)	31 (36.9)	<0.001[c]
I want home testing.	152 (32.5)	130 (33.9)	22 (26.2)	0.17[c]
I think HIV testing is a good way to take care of one's health.	265 (56.6)	223 (58.1)	42 (50)	0.18[c]
Do you want to confirm HIV status and/or link to ART if tested reactive/positive? (n = 426)				0.08[d]
Yes, immediately	362 (86.8)	310 (87.6)	52 (82.5)	
Within 1 month	41 (9.8)	34 (9.6)	7 (11.1)	
1 to 3 months	8 (1.9)	5 (1.4)	3 (4.8)	
3 to 6 months	5 (1.2)	5 (1.4)	0 (0)	
5. Stigma and discrimination related to HIV				
Family disclosure of gender identity				<0.001[c]
Yes, self disclosure	228 (47.6)	178 (44.8)	50 (61)	
Yes, non-self disclosure	128 (26.7)	97 (24.4)	31 (37.8)	
No	123 (25.7)	122 (30.7)	1 (1.2)	
Discrimination within family due to gender identity				<0.001[c]
No	292 (70.4)	235 (70.6)	57 (69.5)	
Yes, current	9 (2.2)	7 (2.1)	2 (2.4)	
Yes, past	45 (10.8)	27 (8.1)	18 (22)	
Do not know/not sure	69 (16.6)	64 (19.2)	5 (6.1)	
In the past 12 months, ever been rejected from workplace due to gender identity				<0.001[c]
No	434 (91)	378 (95.2)	56 (70)	
Yes	43 (9)	19 (4.8)	24 (30)	
Feel embarrassed due to gender identity				0.01[d]
Yes, definitely	9 (1.9)	9 (2.3)	0 (0)	
Yes, maybe	26 (5.5)	23 (5.8)	3 (3.6)	
Probably not	96 (20.1)	88 (22.3)	8 (9.6)	
Definitely not	346 (72.5)	274 (69.5)	72 (86.8)	
In the past 12 months, ever been sexually abused				<0.001[c]
No	328 (68.9)	285 (72.5)	43 (51.8)	
Yes	148 (31.1)	108 (27.5)	40 (48.2)	

Table 1. (*Continued*)

Characteristics	Overall (N = 564)	MSM (n = 465)	TGW (n = 99)	*p*-value
In the past 12 months, ever been physically abused				<0.001[d]
No	456 (95.2)	386 (97.2)	70 (85.4)	
Yes	23 (4.8)	11 (2.8)	12 (14.6)	
In the past 12 months, ever experienced stigma and discrimination in healthcare setting (n = 169)				
Denied services	5 (3)	5 (3.5)	0 (0)	–
Sub-standard services	13 (7.8)	10 (6.9)	3 (13)	0.39[d]

[a]*p*-value for comparison of mean of characteristic between group (Two-sample *t* test).
[b]*p*-value for comparison of median of characteristics between group (Mann–Whitney two-statistic).
[c]*p*-value for comparison of proportion of characteristics between group (Chi-square test).
[d]*p*-value for comparison of proportion of characteristics between group (Fisher's Exact test).
SD, standard deviation; IQR, interquartile range; MSM, men who have sex with men; TGW, transgender women; USD, United States dollar; ART, antiretroviral therapy.

video-based guidance by counsellor while conducting self-testing was satisfactory (95.1%).

3.6 | Technology skills and utilization of counsellors and feasibility of providing online services

There were four MSM, one TGW and three cisgender women staff who responded to the survey. Median (IQR) age was 28.5 (24.5 to 31.5) years. Half had counselling experience of two years or less. Majority (75.0%) spent >4 hours using Internet in a day. All reported having used video calls for communication and felt comfortable using technology in their daily lives.

Smartphones (79.1%) and laptops (37.5%) were the primary devices used for delivering services. Primary apps for conducting video calls included LINE (87.5%), Facebook messenger (20.8%), ClickDesk (8.3%), Zoom (8.3%) and Facetime (8.3%). Majority (75%) reported experiencing a maximum of two Internet glitches per video call session. On a 5-point Likert-scale, majority (83.4%) rated the image quality of HIV self-testing strip image as "very good" or "excellent" and all agreed that HIV test result image captured and displayed was sufficient and conclusive for providing post-test counselling.

4 | DISCUSSION

Our implementation research study results illustrate that conducting online pre-test counselling and online, supervised, HIV self-testing and post-test counselling among MSM and TGW are feasible in Thailand, when conducted by healthcare professionals and trained KP community health workers. Prior HIV testing experiences, privacy and confidentiality needs, HIV testing attitudes, and social network use patterns are significant factors driving the choice to select online, mixed or offline services. Online supervised HIV self-testing significantly engaged first-time testers and those with highest HIV prevalence, further emphasizing the need for large-scale implementation of such model. Our study also demonstrated that an implementation research offering online, mixed and offline HIV testing options with self-selection by participants is feasible and allows for near real-life situations and lessons learned.

Having prior HIV testing experience may help facilitate one's decision to seek unconventional HIV testing services [18]. MSM previously tested for HIV were more likely to choose online pre-test counselling in our study. Inconvenient location and service hours are commonly cited barriers to scaling-up HIV testing among MSM and other KP [8,19]. Those who cited such barriers were more likely to choose online pre-test counselling, offering opportunities to foster participant-counsellor relationship and enable appointment scheduling.

MSM participants with interest in home-based testing and having concerns around confidentiality showed higher preference for online, supervised, HIV self-testing, which supports findings among Chinese MSM who prioritized privacy and confidentiality when selecting online HIV services [20]. In contrast to a previous study [21], seeking sex partners online did not influence participant's decision to seek online HIV testing. Although, consistent with an earlier finding, high social media usage increased participants' selection of online HIV services [20].

Being TGW was another strong predictor for choosing online, supervised, HIV self-testing in our study. High Internet and social media usage patterns among TGW and its potential to reach and provide non-judgmental support to TGW was reported in earlier studies [22-24]. TGW who considered taking an HIV test as a way to living healthy life were also more likely to choose online services. This is vital to designing public health interventions and research projects targeting TGW.

Our results harmonize well with previous study by Flowers et al. highlighting the need for diverse approaches to HIV testing interventions for maximum public health benefit [7]. It is plausible that first-time testers or testers with high risk would access a friendly offline HIV testing clinic where immediate confirmatory testing and linkages to PrEP/PEP or ART are available. Testers who perform regular check up every three to six months may prefer HIV self-testing with an initial supervision by providers.

HIV self-testing is not yet registered in Thailand as the Thai Food and Drug Administration lacks clarity around the level of support optimal for Thai users. Findings from this study and growing literature on the need for online counselling support for HIV self-testers [10] should provide necessary guidance for shaping Thailand's national policy around online HIV self-testing.

Concerns around quality of HIV services and intention to have immediate confirmatory testing and linkage to ART were main factors driving MSM and TGW away from selecting online HIV services. This may be particularly challenging for

Table 2. Factors associated with the selection of online pre-test counselling

	Overall (N = 564)			MSM (n = 465)			TGW (n = 99)		
Factors	**aOR**	**95% CI**	***p*-value**	**aOR**	**95% CI**	***p*-value**	**aOR**	**95% CI**	***p*-value**
Demographic									
Marital status									
Single	–	–	–	1	ref		–	–	–
Living together with male partner	–	–	–	2.20	1.06 to 4.57	0.04	–	–	–
Living together with female partner/others	–	–	–	1.03	0.25 to 4.23	0.97	–	–	–
Education									
Less than Bachelor degree	1	ref		1	ref		–	–	–
Bachelor degree/above	2.02	1.02 to 4.00	0.045	2.77	1.33 to 5.77	0.007	–	–	–
Main occupation									
Unemployed/student	1	ref		–	–	–	–	–	–
Employed	0.38	0.16 to 0.89	0.03	–	–	–	–	–	–
Service worker	0.15	0.04 to 0.53	0.003	–	–	–	–	–	–
Income (USD)									
<429	1	ref		–	–	–	–	–	–
429 to 857	2.31	1.02 to 5.21	0.04	–	–	–	–	–	–
≥858	1.81	0.64 to 5.10	0.27	–	–	–	–	–	–
Main social media/search engine platform used									
Facebook	1.02	0.35 to 2.96	0.97	–	–	–	–	–	–
Line	–	–	–	–	–	–	4.50	0.54 to 37.31	0.16
Instagram	2.22	1.12 to 4.38	0.02	3.97	1.90 to 8.29	<0.001	–	–	–
YouTube	1.20	0.59 to 2.46	0.62	–	–	–	3.72	0.69 to 19.93	0.13
Skype/FaceTime	–	–	–	–	–	–	0.16	0.02 to 1.43	0.10
Google	0.41	0.20 to 0.85	0.02	0.34	0.15 to 0.75	0.007	–	–	
Social media platform for seeking online sex partner									
Applications, e.g., Grindr, Jack'D, Hornet	–	–	–	–	–	–	4.98	0.71 to 35.00	0.11
Instagram	0.27	0.10 to 0.74	0.01	0.21	0.06 to 0.71	0.01	–	–	–
Device(s) used for social media									
Notebook/laptop	1.66	0.84 to 3.29	0.15	–	–	–	–	–	–
Age at first sex >17 years	–	–	–	2.43	1.18 to 4.98	0.02	–	–	–
Ever been tested for HIV									
No	1	ref		1	ref		–	–	–
Yes, ≤2 times	0.96	0.47 to 1.97	0.92	0.85	0.38 to 1.90	0.70	–	–	–
Yes, >2 times	2.57	1.03 to 6.41	0.04	3.21	1.10 to 9.37	0.03	–	–	–
NAT influencing decision to get HIV testing									
No/not sure	–	–	–	–	–	–	1	ref	
Yes	–	–	–	–	–	–	0.13	0.02 to 0.76	0.02
Barriers to HIV testing									
Unattractive/not beautiful place	–	–	–	0.06	0.01 to 0.36	0.002	–	–	–
Inconvenient service hours	1.71	0.89 to 3.30	0.11	2.92	1.32 to 6.45	0.008	–	–	–
Afraid of knowing HIV-positive result	–	–	–	–	–	–	0.13	0.03 to 0.64	0.01
Facilitators for HIV testing									
Quality standard of HIV testing service	0.41	0.20 to 0.86	0.02	0.34	0.14 to 0.81	0.02	–	–	–
Clinic hygiene	0.33	0.16 to 0.66	0.002	0.49	0.22 to 1.10	0.08	0.14	0.01 to 0.28	0.001
Souvenir after HIV testing	1.91	0.93 to 3.90	0.08	2.04	0.88 to 4.74	0.10	–	–	–
Online HIV testing	2.68	1.33 to 5.39	0.006	2.64	1.19 to 5.89	0.02	8.80	1.05 to 73.61	0.045
HIV prevention knowledge score	1.77	0.94 to 3.31	0.08	1.87	0.92 to 3.82	0.09	–	–	–
Know someone close is HIV positive									
No	1	ref		1	ref		–	–	–
Yes	0.43	0.22 to 0.84	0.01	0.29	0.13 to 0.65	0.002	–	–	–
Not sure/do not know	0.61	0.24 to 1.51	0.28	0.54	0.19 to 1.55	0.26	–	–	–

Table 2. (*Continued*)

	Overall (N = 564)			MSM (n = 465)			TGW (n = 99)		
Factors	**aOR**	**95% CI**	***p*-value**	**aOR**	**95% CI**	***p*-value**	**aOR**	**95% CI**	***p*-value**
Attitudes towards HIV testing									
Less benefit than harm of knowing HIV status	0.41	0.18 to 0.94	0.04	0.46	0.17 to 1.24	0.12	–	–	–
Want home testing	1.94	0.97 to 3.90	0.06	2.18	0.96 to 4.94	0.06	–	–	–
HIV testing as a good way to take care of one's health	–	–	–	–	–	–	8.75	1.56 to 49.01	0.01
Family disclosure of gender identity									
No	1	ref		1	ref		–	–	–
Yes, self disclosure	6.60	1.95 to 22.35	0.002	11.28	2.62 to 48.5	0.001	–	–	–
No, non-self disclosure	18.45	4.98 to 68.31	<0.001	14.21	7.09 to 65.08	<0.001	–	–	–
Discrimination within family									
No	1	ref		1	ref		–	–	–
Yes, current and past	3.45	1.14 to 10.44	0.03	10.37	2.10 to 51.21	0.004	–	–	–
Do not know/not sure	2.44	0.85 to 7.04	0.10	2.72	0.80 to 9.26	0.11	–	–	–
Feel embarrassed due to gender identity									
Definitely not	–	–	–	1	ref		–	–	–
Yes definitely/yes maybe/probably not	–	–	–	1.66	0.73 to 3.77	0.23	–	–	–
In the past 12 months, ever been sexually abused									
No	1	ref		–	–	–	–	–	–
Yes	1.02	0.49 to 2.12	0.96	–	–	–	–	–	–
In the past 12 months, ever experienced stigma and discrimination in healthcare setting due to gender identity									
Sub-standard services	0.16	0.02 to 1.43	0.10	0.06	0.00 to 0.80	0.03	–	–	–

aOR, adjusted odds ratio; CI, confidence interval; TGW, transgender women; MSM, men who have sex with men; USD, United States dollar. Models were run separately for overall, MSM and TGW. Factors showing significant level of 0.10 in univariate model were adjusted in multivariate models for each group. Factors not included in multivariate models were shown as – in this table.

countries without current policies to regulate the quality, sale, distribution or use of HIV self-test kits, commonly available online [25,26]. In addition, to implement online HIV services, efforts should be made to ensure that the KP communities clearly perceive high quality of online service delivery and trust that adequate support can be provided for linkage to clinical services.

Almost 40% of MSM and TGW in our study felt that the availability of NAT affected their decision to take HIV testing, pointing to the need for KPs' access to an HIV testing assay which could allow for early detection of HIV infection. The availability of rapid 4th generation antigen-antibody assay highlights the near-future feasibility to have a self-testing assay which could detect HIV infection earlier than the existing assays [27,28].

Level of technology skills among healthcare providers has appeared to be the most important predictor of technology use in the workplace and is related to higher nursing competency [29,30]. Our findings showed that the level of technology ownership, skills and use was innately high among Thai providers who used them based on experience and self-learning, and thus, did not require intensive technology use training to deliver online services. High satisfaction for online counselling guidance reported by participants, and satisfactory video and self-testing result image quality expressed by providers have significant implications in terms of broader scale-up of online, supervised, HIV self-testing services in Thailand. However, among sub-populations or in settings with inadequate digital literacy, efforts should focus on simplifying digital health technologies, which help to bridge, not exacerbate, health and social inequities [31].

Our study has a few limitations. Although participants were allowed to self-select the groups, we could not fully avoid the possibility of bias by study staff at each study site who might have unintentionally influenced participants decision. All three options offered involve some level of social exposure and may not be inclusive enough for those who could not overcome even limited level of social exposure in the Online group. Secondly, due to unavailability of KPLHS clinics in other regions we did not enroll MSM and TGW beyond Bangkok Metropolitan Region and Pattaya to avoid possible bias to select the Online group. The result from this study, thus may not be generalized to MSM and TGW in other provinces. A recent online survey found that 30% of MSM in Southeast Asia had never been tested for HIV and were likely to be young, high-risk, non-gay-identified MSM [32]. Given these groups could be reached online for web-based surveys, there is a high potential of such outreach platforms for delivering online HIV services. To reduce barriers in healthcare access, public health experts and programme

Table 3. Factors associated with the selection of online HIV testing and post-test counselling

	Overall (N = 564)			MSM (n = 465)			TGW (n = 99)		
Factors	**aOR**	**95% CI**	***p*-value**	**aOR**	**95% CI**	***p*-value**	**aOR**	**95% CI**	***p*-value**
Gender									
MSM	1	ref		–	–	–	–	–	–
TGW	6.66	2.91 to 15.25	<0.001	–	–	–	–	–	–
Main social media/search engine platform used									
WhatsApp	–	–	–	0.19	0.05 to 0.72	0.02	–	–	–
YouTube	–	–	–	–	–	–	6.88	1.59 to 29.81	0.01
Skype/face time	0.45	0.17 to 1.2	0.11	–	–	–	–	–	–
Time spent on social media on weekday?									
<4 hours	1	ref		–	–	–	–	–	–
4 to 8 hours	2.82	1.48 to 5.37	0.002	–	–	–	–	–	–
8 to 24 hours	2.33	1.05 to 5.16	0.04	–	–	–	–	–	–
Main device used for social media									
Personal computer (PC)	0.47	0.23 to 0.96	0.04	–	–	–	–	–	–
Age at first sex >17 years	–	–	–	4.39	1.95 to 9.89	<0.001	–	–	–
Perceived HIV risk in the past 6 months									
No risk	–	–	–	1	ref		–	–	–
Mild	–	–	–	0.23	0.08 to 0.7	0.01	–	–	–
Moderate	–	–	–	0.47	0.16 to 1.41	0.18	–	–	–
High	–	–	–	0.34	0.08 to 1.42	0.14	–	–	–
NAT influencing decision to get HIV testing									
No/Not sure	–	–	–	1	ref		1	ref	
Yes	–	–	–	0.42	0.20 to 0.90	0.03	0.11	0.02 to 0.54	0.007
Barriers to HIV testing									
Inconvenient service hours	1.82	0.93 to 3.59	0.08	–	–	–	–	–	–
Concern about confidentiality of HIV result	–	–	–	2.99	1.32 to 6.76	0.009	–	–	–
Afraid of knowing HIV-positive result	–	–	–	–	–	–	0.16	0.04 to 0.67	0.01
Facilitators for HIV testing									
Quality standard of HIV testing service	0.42	0.22 to 0.81	0.01	0.38	0.17 to 0.84	0.02	0.17	0.02 to 1.56	0.12
Clinic hygiene	0.31	0.16 to 0.60	<0.001	0.42	0.18 to 0.99	0.047	0.10	0.01 to 0.86	0.04
Friendly staff	–	–	–	0.56	0.25 to 1.23	0.15	–	–	–
Free HIV testing	–	–	–	0.47	0.21 to 1.03	0.06	–	–	–
Online HIV testing	5.73	2.99 to 10.98	<0.001	6.30	2.87 to 13.86	<0.001	13.46	1.72 to 105.08	0.01
Attitudes towards HIV testing									
Afraid of needles	–	–	–	1.95	0.79 to 4.79	0.15	–	–	–
Want a test which will detect HIV soonest after the exposure	0.30	0.16 to 0.57	<0.001	0.29	0.13 to 0.62	0.002	–	–	–
Want home testing	6.00	3.10 to 11.63	<0.001	10.64	4.60 to 24.63	<0.001	–	–	–
HIV testing as a good way to take care of one's health	–	–	–	–	–	–	8.73	1.78 to 42.76	0.008
Intention to confirm HIV status and/or start ART after reactive/positive test result									
No/not immediately	1	ref		1	ref		–	–	–
Immediately	0.32	0.15 to 0.67	0.003	0.23	0.09 to 0.59	0.002	–	–	–

Table 3. (*Continued*)

	Overall (N = 564)			MSM (n = 465)			TGW (n = 99)		
Factors	**aOR**	**95% CI**	***p*-value**	**aOR**	**95% CI**	***p*-value**	**aOR**	**95% CI**	***p*-value**
In the past 12 months, ever been sexually abused									
No	1	ref		–	–	–	–	–	–
Yes	0.50	0.26 to 0.94	0.03	–	–	–	–	–	–

aOR, adjusted odds ratio; CI, confidence interval; TGW, transgender women; MSM, men who have sex with men; ART, antiretroviral therapy. Models were run separately for overall, MSM and TGW. Factors showing significant level of 0.10 in univariate model were adjusted in multivariate models for each group. Factors not included in multivariate models were shown as – in this table.

implementers are encouraged to adapt online HIV service models explored in our study.

5 | CONCLUSIONS

In summary, we demonstrated the feasibility of conducting online HIV counselling and testing services among Thai MSM and TGW. The online, supervised, HIV self-testing service was particularly preferred by TGW, MSM who had privacy and confidentiality concerns, and those who spent more time using social media per day. Results from this study are vital in designing public health interventions targeting segments of MSM and TGW populations with preference towards online HIV services delivery.

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COMPETING INTERESTS

All authors declare no competing interest.

AUTHORS' CONTRIBUTIONS

NP, TA and PP designed the study. NP led the study and wrote the first draft of the report. NP and TA edited and finalized the manuscript for submission. NP and DT designed the analysis. DT analysed the data. JJ, CN, KH and TS coordinated the study. PM oversaw data management. SP, PeP, ST, DM, SS, SH, and NU implemented the study at their sites. JB and TP supervised laboratory procedures. All authors critically reviewed and approved the manuscript.

ACKNOWLEDGEMENTS

The study team is grateful to the individuals who volunteered to participate in this study and to staff at the Thai Red Cross AIDS Research Centre, RSAT, SWING and Sisters. The project was supported through a grant from amfAR, The Foundation for AIDS Research as part of the GMT Initiative. The KPLHS model at each participating CBOs was established through support from United States President's Emergency Plan for AIDS Relief and the United States Agency for International Development (USAID) through the Linkages Across the Continuum of HIV Services for Key Populations cooperative agreement AID-OAA-A-14-0045 managed by FHI 360. The content of this presentation is solely the responsibility of the authors and does not necessarily represent the official views of any of the institutions mentioned above.

FUNDING

amfAR, The Foundation for AIDS Research as part of the GMT Initiative.

ROLE OF THE FUNDING SOURCE

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

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Ndori-Mharadze T et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25138
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25138/full | https://doi.org/10.1002/jia2.25138

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

Changes in engagement in HIV prevention and care services among female sex workers during intensified community mobilization in 3 sites in Zimbabwe, 2011 to 2015

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Abstract

Introduction: 'Sisters with a Voice', Zimbabwe's nationally scaled comprehensive programme for female sex workers (FSWs), intensified community mobilization activities in three sites to increase protective behaviours and utilization of clinical services. We compare indicators among FSWs at the beginning and after implementation.

Methods: We used mixed methods to collect data at three sites: in-depth interviews (n = 22) in 2015, routine clinical data from 2010 to 2015, and two respondent driven sampling surveys in 2011 and 2015, in which participants completed an interviewer-administered questionnaire and provided a finger prick blood sample for HIV antibody testing. Estimates were weighted using RDS-1 and estimate convergence assessed in both years. We assessed differences in six indicators between 2011 and 2015 using logistic regression adjusted for age, duration in sex work and education.

Results: 870 FSWs were recruited from the three sites in 2011 and 915 in 2015. Using logistic regression to adjust for socio-demographic differences, we found higher estimates of the proportion of HIV-positive FSWs and HIV-positive FSWs who knew their status and reported being on ART in Mutare and Victoria Falls in 2015 compared to 2011. Reported condom use with clients did not differ by year; however, condom use with regular partners was higher in 2015 in Mutare and Hwange. Reported HIV testing in the last six months among HIV-negative FSWs was higher in 2015 across sites: for instance, in Victoria Falls it was 13.4% (95% CI 8.7% to 19.9%) in 2011 and 80.8% (95% CI 74.0 to 87.7) in 2015. FSWs described positive perceptions of the Sisters programme, ease of engaging with health services, and improved solidarity among peers. Programme data showed increases in service use by 2015 across all sites.

Conclusions: Improvements in key HIV care engagement indicators were observed among FSWs in two sites and in testing and prevention indicators across the three sites after implementation of an intensified community mobilization intervention. Engagement with services for FSWs is critical for countries to reach 90-90-90 targets.

Keywords: Female sex workers; HIV; ART; peer education; community mobilization

Additional Supporting Information may be found online in the Supporting information tab for this article.

Received 15 December 2017; **Accepted** 22 May 2018

1 | INTRODUCTION

The World Health Organization and UNAIDS recommend that sex workers access comprehensive HIV prevention, testing, and treatment [1-3]. Female sex workers (FSWs) have a high burden of HIV [4], and 15% of HIV infections in the general adult population globally are considered attributable to unsafe commercial sex [5]. This proportion is likely to increase over time [6]. Sex workers suffer criminalization [7], stigma, discrimination and violence in a number of settings, heightening their vulnerability to HIV [8,9]. Due to their social marginalization, sex workers often choose to access targeted, non-judgmental, and tailored services to meet their needs [10,11]. Despite evidence of their effectiveness [12-14], targeted programmes for FSWs in most countries consist of small scattered projects, with limited scope and coverage [15-18].

Evidence suggests that FSWs often have poor linkage to and retention in care [19] due to a range of factors including stigma and discrimination experienced within healthcare settings [20,21], particularly if they are also living with HIV [22,23]. Peer to peer support, proximity to a targeted health centre, and "sex worker friendly" healthcare providers have been identified as key enablers of HIV testing and retention in care for HIV-positive FSWs [19,24].

The Zimbabwe National AIDS Strategic Plan [25] identifies FSWs as a key population at increased risk of HIV. Since 2009, the national "Sisters with a Voice" (Sisters) programme has provided free preventive and clinical services to FSWs supported by a network of trained peer educators. Services include syndromic management of sexually transmitted infections (STIs), provision of contraception, HIV testing and referral for HIV-positive women to public sector clinics for antiretroviral therapy (ART). ART has been freely available through the public sector since 2004, but in 2011 there was evidence that FSWs were reluctant to attend public clinics due to encountering discriminatory attitudes [26,27]. In response, CeSHHAR Zimbabwe piloted an intensified community mobilization project in Mutare, Hwange and Victoria Falls between 2010 and 2015, based on evidence from India showing that community mobilization for sex workers can increase condom use and reduce HIV and STI rates among FSWs [28-30]. More recent studies confirm that increased peer outreach is associated with FSWs' improved health-seeking and clinic attendance [31,32].

We compare key indicators related to FSW health seeking behaviour in 2011 and 2015 in three sites. We explore whether observed differences might be linked to the delivery of intensified community mobilization.

2 | METHODS

We draw data from three sources to inform the conclusions; Respondent Driven Sampling (RDS) surveys conducted in 2011 [33] and 2015, in-depth interviews with FSWs selected as seeds of the 2015 RDS Survey, and review of programme data from the Sisters' clinics between 2010 and 2015.

2.1 | Study population

Women were eligible for inclusion if they were aged ≥18 years, working at the study site and reported exchanging sex for money in the past 30 days.

2.2 | Intervention setting

The study was conducted in Mutare, a small city bordering Mozambique; Victoria Falls, a tourist town bordering Zambia; and Hwange, the location of a large colliery. The 2011 survey was conducted eight months after initiation of the intensified community mobilization, while the 2015 round took place 54 months after implementation.

2.3 | The intervention

In 2010, we intensified community mobilization in Mutare, Hwange and Victoria Falls, providing peer-delivered activities biweekly instead of monthly. We hired additional peer educators, who brought FSWs together in participatory workshops to build solidarity and reduce competition. We further trained public sector health workers to be more "sex worker friendly" through a three-day workshop, and five-day attachment allowing them to shadow nurses at the Sisters' clinics, and monthly meetings with Sisters clinic staff and peer educators. The aim of intensified community mobilization was to foster an enabling environment for sex workers to adopt protective behaviours and increase their use of health services. In 2014, specific activities designed to engage younger women were introduced [34].

2.4 | Sampling and recruitment for RDS survey

In the absence of a sampling frame, we used Respondent Driven Sampling (RDS) to recruit women. While there is debate on the extent to which RDS achieves representativeness [35,36] it is a recommended approach for recruiting hidden populations [37] and has been used by other recent studies among FSWs in southern Africa [37,38].

First, we conducted rapid ethnographic mapping to inform the feasibility and design of the RDS survey, including selection of initial recruiters (seeds) [38]. Seeds were purposively selected to represent the range of FSWs' ages, geographic areas and sex-work typologies identified during mapping. Sample sizes reflected site size, mapping findings, and number of women seen in the programme to date. Ten seeds were recruited from Mutare and six each from Hwange and Victoria Falls, which are smaller towns. Each seed completed a questionnaire, provided a finger prick blood sample for HIV antibody testing, and was issued with two uniquely identified coupons. Seeds passed these coupons on to FSWs who met study inclusion criteria, inviting them to the study. On presenting a coupon, FSWs were assessed for eligibility and asked to provide written consent to participate. Each recruit was given a further two coupons for peer referral. Participants received US$5 to cover costs of participation, with an opportunity to earn US$2 for each successfully recruited referral.

2.5 | RDS survey data collection

A questionnaire was developed in English, translated into Shona and Ndebele, and pilot tested. Responses were entered directly into a computer-assisted survey instrument (QDS™ Nova research Company in 2011 and Open Data Kit in 2015). Data were collected anonymously, covering sociodemographic and economic variables, sexual behaviour, mental and physical health, history of STIs, sexual and social networks, social capital, utilization of services including HIV testing, ART, PMTCT and family planning.

2.6 | Laboratory procedures

Finger prick blood samples were collected onto filter paper by a nurse and transported to the National Microbiology Reference laboratory in Harare. They were tested for HIV-1 in series using AniLabsystems EIA kit (AniLabsystems Ltd, Fin-01720, Vantaa, Finland) with specimens testing positive re-tested using Vironostika® HIV Microelisa Systems BioMerieux, Inc, Durham NC 27704. Discrepant results were resolved using Western blot. Referral for HIV testing was made freely available in the Sisters clinics.

2.7 | Qualitative data collection and analysis

We conducted semi-structured interviews in 2015 with all study seeds (10 FSWs in Mutare, six in Hwange, and six in

Victoria Falls). Interviews explored FSWs' perceptions of their work, access to and quality of health services, and their experiences of community networks and support. All interviews were conducted in Shona or Ndebele. Audio-recorded data were transcribed and translated verbatim into English, and entered into NVivo 8 (QSR International Ltd, Melbourne, Australia) for coding. For this paper, we extracted data referring to knowledge, participation, and perceptions of the intensified community mobilization.

Following data familiarization, the third author conducted "broad brush" thematic coding on perceptions of available health services, use of services, and facilitators and barriers to accessing both public service and targeted Sisters clinics; this was followed by more detailed inductive coding. Analysis of qualitative data was conducted specifically to complement and help explain quantitative findings on differences over time in uptake of Sisters clinical and community services, in relation to the "intensified" components, and in comparison to other available healthcare.

2.8 | Programme data review

Programme data for 2010 to 2015 was drawn from the Sisters' data collection system which collects client data electronically in real time. Nurses enter data into the system using a tablet at each client visit. A unique identifier is allocated and demographic data are recorded during the first visit. At the first and all subsequent visits clinical data including presenting problems, services offered and diagnoses are collected.

2.9 | Key indicators

Key indicators assessed were drawn from the RDS surveys, namely: HIV prevalence, knowledge of HIV status among HIV-positive FSWs and testing in the last 6 months amongst HIV-negative FSWs, engagement with care and ART use among HIV-positive FSWs, and reported condom use with clients and regular partners. We also investigated self-reported service uptake including contact with peer educators, visits to the clinic, testing behaviour and perceived social cohesion.

We classified individuals who were HIV positive as knowing their status if they tested positive on the survey and self-reported that their last HIV test was positive, and on ART if this was self-reported, or HIV-negative if they tested negative for HIV and reported that they had tested negative within the last 6 months.

2.10 | Statistical analysis

We describe the prevalence of programme engagement and key HIV status, prevention and care indicators in 2011 and 2015, accounting for the RDS design using RDS-I weighting [39] to be consistent across years, as previously reported for the 2011 survey [33]. For 2015, we used the R RDS package version 0.7 to 8 [40], setting identical options to those used in the Stata RDS package [41] in 2011. Bootstrapping using the Salganik 2006 method was used to obtain the confidence intervals [42,43] approximating bootstrapped estimates to the t distribution. The number of bootstrap samples used to generate the confidence intervals were those necessary to compute the standard error to accuracy 0.001.

While we cannot attribute changes in HIV prevention and care indicators to the Sisters programme, we are interested in assessing whether differences in indicators between 2011 and 2015 suggest improvements in engagement with HIV prevention and care services. To determine evidence of bias in RDS estimates at each time-point due to non-convergence of sample waves (dependence on seed characteristics) we assessed the cumulative estimate over sample waves (Appendix 1) [44]. We also checked whether an observed difference in key indicator prevalence between 2011 and 2015 could be due to differences in the demographic composition of sex workers present at the sites. To do this, we pooled data across years for each site and used logistic regression models to examine whether there was evidence for an effect of year on the outcome of interest, adjusted for age, duration in sex work and education (same categories as used in the descriptive analyses, not assuming linearity). For these models, we dropped the seeds and weighted data by the inverse of reported network size, normalized by year so changes in differences in network size by year would not affect results. This approach is in line with other regression analyses using RDS data [45,46].

Programme level data over the course of the intervention was collated by site showing trends in clinic visits and other key indicators by year.

2.11 | Ethical approval

All participants gave written informed consent collected according to the principles of Good Clinical Practice. Approval for the study was given by the Medical Research Council of Zimbabwe (MRCZ), the UCL Ethics Committee, and the London School of Hygiene and Tropical Medicine Ethics Committee.

FSWs were consulted on intervention design and peer educators were actively involved throughout its implementation.

3 | RESULTS

3.1 | RDS recruitment

In 2015, 913 women were included in analysis: 407 in Mutare, 255 in Hwange and 251 in Victoria Falls compared to 836 women in 2011: 370 in Mutare, 237 in Hwange and 229 in Victoria Falls. Following the seeds, there were five additional recruitment waves in all sites in 2011 and six in 2015. Appendix 1 shows estimated convergence over sample waves in each year, which include initial seed characteristics, also previously published [33].

3.2 | Characteristics of sampled population

FSWs' median age in both years was 33. The age distribution remained similar over time in Mutare and Hwange, however the proportion of those younger than 25 years changed from 39.5% (95% CI 30.3 to 48.7) in 2011 to 16.3% (95% CI 12.1 to 20.5) in 2015 in Hwange.

More women reported no education or incomplete primary education in 2011 than 2015 (Table 1). Duration in sex work was shorter in 2015 than in 2011 in Mutare, with more women reporting fewer than five years in sex work. In all sites, across years, the majority of participants reported

Table 1. Sociodemographic characteristics of female sex workers in Hwange, Mutare and Victoria Falls

	Hwange								Mutare								Victoria Falls							
	2011				2015				2011				2015				2011				2015			
	n = 237	%	95% CI		n = 255	%	95% CI		n = 370	%	95% CI		n = 407	%	95% CI		n = 229	%	95% CI		n = 251	%	95% CI	
Education																								
None or incomplete primary	21	12.7	7.1	18.3	3	1.2	−0.4	3.1	49	12.9	8.4	17.4	9	2.2	0.6	4.8	34	15.5	9.1	21.9	8	3.2	1.1	6.2
Incomplete secondary	118	55.3	46.9	63.8	137	53.9	52.9	66.8	186	49.7	42.8	56.6	264	65.2	58.7	69.7	146	67.5	59.1	75.9	170	67.7	63.2	75.6
Complete secondary or higher	87	32.0	24.1	39.9	114	44.9	31.9	45.6	134	37.3	30.4	44.2	132	32.6	27.7	38.5	49	17.0	10.3	23.7	73	29.1	21.0	32.9
Duration in sex work																								
Up to 2 years	38	16.0	17.9	11.7	51	26.1	17.5	34.7	42	11.4	10.1	7	81	22.0	17.0	27.0	59	25.8	31.5	22.7	70	30.7	23.1	38.2
2 to 5 years	87	36.7	37.9	30.6	68	31.1	23.0	39.2	130	35.1	40.6	33.9	86	22.8	17.5	28.1	100	43.7	39.2	32	68	27.9	21.4	34.4
More than 5 years	112	47.3	44.2	36.9	136	42.8	35.0	50.6	198	53.5	49.4	43.1	240	55.2	49.4	61.1	70	30.6	29.3	22.5	113	41.4	34.5	48.3
Duration at site																								
<5 years	57	25.0	17.5	32.6	59	26.4	19.0	33.8	60	20.7	14.3	27.1	65	17.7	13.1	22.3	74	40.1	30.5	49.7	66	29.1	22.0	36.2
5 to 10 years	28	16.0	8.7	23.3	37	17.2	10.2	24.2	53	14.0	9.4	18.6	48	10.5	7.5	13.4	52	21.8	14.1	29.6	56	27.5	19.0	35.9
10 to 20 years	32	14.9	7.7	22.2	40	15.2	10.4	19.9	66	14.7	9.8	19.6	76	20.2	15.0	25.5	57	20.0	13.0	27.0	61	19.6	15.0	24.2
20 to 40 years	97	36.3	27.8	44.7	95	32.0	25.8	38.2	153	43.4	35.7	50.8	157	36.3	31.1	41.5	46	18.1	11.7	24.4	60	20.2	15.0	25.3
>40 years	23	7.7	3.3	12.2	24	9.2	5.5	12.8	38	7.3	3.8	10.8	60	15.3	11.2	19.4	0	0.0	0.0	0.0	8	3.7	1.3	6.0
Where find clients*																								
Bars/night clubs/ entertainment	192	80.5	74.2	86.8	173	69.2	63.0	75.5	298	80.7	75.5	85.9	327	81.9	75.9	87.8	217	94.5	90.7	98.3	193	73.4	65.3	81.6
Telephone/at home	89	38.9	30.9	46.9	7	2.7	0.9	4.5	106	26.8	20.7	32.9	16	3.1	1.6	4.6	42	15.8	9.0	22.6	5	1.6	0.6	2.6
Market stalls	6	3.5	0.4	6.6	12	5.2	2.2	8.3	32	8.2	4.8	11.6	52	12.9	9.4	16.5	2	0.4	−0.2	1.0	13	5.5	1.5	9.4
On the street	71	26.0	18.7	33.3	0	0.0	0.0	0.0	133	35.5	29.4	41.6	3	0.7	−0.3	1.7	30	9.8	5.7	13.9	1	0.3	0.3	0.4
Lodges	18	5.0	2.4	7.7	63	22.8	17.0	28.5	30	5.9	3.1	8.7	5	0.8	0.3	1.3	12	2.0	0.4	3.6	38	19.2	11.2	27.2
Hotels	11	2.4	0.7	4.2	0	0.0	0.0	0.0	19	6.2	3.1	9.3	1	0.7	−4.9	6.2	14	3.4	1.0	5.8	0	0.0	0.0	0.0
Other	20	7.3	3.8	10.9	0	0.0	0.0	0.0	32	7.5	4.4	10.6	0	0.0	0.0	0.0	6	1.7	−1.2	4.6	0	0.0	0.0	0.0
Where collected condoms in the last year																								
Grocery store	37	16.0	10.1	21.8	17	5.2	2.6	7.7	143	34.6	29.4	39.9	58	16.4	11.0	21.8	50	23.5	16.4	30.7	24	13.4	5.0	21.7
Peer educators	17	7.5	3.7	11.2	8	1.8	1.0	2.6	23	4.9	3.3	6.4	15	4.0	1.0	7.0	17	8.4	4.2	12.5	10	3.3	1.3	5.2
Local clinic/hospital	114	50.6	43.2	58.0	104	43.5	36.1	50.9	164	45.7	39.8	51.6	182	46.7	41.0	52.4	93	39.3	32.2	46.4	130	53.1	46.1	60.1
Sisters' clinic	23	9.4	6.0	12.8	178	62.9	54.2	71.7	24	5.9	3.9	7.9	235	52.7	46.7	58.8	33	10.8	7.8	13.9	130	47.8	40.6	55.0
Bars	63	24.9	19.4	30.5	40	17.0	11.4	22.6	105	30.3	24.7	35.9	19	3.8	1.8	5.8	85	38.7	31.4	46.0	36	13.1	8.5	17.6

*These figures are not directly comparable over time. In 2011 participants could list more than one location, whereas in 2015 they could choose only one.

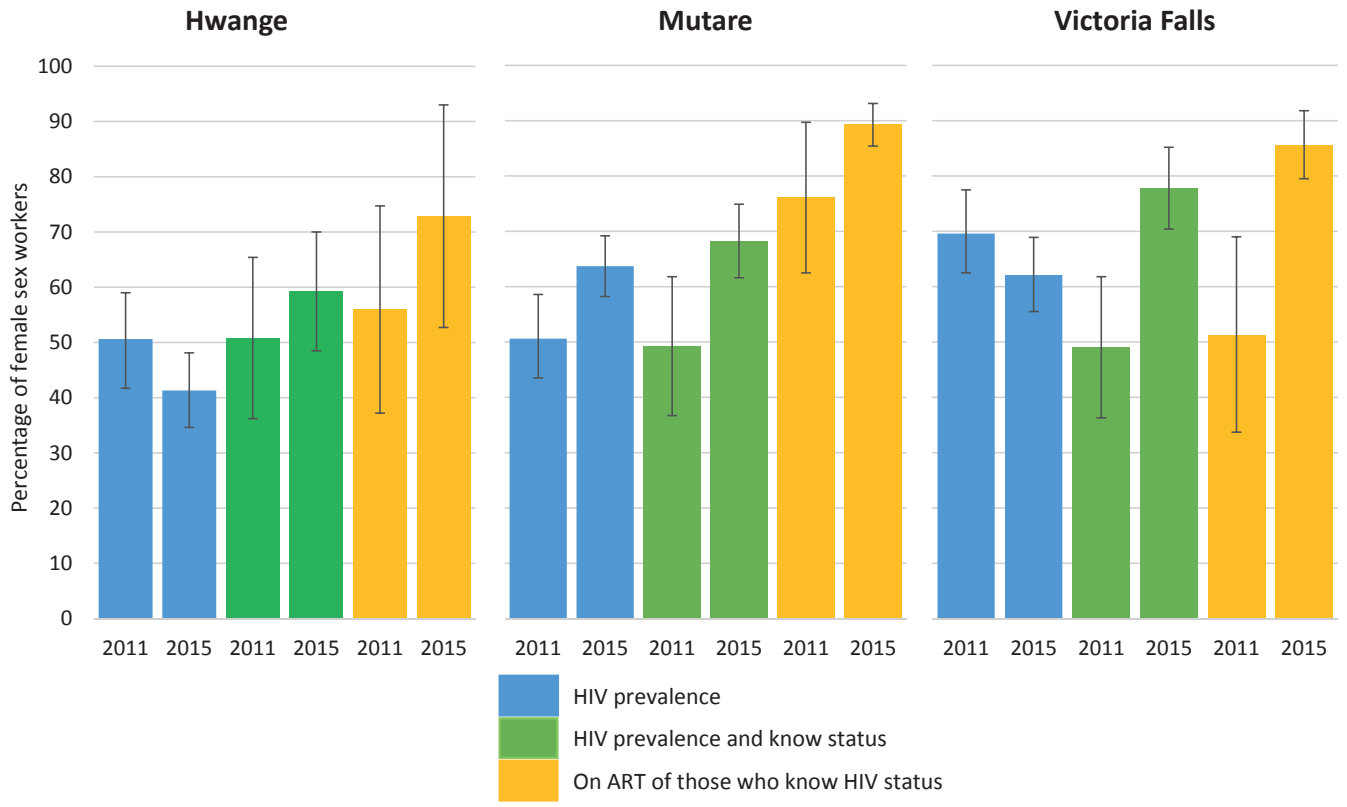

Figure 1. Comparison between 2011 and 2015 of HIV prevalence, knowledge of positive status, and antiretroviral therapy (ART) among female sex workers in Hwange, Mutare and Victoria Falls.

finding clients in bars or nightclubs. Duration at site did not change for those who had stayed at the site for up to 40 years however for more than 40 years was higher in Mutare and Victoria Falls in 2015.

Where FSWs reported they found clients was not comparable because in 2011 participants could list more than one location, whereas in 2015 they could choose only one.

There were significant changes in places where FSWs reported they collected condoms with exception of local clinic or hospital which did not change. FSWs who reported collecting condoms from bars and from peer educators reduced in Hwange and Mutare, but did not change in Victoria Falls. Reported condom collection from Sisters clinics increased between 2011 and 2015 across all three sites.

3.3 | Sisters programme engagement 2011 and 2015

In 2011, 18.8% (95% CI 15.1% to 22.6%), 31.6% (95% CI 26.4% to 36.7%), 29.8% (95% CI 23.7% to 35.9%) FSWs reported having visited the Sisters clinic in the last 12 months in Hwange, Mutare and Victoria Falls respectively. In 2015, the time period over which clinic attendance was assessed was reduced to the previous 6 months and was 77.9% (95% CI 69.1% to 86.7%), 47.0% (95% CI 40.9% to 53.2%) and 50.1% (95% CI 42.4% to 57.9%) in Hwange, Mutare and Victoria Falls respectively.

Contact with a peer educator in the last 12 months was reported by 32.9% (95% CI 26.6% to 39.1%), 31.1% (95% CI 27.8% to 38.4%) and 36.9% (95% CI 29.9% to 43.8%) of women in 2011. In 2015 the time period for contact with peer educators was changed from last 12 to last 6 months, and the proportion reporting contact was perhaps as a consequence reduced to 30.3% (95% CI 24.5% to 36.1%), 20.4% (95% CI 16.7% to 24.0%) and 26.1% (95% CI 21.0% to 31.2%) in Hwange, Mutare and Victoria Falls. The proportion of women who reported receiving condoms from the Sisters clinic was higher in 2015 than in 2011 in all sites. A lower proportion of women reported receiving condoms from peer educators in Hwange (Table 1).

3.4 | HIV status, prevention and treatment

HIV prevalence in Hwange was higher in 2011 than 2015 41.3% (95% CI 34.6 to 48.1), a pattern similar in Victoria Falls with 69.6% (95% CI 61.7 to 76.7) HIV-positive in 2011 and 62.1% (95% CI 55.3 to 68.7) in 2015. In Mutare, HIV prevalence was observed to be higher at 63.7% (95% CI 58.2% to 69.2%) in 2015, to 50.6% (95% CI 43.5% to 58.6%) in 2011 (Figure 1). After adjusting for sociodemographic differences, we observed reduced odds of being HIV-positive amongst FSWs in Victoria Falls (aOR = 0.53, $p = 0.022$) in 2015 compared to 2011 in Hwange (aOR = 0.54, $p = 0.031$). Evidence of an increase in prevalence in Mutare reduced significantly once adjusted (aOR = 1.45, $p = 0.085$) (Table 2).

There was evidence of an increase in the odds that HIV-positive women knew their status in Victoria Falls

Table 2. Differences in HIV status, knowledge of status and whether on antiretroviral therapy (ART) between 2011 and 2015

	Crude odds ratio	95% CI		Wald test *p* value	Adjusted OR	95% CI		Wald test *p* value
Victoria falls								
HIV positive								
2011	1				1			
2015	0.69	0.42	1.14	0.147	0.53	0.31	0.91	0.022
Knowledge of status among those HIV positive								
2011	1				1			
2015	2.83	1.46	5.49	0.002	2.26	1.06	4.83	0.035
On ART among those HIV positive and aware of their status								
2011	1				1			
2015	5.22	2.19	12.44	<0.001	4.38	1.73	11.05	0.002
Mutare								
HIV positive								
2011	1				1			
2015	1.62	1.11	2.39	0.014	1.45	0.95	2.2	0.085
Knowledge of status among those HIV positive								
2011	1				1			
2015	2.18	1.3	3.65	0.003	2.76	1.53	4.96	<0.001
On ART among those HIV positive and aware of their status								
2011	1				1			
2015	2.72	1.2	6.16	0.018	3.63	1.14	11.59	0.03
Hwange								
HIV positive								
2011	1				1			
2015	0.69	0.43	1.1	0.122	0.54	0.31	0.94	0.031
Knowledge of status among those HIV positive								
2011	1				1			
2015	0.99	0.53	1.84	0.963	1.03	0.54	1.98	0.925
On ART among those HIV positive and aware of their status								
2011	1				1			
2015	2.85	1.12	7.26	0.03	1.21	0.41	3.59	0.729

(aOR = 2.26 p =0.035) and Mutare (aOR = 2.76, $p < 0.001$), but not in Hwange.

There was strong evidence that HIV-positive FSWs who reported being aware of their status were more likely to report being on ART in 2015 in Victoria Falls (aOR = 4.38, $p = 0.035$) and in Mutare (aOR = 3.63, p = 1.14 to 11.59). While a similar, though smaller, effect was seen in Hwange in the unadjusted results, there was no longer evidence for this effect (aOR = 1.21, $p = 0.729$) after adjustment.

There was strong evidence that the proportion of HIV-negative FSWs who reported testing for HIV in the previous 6 months was much higher in 2015 compared to 2011. In Hwange, it increased from 25.1% (95% CI 17.4% to 34.7%) to 78.1% (95% CI 71.0 to 85.2), in Mutare from 30.3% (95% CI 23.2% to 38.6%) to 78.6% (95% CI 71.7% to 81.5%), and in Victoria Falls from 13.4% (95% CI 8.7% to 19.9%) to 80.8% (95% CI 74.0 to 87.7). This effect remained even after adjustment (Figure 2).

There was little evidence of a difference in consistent condom use with clients in the past month in 2011 and 2015, except in Mutare, where an increase was observed in 2015 after adjustment (aOR = 1.50, $p = 0.058$).

In Mutare and Hwange, condom use with regular partners was higher in 2015 compared to 2011, (aOR = 2.44, $p = 0.003$ and aOR = 2.51, $p = 0.003$), but there was little evidence of a difference in Victoria Falls.

3.5 | Qualitative results

Interviews conducted with the 22 RDS seeds in 2015 illustrate how FSWs perceived the intensified community mobilization. All 22 respondents reported knowing about the local Sisters clinic, and having used it at least once, although this was not a prerequisite for study recruitment. Table 3 presents excerpts from FSWs' accounts of why they engaged with Sisters, how they felt sex workers' health and wellbeing were affected over the intervention period, and reasons not all FSWs were reached through the programme.

Respondents overwhelmingly praised the clinics, which were perceived to be the mainstay of the Sisters programme. Respondents compared Sisters favourably to other public or private facilities where user fees were charged, staff were considered insensitive and sometimes discriminatory and hostile towards FSWs. FSWs highlighted the welcoming attitude

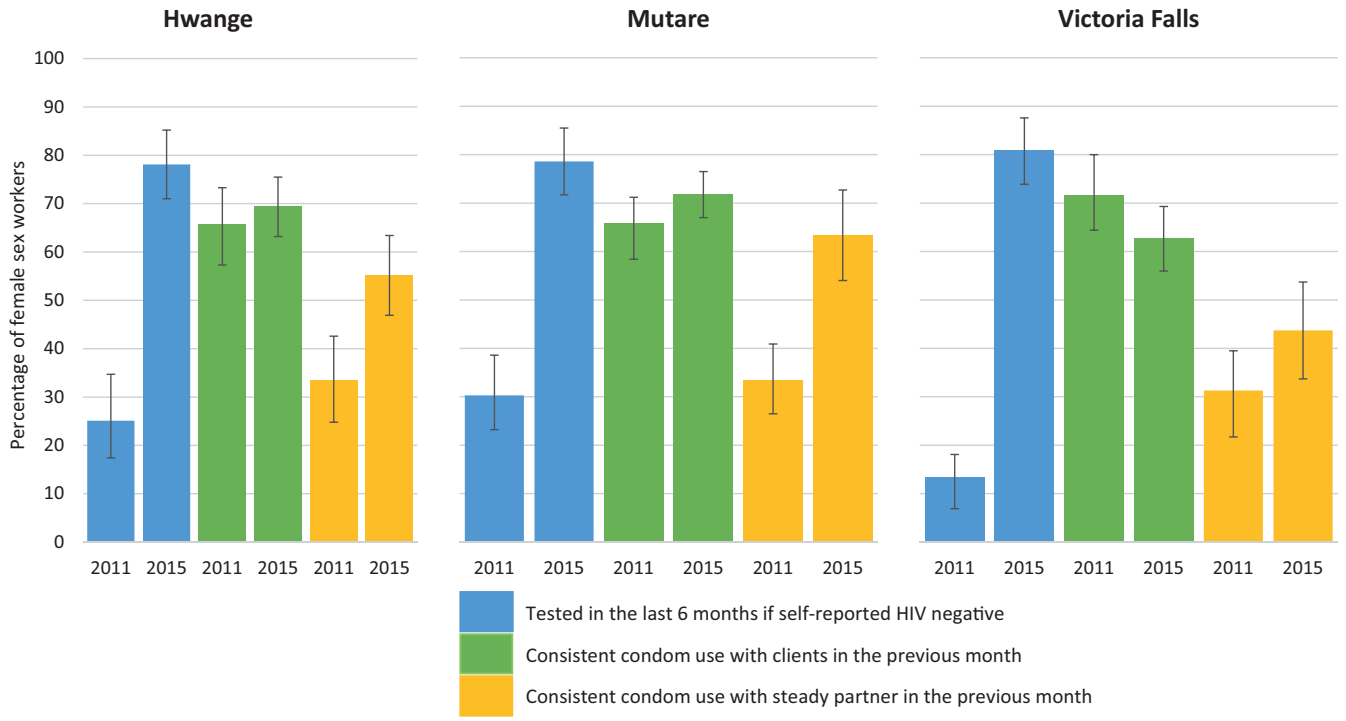

Figure 2. Comparison between 2011 and 2015 in proportions of women testing HIV negative and reporting recent HIV testing and condom use in Hwange, Mutare and Victoria Falls.

of nurses, free services, comprehensive vaginal examinations, and reliable supply of medication as key advantages of the Sisters clinic.

FSWs also described how the community's trust in Sisters took time to develop. Several reflected back to when the local Sisters clinic was first established, describing widespread fears that they might be "outed" as sex workers. Introduction of peer educators and community mobilization meetings was seen to streamline the trust-building process and increase the rate at which FSWs were willing to attend the clinical services. Some women described coming for meetings first and then felt confident to attend the clinic.

The interactive sessions were also credited with expanding FSWs' awareness of self-care and prevention and treatment. Regular HIV testing was particularly seen as a proactive measure FSWs now took. Most interviews mentioned positive changes in relations between FSWs, suggesting that the community mobilization process led to feeling more "united" and willing to cooperate and help one another, particularly in encouraging each other to seek treatment at the clinic and get HIV tested.

However, respondents also described barriers to engaging with Sisters services. Not all sex workers could be persuaded to attend, particularly sex workers who wanted to hide their involvement in sex work. Others did not prioritize health, and were described as "lazy" "ignorant" or simply "thinking differently" compared to FSWs who had taken up the targeted services.

3.6 | Programme review results

Increases were observed in clinic visits across all sites, with the highest increase in Mutare, from 65 FSWs in 2010 to 1514 FSWs in 2015. The number of new FSWs attending clinics also increased. The lowest increase was observed in Hwange from 65 new FSW attendees in 2011 to 171 new FSW attendees in 2015. The number of FSWs' testing and diagnosed with HIV increased in all sites; the greatest increase in Mutare, where 25 FSWs were tested in 2010 compared to 518 FSWs in 2015 (Table 4).

4 | DISCUSSION

This paper compares results from RDS surveys conducted in 2011, eight months after the implementation of intensified community mobilization, and in 2015, after 54 months in three sites. We also show programme reach between 2010 and 2015 and capture FSWs' feelings and perceptions about the programme. There was some evidence of change in HIV prevalence, knowledge of status and linkage to ART, and condom use with regular partners. Sisters' clinics reached more women by 2015. Qualitative data suggests improved familiarity with the programme, growing trust in its intentions, and regular opportunities to engage with each other during peer-led community meetings might have been the mechanisms through which the programme increased FSWs' engagement with care.

We used RDS to obtain estimates as representative as possible of the FSW population at each site. In assessing differences between 2011 and 2015, we used very similar protocols and reviewed RDS performance. We examined our quantitative results alongside qualitative data demonstrating FSWs' observations regarding service use, as well as clinic records showing FSW engagement with Sisters clinics.

Table 3. FSW perceptions of intensified service

Services	Excerpts from interviews with seeds selected as RDS recruiters in 2015 about *Sisters with a Voice* services
Quality of care	The services at Sisters with a Voice clinic are of quality, especially on drugs. They are not shady when it comes to drugs. If the course is for seven days, they will give you exactly seven, but at other clinics they will tell you that the course was supposed to be for seven days but due to the shortage of pills 'we are now giving you four.' (Hwange, 44, sex worker for 10 years, bars)
	Here at the sister's clinic there is privacy, if I have a wound 'down there' I can come here and say 'sister, I am not sure about what is happening, the condom burst so now look at the wound I have', but at the hospital they will be saying 'go away, we are busy.' (Victoria Falls, 37, sex worker for 13 years, home)
Facilitators of service use	I chose to come to this clinic because I get treatment for free and the medication that I want is available. If I go to [other clinic] they can tell me to pay 2 dollars. . . . They will tell me to buy medication after paying 2 dollars or they will say they don't have it. . . . And [at Sisters] they treat us well, they don't ask me where I contracted the STI, they don't care about that, they just treat us like people (Mutare, 33, sex worker for 15 years, bars & truck stops)
	You feel free. We used to cry, you know when you get to a queue and you are asked, 'how are you this morning?' We didn't experience this when we were growing up, a person saying good morning to you girls, smiling. . . . We want our nurses to welcome us and just say 'good morning'. It has an impact. . . . That is what we liked at Sisters with a Voice clinic (Mutare, 47, sex worker for 33 years, bars)
	I first came to attend meetings, I came to learn and see how it goes. Then I got sick and they helped me, so then I said 'I can get help here and also some lessons.' . . . Yes it has helped me because I managed to tell others and they are now able to come. I think I can say that, this is our place. . . . I am comfortable about this place (Victoria Falls, 23, sex worker for 5 years, bars)
Barriers to service use	Ah, I can say that these are the type of sex workers who will not want it to be known, they do not want to show that they are sex workers. . . . Yes, they know that this clinic is for sex workers, so maybe this person will be pretending that they are good [not selling sex], so for her to be seen at a sex workers' clinic would not be good because other people will be asking why she is going there. (Hwange, 38, sex worker for 2 years, bar based)
	. . . some people tell themselves that if they go then 'others will see what I do' so they don't want to be seen, they hide themselves (Victoria Falls, 23, sex worker for 5 years, bars)
	The way we [sex workers] think is different [from each other]. There is a person to whom I said 'here is a voucher, go to the clinic' and she said 'ah I don't have the time.' So she might think that it is not important. . . . Yes, they are those who say 'we will never set a foot there'. (Mutare, 27, sex worker for 4 years, nightclub)
Community outreach	When I started attending Sisters meetings, we were taught by mobilization - they used to touch on everything, the way we take care of children, how we take medication, and taking care of ourselves, and that even if I am a sex worker I should love myself as I am. (Mutare, 33, sex worker for 15 years, bars & truck stops)
	It's very important to have peer educators. . . . I didn't know that there was a clinic, but if they move around our houses or bars and find people and tell them to come to the clinic if they are sick, there will be others who are sick and don't know where to go but if they get people who advise them to go to such a place they can come and get help. (Victoria Falls, 29, sex worker for 3 years, bars)
	Ah peer educators say 'girls we are wanted at work, take a bath and let's go'. They wait for us. . . . 'Girls here are some condoms'. They carry them in their bags. 'Girls, here are some condoms, take some condoms. Here are some condoms.' Our peer educators have love. (Mutare, 20, sex worker for 8 years, bars & street)
	What has changed is that sex workers are more united because isn't you see that some of us meet here, it adds, it's a bond. We won't ignore each other when we meet. We greet each other and also we know each other better that that one is a sex worker. (Mutare, 34, sex worker for 8 years, bars)
Change over time	It has changed people's lives, because people are now being tested, they didn't want to be tested at the hospital . . . but here at Sisters clinic they come. (Victoria Falls, 29, sex worker for 3 years, bars)
	Ah, I think that it has made a huge difference . . . I can say that most of us would just get unplanned pregnancies, you would [often] see a sex worker pregnant, so they [Sisters] are helping them a lot because they offer depo and other family planning tablets, and they give us condoms so that we do not get sexually transmitted infections (Hwange, 38, sex worker for 2 years, bar based)
	Yes their health, and it has reduced the rate of STIs because they give us condoms for free, lately I have not heard that there is a sex worker who is seriously ill from an STI. . . . Even the rate of getting pregnant has reduced. (Victoria Falls, 24, sex worker for 2 years, bars)
	When the clinic started in 2010, or was it 2011, there were just a few people who would come because they were scared. But now there are many, and they even come to ask when the [mobile] clinic will be coming because they want to go there, something which never used to happen back then, but now a lot of people come to the clinic, the attendance has increased now (Hwange, 31, sex worker for 8 years, street & highways)

Table 4. Clinic attendance and clinical services received by female sex workers (FSWs) between 2010 and 2015

	2010	2011	2012	2013	2014	2015
Hwange						
Number of total SW reached with clinics	65	267	598	962	811	986
Number of new SW reached with clinics	65	132	235	267	181	171
SW tested for HIV at the sites	7	23	59	139	81	148
SW who knew their HIV status at first visit	42	101	192	233	167	160
Mutare						
Number of total SW reached with clinics	65	713	1,093	782	1,084	1,514
Number of new SW reached with clinics	52	523	461	239	468	556
SW tested for HIV at the sites	6	93	199	186	63	426
SW who knew their HIV status at first visit	25	394	412	211	430	518
Vic falls						
Number of total SW reached with clinics	74	341	275	257	353	630
Number of new SW reached with clinics	74	154	66	55	136	197
SW tested for HIV at the sites	6	41	22	15	38	92
SW who knew their HIV status at first visit	47	112	57	47	121	189

Consistent with previous studies, we found low condom use with regular partners in 2011 [47,48]. This study suggests that peer education and intensive community outreach and participation can improve condom use with regular partners [49]. Similar positive impact was observed for clinic attendance. While receiving condoms from a peer educator did not show any change, this may have been compensated by FSWs' collecting condoms directly from clinics, which increased across sites.

HIV prevalence among FSWs remains three to four times higher than that of women aged 15 to 49 in Zimbabwe's general female population, which was 17.7% [50] in 2011 and 16.6% in 2015 [51]. This is consistent with other studies showing HIV prevalence as high as 50% to 60% among FSWs [46,52]. Observed changes in HIV prevalence, while adjusted for socio-demographic differences of the samples in 2011 and 2015, could have been affected by changes in incidence and in the proportion successfully initiated and sustained on treatment, and subject to unmeasured confounding. HIV prevalence in the general population did not change between 2011 [50] and 2015 [51]. The proportion of FSWs aware of their HIV-positive status and, among those who were on ART, was significantly higher in Victoria Falls and Mutare in 2015 than in 2011, even after adjustment.

These findings are similar to previous research among FSWs in Zimbabwe [53], although the proportion on ART was higher than the estimated 38% to 39.3% [54,55] in other settings. The Sisters' clinic in Hwange was available twice a week at an outreach site, compared to daily in Victoria Falls and Mutare at static clinics, which may explain variations. The percentage of FSWs taking ART of those who know their status in the three sites is similar to that of women in the general population at 87.3% [51]. However, because there remain gaps in knowledge of status, the percentage of all HIV-positive FSWs on ART falls short of the 90-90-90 target, which would mean 81% of all FSWs living with HIV on treatment. In fact, 39.5% in Hwange, 61.5% in Mutare and 66.8% in Victoria Falls of all HIV-positive FSWs reported taking ART in 2015. We did not measure viral suppression, but another study in Zimbabwe showed viral suppression between 67% and 72% among HIV-positive FSWs [53]. As testing coverage increases, innovative solutions will be required to reach women who have not yet tested, or who test infrequently. If viral suppression is high among FSWs, further transmission into the general population will reduce.

HIV testing is a critical entry point for HIV services [56]. We detected large increases in HIV-negative FSWs testing in the last six months, six times higher in Victoria Falls. This meets WHO recommendations for FSWs to test annually [57]. Studies from Kenya have shown increases in testing among FSWs where friendly and targeted services are offered [58]. Uptake of preventive behaviours such as reported condom use with clients did not improve as anticipated by the intensified services. Programmes will need to better link HIV-negative FSWs to prevention services including PrEP as part of a combination prevention strategy [59,60].

We suggest that the FSWs' positive perception of the Sisters programme helped overcome barriers to testing [61,62], and peer-led interactions with other HIV-positive FSWs reduced anxiety associated with receiving a positive result. However, we did not interview anyone who claimed to face barriers to attending the Sisters clinics, therefore were unable to examine which aspects of the programme were less welcoming and accessible, and who felt excluded as a result. Furthermore, FSWs compared Sisters services favourably to other local facilities, suggesting that the training component of the intervention, which aimed to reduce discrimination by public sector health workers and make them more "sex worker friendly," did not demonstrably change FSWs' views of these services.

Community mobilization sessions were seen as a good opportunity to unite FSWs and increase peer support for accessing HIV services. This resonates with previous findings that strong peer support networks are associated with willingness to engage with testing, care, treatment initiation and adherence [63-65]. There is a need to learn from other

contexts how to build strong FSW movements with effective solidarity and social cohesion. Positive effects of strong sex worker networks have been observed, particularly in Asia [66,67].

The study design had some limitations. It was not possible to enrol a control arm, making it difficult to attribute changes observed to the intervention. Changes in engagement in care for HIV-positive FSWs may have been confounded by developments in the National ART programme, which expanded during the intervention period. Demographics of study participants for the two surveys were different and may have influenced key indicators, for example, HIV prevalence. The first survey was conducted eight months into implementation, ideally this should have been done prior to the intervention's commencement, to allow for a better estimation of a baseline.

5 | CONCLUSION

Improvements in key HIV care engagement indicators were observed among FSWs in two sites and in testing and prevention indicators across the three sites after implementation of an intensified community mobilization intervention. The experiences of community mobilization programmes targeting key populations including sex workers are critical to inform scale up and translation into sustainable policies and programmes. Integrated, peer-led approaches to biomedical interventions for FSWs that include ART and PrEP may help countries achieve the 90.90.90 targets by 2020.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

FMC, SM, JD and SM conceived and designed the experiment. TNM, EF, CD, XA, SM, JB and JRH analysed the data. TNM and EF wrote the manuscript. FMC, JB, JRH, CD and XA assisted in drafting the manuscript.

ACKNOWLEDGEMENTS

We acknowledge GIZ and UNFPA who provided technical oversight to the three-year implementation of the intervention as funding partners. We also acknowledge CeSHHAR Zimbabwe staff who worked within the "Sisters with a voice" project for the three year period, peer educators and FSWs who participated in the study.

FUNDING

The 2011 and 2015 data collection was funded by The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ).

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:
Appendix 1. RDS Diagnostics in 2011 and 2015.
Appendix 2. Respondent Driven Sampling Questionnaire 2015 in word format.

De Boni RB et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25116
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25116/full | https://doi.org/10.1002/jia2.25116

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

VIEW POINT

Self-testing, communication and information technology to promote HIV diagnosis among young gay and other men who have sex with men (MSM) in Brazil

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Keywords: men who have sex with men; key and vulnerable populations; self-testing; HIV; mobile applications; Brazil

Received 23 April 2018; **Accepted** 9 May 2018

Worldwide, key populations (KP), including gay and other men who have sex with men (MSM), are subject to human rights violations, criminalization, stigma and discrimination [1,2]. These socio-structural factors are crucial to understand the low HIV testing uptake in many countries, as MSM may fear or may have experienced lack of privacy, confidentiality breaches and healthcare staff mistreatment [3]. In Brazil, MSM report a low frequency of HIV testing despite higher estimated HIV prevalence (9.4% among 18 to 24 year olds; 19.8% among those 25 years and older [4]), compared with 0.6% among the general population [5]. HIV self-testing (HIVST) is currently recommended by the World Health Organization to help reduce gaps in HIV diagnosis, especially for KP [6]. Furthermore, HIVST has been highly accepted and accurate [7,8], with oral tests being preferred over blood tests [9].

With the need to expand HIV diagnosis options for MSM, especially among young MSM, a committed team of governmental, research and non-governmental organizations in Curitiba, Brazil launched and evaluated a multi-component implementation science project from February 2015 to February 2017 to improve HIV outcomes for MSM. This project, called *A Hora É Agora* (The Time is Now) [10], implemented a multi-pronged approach to increase HIV testing and linkage to care among MSM. The most innovative of the project's components was a web-based platform and associated mobile application designed to provide HIV prevention information, allow for self-assessment of risk, and deliver HIVST packages to eligible individuals (males, 18 years old and up, resident in Curitiba, with negative/unknown HIV status) upon request [11]. Each HIVST package contained two oral-fluid test kits, instructions for use and interpretation of HIVST results, a supply of condoms and lubricant, and information on confirmatory testing. Options for receiving the HIVST kits included either home delivery by mail or pick-up at a government-sponsored pharmacy.

A centerpiece of the project was a communications plan tailoring dynamic visuals with printed and virtual messaging to appeal to the target population; an attractive, online instructional video for HIVST users [https://www.ahoraeagora.org]; and frequent in-person outreach events in places where MSM socialize in Curitiba. The project maximized the use of social media to reach out to and to engage young men in HIVST. Facebook and gay online sites such as ManHunt and Grindr played a key role in disseminating HIV testing messages. Mobile tools, such as WhatsApp and other freeware instant messaging applications boosted communications between users and project staff, including health system navigators for linkage to care. Working to ensure outreach to these groups, organizations involved in project implementation partnered with gay and MSM-friendly establishments such as saunas, movie theatres, cafes, and bars to further disseminate HIVST information.

With an initial goal to distribute 1000 test kits per year, the project quickly exceeded all expectations with 7352 HIV self-test requests over 24 months (Figure 1).

Beyond the high demand, the project was able to reach a large percentage (31%) of MSM who had never tested before, with those between 18 and 28 years old reporting a higher percentage of first-time testers (36%), than those 29 years or older (18%). Of the 4356 MSM who completed the online risk survey, 72% were 18 to 28 years old, showing how innovative strategies can address the common challenge of increasing youth access to healthcare [12].

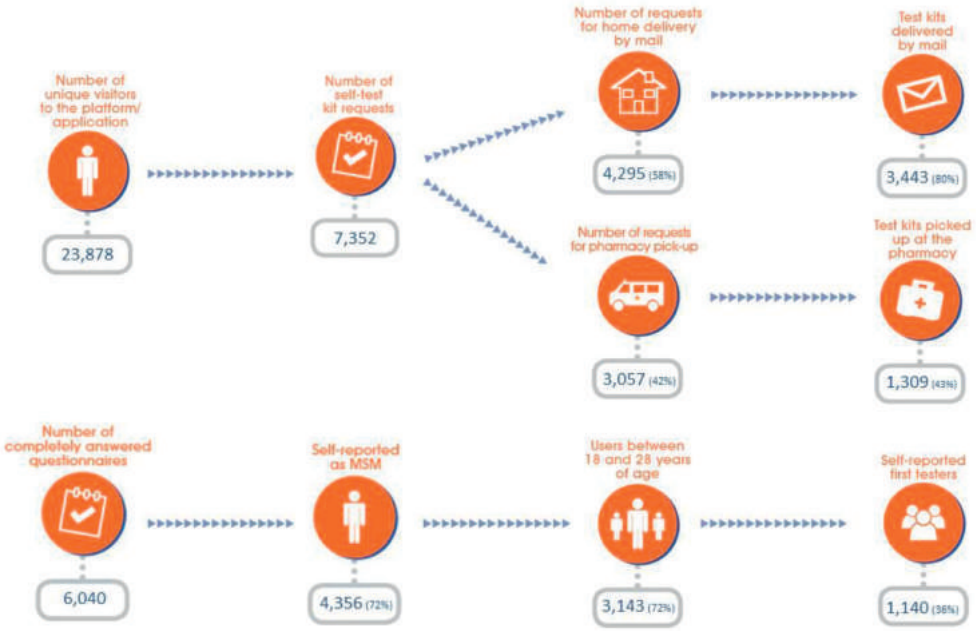

Figure 1. Web-based and mobile platform, HIV self-testing uptake and men who have sex with men (MSM) testing for the first time. A Hora É Agora Project, Curitiba (Brazil), 2015 to 2017.

From the design phase through programme implementation, MSM's anonymity, privacy and targeted messaging formed the critical pillars of this initiative – confirmed by users' preferred choice of delivery by mail (58%). Although this option required a valid address, users were able to use any name and any address where they were most comfortable receiving the test kit. To ensure privacy, the HIVST kits were mailed in a plain cardboard box with no indication of its contents.

The availability of confirmatory testing and health navigation options for those who self-reported a positive screening test were critical components of the comprehensive project. Although not mandatory, 34 individuals voluntarily reported a reactive HIVST result on the project website. Understanding HIVST as a screening strategy, 44 sought confirmatory testing in the project-recommended health unit. Of these, 40 accepted linkage to HIV services support by peers and health system navigators, another component of the project that assisted new patients entering Brazil's decentralized health system and the cascade of care.

1 | IMPROVING UPON CURITIBA'S MODEL

With essential adjustments to Curitiba's promising web-based HIVST model, we have recently expanded the project to São Paulo, Brazil, the largest metropolitan area in South America (population 12 million) with the highest concentration of people living with HIV and the majority of new infections in Brazil.

The relatively high cost of mail delivery and the lower observed uptake of pharmacy-based HIVST pick-ups sparked creative thinking among organizations responsible for expansion to São Paulo. As a result, automated HIVST dispensers will be installed in target areas in both Curitiba and São Paulo, with a focus on venues that are open 24/7 and near gathering points of gay and other MSM. Users requesting HIVST kits via web-based and mobile platforms will receive a randomly generated, four-digit code to be entered into strategically placed dispensing machines that distribute tests from individual cabinets. These self-service dispensers are expected to be a key option for reduced costs and increased ease of access. The project expects to dispense 10,000 tests in São Paulo by September, 2018.

Communication and information technologies have enhanced HIVST delivery in Brazil and show promise in attracting young gay and other MSM who value anonymity and privacy in accessing HIV services for diagnosis and subsequent treatment for positive cases. The success of Brazil's web-based HIVST platform may translate well to other countries that struggle to serve gay and other MSM in the context of societal and self-stigma, narrowing inequalities in test access. As we embark on the expansion of this programme to São Paulo and beyond, we anticipate learning additional lessons on how to encourage systematic reporting of results, expand access to other key populations, reduce costs, and improve sustainability while achieving epidemic control.

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COMPETING INTERESTS

All authors declare that they have no significant competing financial, professional, or personal interests that might have influenced the performance or presentation of the work described in this manuscript.

AUTHORS' CONTRIBUTIONS

RBB, ABJ, VGV, MC, and BG participated in study design. RBB, ABJ, NL, MC, RGC and VC were involved in planning and supervision. RBB, VGV, RGC and BG analysed the data. RBB, NL, ACFSS and TB wrote this paper with input from all authors. All authors approved the final version of the manuscript and are responsible for all aspects of this study, thus ensuring its accuracy and integrity.

ACKNOWLEDGEMENTS

Nilo M. Fernandes, Flavia Lessa, Liza Regina Bueno Rosso, Leonardo Lincoln, João Geraldo da Silva Netto, Juliane Cardoso V. dos Santos, Bernardo Almeida, Maeve B. de Mello, Raquel L. Miranda, Renato Lima, Simone Muniz, the peer educators and *linkadores* for their contributions.

FUNDING

This publication was supported by the Cooperative Agreement Number NU2G GH001152, funded by the United States President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention (CDC). Its contents are solely the responsibility of the authors and do not necessarily represent the official position of the funding agencies.

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Bhattacharjee P et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25122
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25122/full | https://doi.org/10.1002/jia2.25122

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

RESEARCH ARTICLE

Can a national government implement a violence prevention and response strategy for key populations in a criminalized setting? A case study from Kenya

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Abstract

Introduction: Key population (KP) members frequently experience violence that violates their human rights, increases their risk of HIV, and acts as a barrier to access and uptake of HIV services. To be effective, HIV programmes for members of KPs need to prevent and respond to violence against them. We describe a violence prevention and response strategy led by the national KP programme in Kenya and examine trends in reports of and responses to violence (provision of support to an individual who reports violence within 24 hours of receiving the report).

Methods: Quarterly programme monitoring data on the number of reports of violence and the number of responses to violence from 81 implementing partners between October 2013 and September 2017 were aggregated annually and analysed using simple trend analysis. Reports of violence relative to KP members reached, expressed as a percentage, and the percentage of reports of violence that received a response were also examined.

Results and Discussion: Between 2013 and 2017, annual reports of violence increased from 4171 to 13,496 cases among female sex workers (FSWs), 910 to 1122 cases among men who have sex with men (MSM) and 121 to 873 cases among people who inject drugs (PWID). Reports of violence relative to KP members reached increased among FSWs (6.2% to 9.7%; $p < 0.001$) and PWID (2.1% to 6.0%; $p < 0.001$) and decreased among MSM (10.0% to 4.2%; $p < 0.001$). During the same period, timely responses to reports of violence increased from 53% to 84% ($p < 0.001$) among FSWs, 44% to 80% ($p < 0.001$) among MSM and 37% to 97% ($p < 0.001$) among PWID.

Conclusions: Over the past four years in Kenya, there has been an increase in violence reporting among FSWs and PWID and an increase in violence response among all KPs. This case study demonstrates that violence against KP members can be effectively addressed under the leadership of the national government, even in an environment where KP members' behaviours are criminalized. Creating an enabling environment to promote wellbeing and safety for KP members is a critical enabler for HIV prevention programmes to achieve 95-95-95 goals.

Keywords: key populations; violence response; Government of Kenya; HIV; enabling environment

Received 15 December 2017; **Accepted** 4 May 2018

1 | INTRODUCTION

The HIV Prevention 2020 Roadmap provides guidance and demonstrates commitment from African countries to accelerate interventions to reduce new HIV infections by 75% [1]. In Africa, the proportion of new infections among key populations (KPs), defined as female sex workers (FSWs), men who have sex with men (MSM), and people who inject drugs (PWID), is substantial [2]. Greater investment in KP programmes can improve the effectiveness of HIV interventions [3]. However, punitive laws related to sex work, same-sex sexual practices and drug use; stigma and discrimination in community and healthcare settings; and violence hinder access to and uptake of HIV-related services among KPs [4-6]. In such environments, UNAIDS has called upon governments to create an enabling environment and develop pragmatic solutions to ensure that KPs can organize to reduce risk and prevent HIV, while simultaneously increasing access to prevention programmes [1].

Kenya has a mixed and geographically heterogeneous HIV epidemic, with an estimated national adult HIV prevalence of 5.9% [7], and an estimated 33% of all new infections occurring among KP members [8]. In Nairobi, HIV prevalence is 6.1% among adults, 29.3% among FSWs, 18.2% among MSM and

18.7% among PWID [7,9]. The KP programme is led by the National AIDS and STI Control Programme (NASCOP) and the National AIDS Control Council (NACC) within the Ministry of Health and implemented by 81 partners primarily funded by PEPFAR and the Global Fund. NACC and NASCOP, in collaboration with KP-led organizations, have developed policies [10] and guidelines [11] to support KP programme implementation. The programme has been scaled up to reach an average of 139,041 FSWs in 33 counties, 26,972 MSM in 29 counties and 14,527 PWID in 16 counties quarterly [12]. A national population-based survey conducted by NASCOP with 5,353 KPs in 2017 found that, in the last three months, 88% of FSWs, 80% of MSM and 84% of PWID were met by a peer educator; 85% of FSWs, 76% of MSM and 74% of PWID received an HIV test; and 74% of FSWs, 68% of MSM and 72% of PWID accessed services from a programme site [13].

Research in Kenya has found that physical, sexual and emotional violence against KPs is common and frequently perpetrated by sex work clients, police, religious leaders, intimate partners and strangers [14-24]. A survey conducted by NASCOP in 2017 found that 22% of FSWs, 14% of MSM and 12% of PWID experienced physical or sexual violence, while 48% of FSWs, 20% of MSM and 44% of PWID experienced police violence in the past six months [13]. Each population has unique experiences with violence: violence against FSWs is often physical violence perpetrated by clients and regular sex partners, while violence against MSM is often "opportunistic aggression" perpetrated by strangers [15]. Furthermore, MSM who engage in sex work are two times more at risk of violence than those who do not [25]. Violence against PWID is often associated with cocaine or heroin use and includes arbitrary police sweeps, beatings, harassment, bribery, remand, and imprisonment [20]. Across populations, violence is fuelled by gender inequalities and stigma and discrimination against persons perceived to depart from conventional gender and sexual norms and identities [26-28]. The Kenyan legal system and county by-laws that criminalize behaviours related to sex work, same-sex sexual practices and drug use also legitimize violence, stigma and discrimination against KPs [29-32].

Violence against KP members increases HIV risk and decreases HIV service uptake [33-37]. Studies in Kenya show that violence and HIV are linked through intermediate risk factors such as unprotected sex and unsafe injecting practices [20,38,39]. One study found that female and male sex workers who anticipate sexual violence or experience physical violence are more likely to avoid or delay HIV services than those who do not [24]. Experiencing violence or fear of violence can also result in KPs prioritizing their safety over less immediate concerns such as HIV [40,41]. Furthermore, modelling in Kenya suggests that eliminating sexual violence against FSWs could avert 17% of new HIV infections among FSWs and their clients over 10 years [38].

The Kenyan national KP programme has prioritized violence as a key structural barrier to HIV-related services [11], and adopted strategies to address violence against KPs in the National Guidelines for HIV/STI Programming with KPs [11]. The KP programme posits that increasing violence reporting by KP members and improving responses to violence by implementing partners will reduce violence and thereby reduce new HIV infections among KP members in the long run [3,11,42]. In this paper, we describe a violence prevention and response strategy adopted by the KP programme and examine trends in reports of and responses to violence.

2 | METHODS

2.1 | Data Source

Eighty-one implementing partners who serve FSWs, MSM and PWID, and operate in primarily urban areas, collected individual-level service utilization data monthly (number of KPs reached, number of reports of violence and number of responses to violence) and submitted quarterly, aggregate-level information to NASCOP as part of routine programme monitoring between October 2013 and September 2017. A report of violence is defined as a KP member disclosing violence — such as sexual assault, physical assault, verbal abuse, discrimination and arbitrary arrest — to a violence response team member via a helpline, a peer educator during outreach or a clinician during a facility visit. A response to violence is defined as a violence response team member, peer educator or clinician providing first-line support within 24 hours of receiving the report to the individual who disclosed violence. First-line support includes active listening, providing key messages and information on rights, safety planning, and providing services directly or through referrals.

2.2 | Analysis

Number of KPs reached, number of reports of violence and number of responses to violence were aggregated annually and analysed. The rates of increase in KP members reached and reports of violence were analysed using the reported numbers in 2013 to 2014 as the reference year, and then dividing the numbers from subsequent reporting years over the reference year. The 2013 to 2014 period was selected as the reference year as it was before the violence prevention and response strategy was introduced in 2014 to 2015. Reports of violence relative to KP members reached, expressed as a percentage, and the percentage of reports of violence that received a response were also calculated. A chi square test was used to determine whether changes in violence reporting and response over time were statistically significant.

2.3 | Ethics approval

These data were collected through routine programme monitoring and cannot be linked to any individual. Ethical approval to conduct secondary data analysis was received from the Kenyatta National Hospital — University of Nairobi Ethical Review Committee, number P647/11/2017.

2.4 | Violence prevention and response strategy

The national KP programme developed a violence prevention and response strategy (Figure 1) and complementary protocol [43], in consultation with KP-led organizations, to guide NASCOP, NACC and implementing partners to develop and implement a violence prevention and response plan. Although the national KP programme has a two-pronged strategy that includes violence prevention, this paper focuses on violence response.

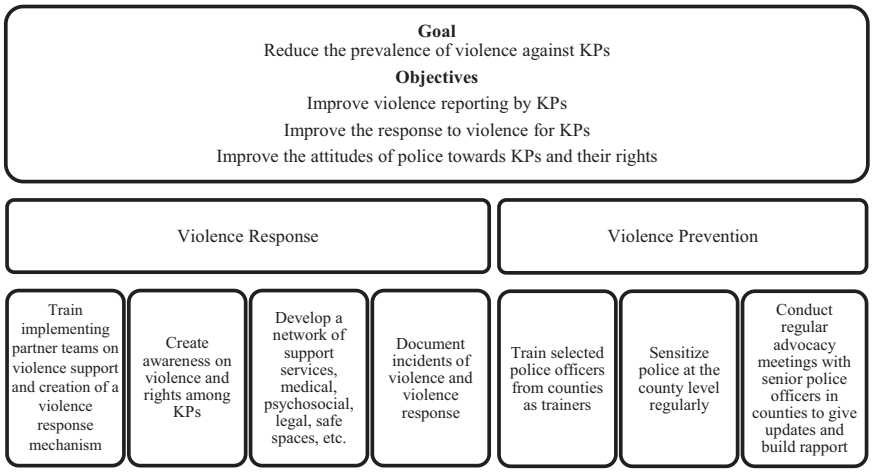

Figure 1. Two-pronged strategy to address violence against key populations (KPs) in Kenya.

Building implementing partner knowledge and skills to support KP victims of violence is central to violence response. Implementing partners were trained using a national curriculum developed by NASCOP [44], and in turn, educated KPs on violence and their rights using NASCOP-supported communication materials during outreach and clinical services. Implementing partners conducted educational events at drop-in centres to encourage reporting and service seeking and to set up mechanisms to effectively and efficiently respond to violence. Some implementing partners have violence response teams that manage 24-hour helplines. The violence response teams consist of peer educators, peer paralegals and outreach workers that are supported by clinicians, advocacy officials and programme managers. Each implementing partner developed a network of services to ensure that post-violence support (clinical, psychosocial, legal and safety) could be provided directly or through referral. KP members are encouraged to report violence by calling violence response team helplines, disclosing to a peer educator during outreach or disclosing to a clinician during a facility visit. When violence is disclosed, the violence response team member, peer educator or clinician seeks information about the incident and provides first-line support. They assess the situation and, in collaboration with the victim, develop a response and support plan that includes further post-violence support, per need and client preferences. They also document the incident of violence in a standard national format. In Kenya, the goal is to initiate post-violence support within 24 hours of receiving a report.

5 | RESULTS AND DISCUSSION

Between 2013 and 2014 (reference year) and 2016 to 2017, the annual number of KP members reached increased from 67,432 to 139,041 among FSWs, 9118 to 26,972 among MSM and 5856 to 14,527 among PWID (Tables 1-3). During the same period, the annual number of reports of violence increased from 4171 to 13,496 among FSWs, 910 to 1122 among MSM and 121 to 873 among PWID. Reports of violence relative to KP members reached increased among FSWs (6.2% to 9.7%; $p < 0.001$) and PWID (2.1% to 6.0%; $p < 0.001$) and decreased among MSM (10.0% to 4.2%; $p < 0.001$). The percentage of reports of violence that received a response increased among all KPs: 53% to 84% among FSWs ($p < 0.001$), 37% to 97% among PWID ($p < 0.001$) and 44% to 80% among MSM ($p < 0.001$).

Table 1. Annual data on programme reach, reports of violence and responses to violence by FSWs in Kenya, October 2013 through September 2017

Indicator	Oct 2013 to Sept 2014[a]	Oct 2014 to Sept 2015	Oct 2015 to Sept 2016	Oct 2016 to Sept 2017
Number of FSWs reached	67432	88327	113096	139041
Number of FSW reports of violence	4171	5341	11707	13496
Rate of increase in number of FSWs reached	1.0	1.3	1.7	2.1
Rate of increase in number of FSW reports of violence	1.0	1.3	2.8	3.2
FSW reports of violence relative to FSWs reached, expressed as a percentage	6.2	6.0	10.4	9.7[b]
Percent of responses to FSW reports of violence	53	65	74	84[b]

[a]Reference year
[b]$p < 0.001$

Table 2. Annual data on programme reach, reports of violence and responses to violence by MSM in Kenya, October 2013 through September 2017

Indicator	Oct 2013 to Sept 2014[a]	Oct 2014 to Sept 2015	Oct 2015 to Sept 2016	Oct 2016 to Sept 2017
Number of MSM reached	9118	12106	16680	26972
Number of MSM reports of violence	910	849	1026	1122
Rate of increase in number of MSM reached	1.0	1.3	1.8	3.0
Rate of increase in number of MSM reports of violence	1.0	0.9	1.1	1.2
MSM reports of violence relative to MSM reached, expressed as a percentage	10.0	7.0	6.2	4.2[b]
Percent of responses to MSM reports of violence	44	77	86	80[b]

[a]Reference year
[b]$p < 0.001$

Table 3. Annual data on programme reach, reports of violence and responses to violence by PWID in Kenya, October 2013 through September 2017

Indicator	Oct 2013 to Sept 2014[a]	Oct 2014 to Sept 2015	Oct 2015 to Sept 2016	Oct 2016 to Sept 2017
Number of PWID reached	5856	7001	10990	14527
Number of PWID reports of violence	121	533	839	873
Rate of increase in number of PWID reached	1.0	1.2	1.9	2.5
Rate of increase in number of PWID reports of violence	1.0	4.4	6.9	7.2
PWID reports of violence relative to PWID reached, expressed as a percentage	2.1	7.6	7.6	6.0 [b]
Percent of responses to PWID reports of violence	37	48	89	97[b]

[a]Reference year
[b]$p < 0.001$

Violence response is relatively new in KP programmes, and it is vital to monitor whether such activities result in expected outcomes [45]. In the absence of validated and internationally agreed-upon indicators specific to violence against KPs, projects such as the *Avahan* AIDS Initiative in India collected data on reports of and responses to violence to monitor programme effectiveness [5,6]. Programmatic data on reports of violence are important because violence cannot be redressed if unreported [46], and reporting is a critical first step to link victims to post-violence support [5,6]. Reports of violence over time also provide useful information about programme outcomes as increased reporting often occurs when KPs understand that violence was committed, know their rights, have an enabling environment to disclose violence and seek support, and have confidence in the response mechanism [5,6,46,47]. Programmatic data on responses to violence are also important as they show whether KPs who reported violence received critical post-violence support such as post-exposure prophylaxis [48]. These data can also inform processes to address violence within the programme and guide the development of policies relevant to KPs [49].

Among FSWs and PWID, the increase in reports of violence relative to individuals reached may be due to the introduction of the national violence prevention and response strategy in 2014 to 2015. This is in line with global literature that shows that programmes tend to see an uptick in reports of violence after a programme monitoring system is established [5] and victims are sensitized [46]. The increase in responses to reports of violence may also help explain this rise as FSWs and PWID may be more likely to report violence if they have social proof that their peers have received a positive response upon disclosing violence [50].

Among MSM, the decrease in reports of violence relative to individuals reached tells a different story. MSM-serving organisations in Kenya established a system to ensure safety and security among MSM, sensitized police and religious leaders and conducted community outreach beginning in 2010 in reaction to violence against MSM in Mtwapa [23]. This system was strengthened in anticipation of a backlash when Uganda's Anti-Homosexuality Act was passed in 2014 [23]. This longer-term effort, coupled with the high percentage of reports of violence in the reference year and decreases in reports in subsequent years, suggest that an uptick in reporting occurred before the strategy was introduced and that the decrease in reports of violence may reflect actual decreases in violence.

These programmatic data alone, however, have limited ability to show trends in actual violence. Fortunately, in Kenya, there is supplemental information on prevalence of physical/

sexual violence and police violence against KP members from national population-based surveys conducted 2014 to 2017 [13]. According to the surveys, prevalence of physical/sexual violence stayed static among FSWs, increased among PWID and decreased among MSM while police violence increased among FSWs and decreased among PWID and MSM [13]. Programmatic and population-based data offer useful information on their own and in relation to one another. For example, even at peak reporting, programmatic data on reports of violence have not reached the level of violence found in the surveys. This suggests that KPs may still be underreporting violence to implementing partners, for example, because there are remaining barriers to reporting, such as perceived stigma against victims [51], or because KPs are more equipped to address violence through their own networks without implementing partners [52].

5.1 | Limitations

These programmatic data do not provide a full account of violence experienced by KPs in Kenya. For example, as the data were reported in aggregate on a quarterly basis, we were not able to conduct advanced statistical analysis, including exploring whether violence outcomes are related to HIV outcomes. As mentioned previously, programmatic data are limited in tracking actual violence and could overestimate violence (if some KPs report multiple incidents of violence) or underestimate violence (if KPs do not report violence they experience).

Going forward, it will be important to continue to collect and triangulate programmatic and population-based data to analyse trends, including types of violence and perpetrators, over time. To address challenges in interpreting violence data, there is also a need for refined metrics and research to explore whether violence prevention and response interventions in KP programmes are having the intended effects, including specific questions on KP members' experiences and satisfaction with violence prevention and response services. Future research also needs to explore whether an increase in responses to violence corresponds with an increase in HIV service uptake and whether those who report violence are more likely to re-test or adhere to antiretroviral drugs than those who do not report violence.

6 | CONCLUSIONS

The programmatic data from the national KP programme show that reports of violence relative to individuals reached increased among FSWs and PWID but decreased among MSM while the percent of reports of violence that received a response increased among all KPs. These data suggest that FSWs and PWID have the desire and ability to report violence, that MSM are seeing decreases in violence and that implementing partners are responding to reports of violence in a timely manner. This paints an overall positive picture of the impacts of the national violence prevention and response strategy and emphasizes the need for multiple sources of information to triangulate data and observe changes that may not become immediately apparent in programmatic or population-based data alone.

In most parts of Africa, where sex work, same-sex sexual practices and drug use are criminalized, implementing HIV programmes for KPs can be a challenge. However, Kenya has shown that with government leadership, it is not only possible to implement a robust key population programme, but also to address violence to help create an enabling environment for KPs to access HIV-related services and thus enable the country to move more effectively towards meeting the 95-95-95 global targets.

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ACKNOWLEDGEMENTS

The authors would like to acknowledge all the implementing partners including KP-led organizations who report every quarter to NASCOP. We also thank all the peer educators and outreach workers from KP communities who provide support to KP victims of violence and build their confidence to report violence. Their efforts in documentation provide evidence to the implementing partners and the country to advocate for effective violence prevention and response. Acknowledgements are also due to the Key Populations Technical Support Unit (TSU) housed within NASCOP, Ministry of Health, which supports implementation of KP-related national strategies. The TSU project is implemented by the University of Manitoba with funding support from the Bill & Melinda Gates Foundation (BMGF) and the U.S. Agency for International Development (USAID), through the LINKAGES project implemented by FHI 360.

FUNDING

This publication is made possible by the support of BMGF under grant ID OPP 1032367 as well as the American People through USAID under cooperative agreement number AID-OAA-A-14-00045. The views expressed herein are those of the authors and do not necessarily reflect the official policy or position of BMGF, USAID, or the U.S. government.

AUTHORS' CONTRIBUTIONS

PB and GJM were involved equally in the development of this manuscript. HKM, PB, TMK, JMM, RTM and SJM designed and implemented the intervention. PB and SKI were involved in analysing the quantitative data. RLD, SM, HKM and BEO were involved in reviewing and finalizing the manuscript. All authors have reviewed and approved the final manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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Friedland BA et al. *Journal of the International AIDS Society* 2018, **21**(S5):e25131
http://onlinelibrary.wiley.com/doi/10.1002/jia2.25131/full | https://doi.org/10.1002/jia2.25131

JIAS
JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

VIEWPOINT

Measuring intersecting stigma among key populations living with HIV: implementing the people living with HIV Stigma Index 2.0

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Keywords: HIV; stigma; key population; intersectionality; Stigma Index; PLHIV

Received 16 April 2018; **Accepted** 17 May 2018

Addressing stigma affecting people living with HIV (PLHIV) is a global priority [1]. Stigma, defined as "the co-occurrence of labeling, stereotyping, separation, status loss, and discrimination in a context in which power is exercised" [2], has a negative impact on the health of PLHIV, and contributes to psychosocial stress, coercion and violence, job loss, and social exclusion [3]. Among PLHIV, gay men and other men who have sex with other men (MSM), transgender individuals, sex workers, and people who use drugs (PWUD) – often referred to as key populations – are situated at the intersection of HIV-related stigma and prejudice against their identities, occupations, or behaviours, often exacerbating their experiences of stigma and discrimination [4,5]. To support the health and rights of key populations living with HIV, it is important to understand their experiences of stigma, as well as to explore the intersectionality between HIV, key population status, and other marginalized group memberships, such as ethnic/and racial minorities, prisoners, migrants, and persons with disabilities. Yet to date, the psychometric study of intersecting patterns of stigma has been limited.

The PLHIV Stigma Index (Stigma Index) provides evidence on stigma and discrimination that has been essential for informing HIV policy, PLHIV rights advocacy efforts, and stigma-reduction interventions [6-9]. Developed by the Global Network of PLHIV (GNP+), the International Community of Women Living with HIV (ICW), the International Planned Parenthood Federation (IPPF), and UNAIDS [10] the Stigma Index is a research tool by which PLHIV capture data on their experiences of stigma and discrimination. As of November 2017, more than 100,000 PLHIV had been interviewed in over 50 languages by 2000 trained PLHIV interviewers.

In 2016, the Population Council's Project SOAR and the Stigma Index partners (UNAIDS, GNP+, ICW), with PEPFAR funding from the Office of HIV/AIDS Research of the United States Agency for International Development (USAID), undertook a process to update the Stigma Index to more fully capture the experiences of key populations living with HIV, as well as to respond to changes in global treatment guidelines, and to better understand the persistent barriers to HIV testing and treatment. Throughout the consultative, iterative process of revising the Stigma Index questionnaire, multiple stakeholders, including PLHIV networks and advocates, were asked for their input. A common recommendation was to enable respondents to share experiences of both HIV-related and key population-related stigma. Based on lessons learned from implementation in over 90 countries, stakeholders made a number of specific suggestions that were incorporated into the updated Stigma Index, including: adding a separate section with specific questions to measure stigma experienced by key populations; ensuring background demographic questions would enable analysis of stigma and discrimination by subpopulation; integrating a validated two-part gender identity question into the demographics section; separating gender identity from sexual orientation in questions and responses; utilizing existing surveys and scales for measuring stigma and discrimination in key populations [11-13]; and narrowing the timeframe to the past 12 months to better capture changes over time.

The updated survey – the Stigma Index 2.0 – was pilot-tested by the National Forum of PLHIV Networks in Uganda (NAFOPHANU) in Kampala, Uganda; by Metabiota, in collaboration with ReCAP+ in Douala and Yaoundé, Cameroon; and by Enda Santé, in collaboration with RNP+ in Dakar and Ziguinchor, Senegal. PLHIV were recruited from PLHIV networks, community-based organizations serving key populations, ART clinics, and through snowball sampling. Data were collected on tablet computers (Cameroon and Senegal) or mobile phones (Uganda) in multiple languages. The pilot study protocol was approved by local ethics committees in each country, and by the Institutional Review Boards of the Johns Hopkins School

of Public Health (Baltimore, MD, USA) and the Population Council (New York, NY, USA).

Respondents were classified as "key populations" based on two items in the demographics section: 1) discordant responses to the two-part gender identity question (i.e. born "male," currently identify as "female") or 2) a "yes" response to group identity (MSM, lesbian, transgender, sex-worker, PWUD); or a "yes" response to any of five questions about behaviours in the new key population section (e.g – to men only, "have you ever had sex with another man").

In 2017, 1204 PLHIV completed the survey, approximately 40% of whom identified as a member of at least one key population group (40% Cameroon; 34% Senegal; 43% Uganda). Of the total sample, 18% of respondents identified as sex workers; 10% as gay or MSM; 5% as transgender (men and women), 3% as PWUDs, and <1% as lesbian [14]. A substantial proportion of respondents reported having ever experienced at least one of 11 forms of HIV-related stigma, such as exclusion from family, social, religious activities; verbal or physical harassment; or blackmail. In Senegal, the country with the lowest reports of HIV-related stigma, 33% of key population members experienced at least one form of stigma compared to 18% of other respondents. By contrast, in Cameroon and Uganda, where prevalence of stigma was higher, overall, experienced stigma among key populations and the other respondents was similar (76% vs. 75%, Cameroon; 53% vs. 51%, Uganda) [14].

The new key population section indicated higher levels of stigma and violence in Cameroon than the other two countries. Among MSM living with HIV, the most commonly reported type of stigma was verbal harassment, which was reported by nearly twice as many MSM in Cameroon (83%) as in Senegal (44%) or Uganda (32%). Among transgender women living with HIV, "unjust remarks by family" was reported by nearly three times as many respondents in Cameroon (89%) than in Senegal (36%) or Uganda (30%). Differences by country in abuses experienced by sex workers living with HIV was less pronounced; forced sex was reported by 52%, 41% and 32% of respondents from Cameroon, Senegal, and Uganda, respectively.

The widespread adoption of the original PLHIV Stigma Index [6,10] and use of results for global [15-17] and national [18,19] reporting, as well as for empowerment and advocacy by and for people living with HIV [20,21], demonstrated the demand for a tool to monitor stigma and discrimination worldwide, and to support and develop leadership among people living with HIV. With its expanded scope and agility, the Stigma Index 2.0 creates opportunities for countries and communities to implement a tool that yields evidence-based data including measurement of the intersectionality of stigma affecting key populations living with HIV to more effectively implement stigma mitigation interventions as part of human rights-affirming HIV responses. Furthermore, with the emphasis on experiences of stigma and discrimination in the past 12 months, the Stigma Index 2.0 can be used to monitor progress and challenges over time. Given the potential impact on the response to the AIDS epidemic, proactive efforts to support PLHIV networks and in-country partners to implement the Stigma Index 2.0 and dissemination of results should be encouraged.

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AUTHORS' CONTRIBUTIONS

BF drafted the manuscript. BF, JP, SB, LN and AG conceptualized key messages. LS, LN, SB, UA, AC, CM, JP and SG edited the manuscript. CM, JP, SB, AG, LN, SG, BF, FA, UA, AC, AJ and LS contributed to the Stigma Index revisions and interpreted results.

ACKNOWLEDGEMENTS

We greatly appreciate the representatives of PLHIV networks and advocates who contributed to the Stigma Index update process, as well as Julian Hows and Jennifer Bushee (both formerly of GNP+), Noah Metheny (formerly of USAID), and Cameron Wolf (USAID). We are grateful to Stella Kentutsi (NAFOPHANU), Ubald Tamoufe (Metabiota) and Daouda Diouf (Enda Santé) and their teams for their leadership implementing the pilot studies, and to Gnilane Turpin and Fan Yang (both of Johns Hopkins University) for their technical assistance and data analysis. Thanks to Benny Kottiri for helpful edits to the manuscript. We are especially thankful to the PLHIV from NAFOPHANU, ReCAP+ and RNP+ who implemented pilot study activities, and to the 1204 PLHIV who responded to the survey.

FUNDING

Support for the Stigma Index update through the Population Council's Project SOAR (Cooperative Agreement AID-OAA-A-14-00060) was made possible by the generous support of the American people through the President's Emergency Plan for AIDS Relief (PEFPAR) and the U.S. Agency for International Development (USAID).

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The contents of this viewpoint are the sole responsibility of the authors and do not necessarily reflect the views of the U.S. President's Emergency Plan for AIDS Relief, the U.S. Agency for International Development or the U.S. Government.

COMPETING INTERESTS

The authors have no conflicts of interest to declare.

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Website: www.jiasociety.org

eISSN: 1758-2652

Contact details

Editorial office:
Avenue de France, 23
CH-1202 Geneva
Switzerland

Email: editorial@jiasociety.org

Tel: +41 (0) 22 710 0800

Publisher

The *Journal of the International AIDS Society* is published by John Wiley & Sons Ltd on behalf of the International AIDS Society

John Wiley & Sons Ltd
9600 Garsington Road
Oxford, OX4 2DQ UK

Telephone: +44 1865 776868

Email: customer@wiley.com

Production Editor

Jose Pedro Costa Moreira (email: jcostamore@wiley.com)

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