

An Economic Evaluation of a Community-Based Organization Led HIV Self-Testing Program Among Men Who Have Sex With Men in China

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Abstract

Introduction: HIV self-testing (HIVST) is effective in improving the uptake of HIV testing among key populations. Complementary data on the cost-effectiveness of HIVST is critical for planning and scaling up HIVST. This study aimed to evaluate the cost-effectiveness of a community-based organization (CBO)-led HIVST model implemented in China.

Method: A cost-effectiveness analysis (CEA) was conducted by comparing a CBO-led HIVST model with a CBO-led facility-based HIV rapid diagnostics testing (HIV-RDT) model. The full economic cost, including fixed and variable cost, from a health provider perspective using a micro costing approach was estimated. We determined the cost-effectiveness of these two HIV testing models over a two year time horizon (i.e. duration of the programs), and reported costs using US dollars (2020).

Results: From January 2017 to December 2018, a total of 4,633 men tested in the HIVST model, and 1,780 men tested in the HIV-RDT model. The total number of new diagnosis was 155 for HIVST and 126 for the HIV-RDT model; the HIV test positivity was 3.3% (95% confidence interval (CI): 2.8-3.9) for the HIVST model and 7.1% (95% CI: 5.9-8.4) for the HIV-RDT model. The mean cost per person tested was \$14.57 for HIVST and \$24.74 for HIV-RDT. However, the mean cost per diagnosed was higher for HIVST (\$435.52) compared with \$349.44 for HIV-RDT.

Conclusion: Our study confirms that compared to facility-based HIV-RDT, a community-based organization led HIVST program could have a cheaper mean cost per MSM tested for HIV in China. Better targeting of high-risk individuals would further improve the cost-effectiveness of HIVST.

Background

Men who have sex with men (MSM) are one of the key populations that are particularly vulnerable to acquiring HIV. The HIV prevalence rate of MSM in China has increased from 1.4% in 2001 to 8.0% in 2015.[1–3] In 2017, MSM accounted for 26% of all newly reported HIV cases in China, compared with 15% in 2011.[4] The global strategy to control the HIV epidemic hinges on early diagnosis and treatment of HIV.[5] A low HIV testing rate is one of the important reasons for the ongoing spread of HIV among MSM in China.[6, 7]

To improve HIV testing rates, exploring the synergies between mobile health and HIV rapid testing technologies is needed. China's internet and mobile internet users currently exceed 854 million people by the end of June 30, 2019[8] and there is a growing use of social networking apps for socializing and sexual partner seeking.[9–11] This explosive growth of Internet use brings opportunities to develop innovative HIV testing strategies.[12] HIV self-testing (HIVST), where an individual performs their own test and interprets their result provides a convenient, quick, private and acceptable alternative to HIV testing through health facilities.[13, 14] HIVST can expand the coverage of HIV testing among key populations. [15]

Investing in HIV testing models which incorporates mobile health with HIV rapid diagnostic testing within community-based organization (CBOs) may be a way to facilitate greater HIV testing coverage, particularly among key populations. Some CBOs in China are already working with the local Centers for Disease Control and Prevention (CDC) to develop self-testing scale-up pilot programs among MSM.[16] For instance, since 2015 in Zhuhai (a small city in Southern China with more than 17 000 MSM)[17], two community-based HIV testing strategies have been implemented among MSM. These CBOs use the Internet and social media platforms to promote online HIVST and CBO-led facility-based HIV rapid testing (HIV-RDT). The Chinese government recognizes that CBOs are an indispensable force in HIV prevention and control and explicitly included AIDS prevention and treatment content into government-funded community organization services.[16, 18, 19] The Chinese State Council also supports different strategies, including CBO-led HIV self-testing in the 13th Five-Year Plan for AIDS Prevention and Control (2017-22).[16]

Though rapid HIV testing service is recommended by Chinese national policies, there are limited data on the sustainability or cost-effectiveness of community-based HIV testing models. An economic analysis of these programs could help support government policies around the implementation of HIV testing in China and provide examples of cost-effective HIV testing models for other low- and middle-income countries. There is one other economic evaluation for HIVST that demonstrates its cost-effectiveness in MSM from North America,[20] but none that we are aware of from a low- or middle-income country. Thus the aim of this study was to conduct a cost-effectiveness analysis of HIV self-testing compared to facility-based HIV rapid testing for Zhuhai's MSM population from a health provider perspective.

Methods

Study setting

This implementation study was conducted in Zhuhai, China. The city was one of the first sites to pilot HIVST among key populations in China. With funding and policy support from the Zhuhai city government and Municipal Center of Diseases Control, a gay-friendly community-based organization, named Zhuhai Xutong Voluntary Services Center (abbreviated as Xutong), initiated a social-media based online system in 2016 to distribute free HIV self-test kits to MSM. MSM accessed the self-test kit application system through Xutong's public WeChat account. WeChat is social media platform similar to Facebook and Twitter, with secure messaging functions, and is the most popular social media software in China.[21] Xutong conducts two different HIV testing models online and offline based on Wechat. Participants who were 16 years or older, born biologically male, and ever had sex with another man were included in this study. This study uses the implementation data collected from the HIV testing services that targeted MSM in Zhuhai, China.

In Model 1 (referred hereafter as 'CBO-led HIVST'), men could click banner ads on Xutong's Wechat platform, which promoted blood-based HIVST kits. This directed men to information regarding how to apply for free HIVST kits. Men who were interested in applying for test kits had to pay a deposit

(\$14.5/kit), which was immediately refunded upon the upload of a photograph of the test kit result. These costs related to the deposit and refund was not considered in our economic model as it was cost-neutral to the payer. Each test kit package contained a test kit, lubricants, and condoms. Test kits were mailed to participants after they paid the deposit and provided shipping information. Each test package contained instructions and a QR code for the tester to upload a photograph of the test result anonymously. If an invalid result occurred (e.g. due to not reading the result in time or incorrect use of the kit), the CBO staff contacted the participant to return the deposit, and encouraged him to re-apply for another self-test kit.

In Model 2 (referred hereafter as 'CBO-led facility-based HIV rapid diagnostics testing (HIV-RDT)'), Xutong also offers individuals or groups of offline HIV rapid testing services through banner ads on the WeChat platform. The testing facilities that men can choose include one community clinic (Lingnan Community Health Service Station) and three hospitals (The Fifth Affiliated Hospital Sun Yat-Sen University, The Fifth Affiliated Hospital of Zun Yi University, Zhuhai Doumen Qiaoli Hospital of TCM). Professional health workers in a private room provide one-on-one HIV-RDT, counseling and a small gift pack with condoms, lubricants, and information flyers. Testing was provided without cost.

Follow-up of screening positive cases

In the HIVST model, Xutong's staff, mostly gay men, were trained as lay health workers who provided free post-test counseling services by checking the uploaded test results and referred HIVST screening positive cases to the nearest HIV/AIDS Treatment Hospital to do confirmatory testing and follow-up care.

Participants were assigned a unique study number for uploading their result however the CBO staff were able to de-identify the study number for purposes of contacting participants who had a positive result.

In the HIV-RDT model, professional health workers in the CBO provided free pre- and post-test counseling services. Similarly, when an HIV screening positive case was found, the medical staff would refer him to the HIV/AIDS Treatment Hospital for confirmatory testing and follow-up care.

Costs

We estimated the full economic cost (i.e., includes the costs of all resources used to introduce the testing models) from a health provider perspective using a micro costing approach. We observed actual resources used during the implementation and categorized cost items as either fixed or variable. For fixed costs (i.e., independent of number of tests conducted), we estimated the cost of start-up (training), capital (building rent), personnel support, and office equipment from five participating sites. We annualized costs over the expected useful life using a discount rate of 3%. For variable costs (i.e., dependent on the number of tests conducted), we estimated the cost of supplies used for HIV testing and personnel cost. Costs were inflated to 2020 values based on the World Bank's annual (%) inflation consumer prices (1.6%),^[22] and all costs were reported in 2020 USD (1USD = 6.88 Yuan).^[23] We analyzed the cost in Excel 2019 (Microsoft, USA).

Cost-effectiveness analysis

Using the data informed by the implementation study, we calculated the incremental cost-effectiveness ratios (ICER) for cost per test conducted and cost per HIV diagnosed comparing HIVST with HIV-RDT. An ICER is the incremental cost of the HIVST compared with HIV-RDT program, divided by the incremental effectiveness (i.e. difference in number of men tested or diagnosed with HIV). The time horizon was two years, i.e. the length of the implementation study. To project the long-term impact of HIV testing (i.e. accounting for HIV management and secondary effects of infections averted) was beyond the scope of this analysis. Thus, we provided a conservative estimate of the value of these HIV testing models. We report our findings according to the Consolidated Health Economic Evaluation Reporting Standards (CHEERS).

Results

The implementation study was conducted from January 2017 to December 2018. A total of 4,633 men tested in the HIVST model (from 4,781 kits delivered) and 1,780 men tested in the HIV-RDT model. The HIV test positivity was 3.3% (95% confidence interval (CI): 2.8–3.9) for the HIVST model and 7.1% (95% CI: 5.9–8.4) for the HIV-RDT model.

Table 1 summarizes the cost associated with the study. The total cost of the two testing programs in the trial was \$42,477 for HIVST and \$65,126 for HIV-RDT. Figure 1 shows that the biggest drivers of costs were the variable costs of supplies for HIVST and the variable costs of personnel for HIV-RDT. A total of 4633 men were tested for HIVST and 1780 men for HIV-RDT. The number of men testing positive for HIV was 155 in the HIVST arm and 126 in the HIV-RDT arm.

Table 1

Costs of community-based organization led services to provide HIV self-testing and HIV rapid diagnostic testing in Zhuhai, China, 2017–2018.

HIV self-testing	Economic cost (USD 2020)
<i>Fixed cost</i>	
Building rental ¹	1275
Office, including computers, desks, chairs	398
Start-up, including daily transport expenses, training fee for participants, overtime meal allowance, volunteer transport	1138
<i>Variable cost</i>	
Supplies, including HIV rapid test (SD Bioline), reagent consumables, packaging material, condoms, lubricant, postal express fee	28607
Personnel employed*, tasks include publicity of service, assembly and delivery of test packages, interpretation of results, follow up of HIV positive results	12113
Office, including internet, electricity, property management, telephone bill, online subscription WeChat platform to run the testing service	498
Facility based HIV rapid diagnostic testing²	
<i>Fixed cost</i>	
Building rental	9919
Office, including computers, desks, chairs	1342
Start-up, including daily transport expenses, training fee for participants, overtime meal allowance, volunteer transport	2313
<i>Variable cost</i>	
Supplies, including HIV rapid test (SD Bioline), reagent consumables, packaging material, condoms, lubricant	8415
Personnel employed, tasks include publicity of service, assembly and delivery of test packages, interpretation of results, follow up of HIV positive results	40773
Office, including internet, electricity, property management, telephone bill	4744

¹ We included building rental and office equipment for the HIVST model to account for its integration into an existing community-based organization (XuTong CBO). As this is an economic analysis, we incorporated all costs including the cost of donated time and resources from the CBO.

² Facility based HIV testing was available from Xutong CBO, The Fifth Affiliated Hospital of Zunyi Medical University, The Fifth Affiliated Hospital of Sun Yat-Sen University, Chronic Disease Prevention Station of Doumen, and Lingnan Community clinic

* we calculated an hourly wage from salaried staff and volunteers, with appropriate allocation factors according to the time spent on implementing the program.

Cost-effectiveness of HIVST and HIV-RDT (Table 2)

Table 2

The cost-effectiveness of HIV self-testing compared with HIV rapid diagnostic testing for men who have sex with men in China

	Cost USD (2020)	Incremental cost	Effectiveness	Incremental effectiveness	ICER
			Per person tested		
HIV-RDT	44029		1780		
HIVST	67506	23477	4633	2853	\$8.23
			Per person diagnosed		
HIV-RDT	44029		126		
HIVST	67506	23477	155	29	\$809.55
HIVST = HIV self-testing; HIV-RDT = HIV rapid diagnostic testing, based in a facility.					

The mean cost per person tested was \$14.57 for HIVST and \$24.74 for HIV-RDT. The mean cost per person diagnosed was \$435.52 for HIVST and \$349.44 for HIV-RDT. The ICER for HIVST compared with HIV-RDT was \$8.23 per additional person tested and \$809.55 per additional person diagnosed.

Discussion

As HIVST continues to be scaled up globally, determining the value of HIVST distribution models compared with other HIV testing models is important to inform HIV testing policies. We examined the costs of providing HIVST compared with facility-based HIV-RDT through CBOs for MSM in Zhuhai, China. This is the first report of the cost per person-tested and cost per person diagnosed within this context, adding to the limited literature of cost-effectiveness of HIV testing models in low- and middle-income countries, which are not focused on MSM.[24–26] Our implementation study results combined with its economic evaluation alongside the study confirms the feasibility and cost-effectiveness of providing CBO-led HIVST and HIV-RDT for MSM, a difficult-to-reach population with rising HIV incidence.[27, 28]

Our study confirms the appeal of HIVST among MSM living in China, showing a greater absolute number of men tested and diagnosed with HIV through HIVST compared to facility-based HIV-RDT. This is consistent with findings from a randomized controlled trial in MSM living in the US concluding that HIVST improved testing frequency and newly identified HIV.[29] Another study in Zhuhai showed that 82.9% of MSM were willing to recommend HIV self-test products to their friends, and 97.2% were satisfied with this self-testing service.[30] Similar studies confirm that HIVST is acceptable.[4, 31, 32] We strengthen the growing literature of the acceptability of HIVST among MSM, by also confirming the cost-effectiveness of HIVST, compared to facility-based testing. We found that the cost per person tested using HIVST was \$14.57, which is comparable to a systematic review of HIVST in sub-Saharan Africa that reported an average of \$12.39 per person tested (Nurilign Ahmed, London School of Hygiene and Tropical Medicine, personal communication), and cheaper than the estimate from the US: \$61 per person tested.[29]

Interestingly our study found higher HIV positivity rate among men using the HIV-RDT model. Our current study is unable to discern why this was the case. It is possible that men who tested positive using HIVST did not upload their result, thereby affecting the test positive yield of our HIVST arm. Other potential reasons might be that men with a higher self-perception of HIV risk might prefer HIV testing to be conducted by trained staff in a health facility as they might perceive the diagnostic results to be more accurate.[33] Those tested in facilities might also have more rapid linkage to care if found to be HIV-positive, or could also receive additional face-to-face counseling to stay HIV-negative if they do not currently have HIV. Some studies suggest that HIVST testers might be testing more frequently than those tested in facilities,[14, 34] thus contributing to a lower HIV test positivity. Future studies are warranted to confirm if our observation of a higher positivity rate in HIV-RDT programs compared to HIVST can be replicated in other settings and the reasons behind this.

The main strength of this study is that we used real-world data from an implementation study to inform our economic evaluation. Our findings should be read in light of several limitations. First, as our findings are informed by one trial in Zhuhai, the conclusions are not necessarily generalizable to other parts of China, where there may be differences in HIV epidemiology or testing behaviors. Our study should be replicated in other settings to confirm our findings. Second, our study did not report the long-term benefits of HIV testing such as disability-adjusted life-years averted which would ideally use a dynamic transmission model. Nevertheless, our outcomes of cost per person tested is valuable for decision-makers to help budget for HIV testing programs and prioritize programs that have lower cost per person tested (such as HIVST programs) to maximize value for money.[35] In addition, knowing the cost per person diagnosed provides information on the efficiencies of targeting the right individuals for testing. Third, there could be differences in the proportion of people linking to care and starting ART if they use HIVST compared with facility based testing.[36] Having a lower proportion of men linking to care could change our conclusions; this highlights the need to ensure those testing positive using HIVST also have a confirmatory test within a facility to optimize their linkage to care.

Conclusion

Sustainable and cost-effective methods to improve HIV testing coverage is needed. Our study confirms that compared to facility-based HIV-RDT, a community-based organization led HIVST program could have a cheaper mean cost per MSM tested for HIV in China. Better targeting of high-risk individuals would further improve the cost-effectiveness of HIVST.

Abbreviations

CBO: community-based organization

CDC: Centers for Disease Control and Prevention

CI: Confidence Interval

HIV-RDT: facility-based HIV rapid testing

HIVST: HIV self-testing

MSM: who have sex with men

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the ethics review committees at the Zhuhai Municipal Center for Diseases Prevention and Control (Zhuhai, China). Written (for facility-based testing) and electronic informed consent (HIV self-testing) were obtained from the participants before HIV testing.

Consent for publication

All authors consent for publication.

Availability of data and materials

Not applicable.

Competing interests

All authors state they do not have any competing interests to declare.

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Authors' contributions

JJO, WT, LH and SH conceived this study. SH, WD, YZ, XL, XH and WT collected the data. SH and JJO analyzed the data. SH and JJO drafted the initial manuscript; WD, YZ, XH, XL, LH and WT contributed to the manuscript. All the listed authors approved the final version for submission.

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Figures

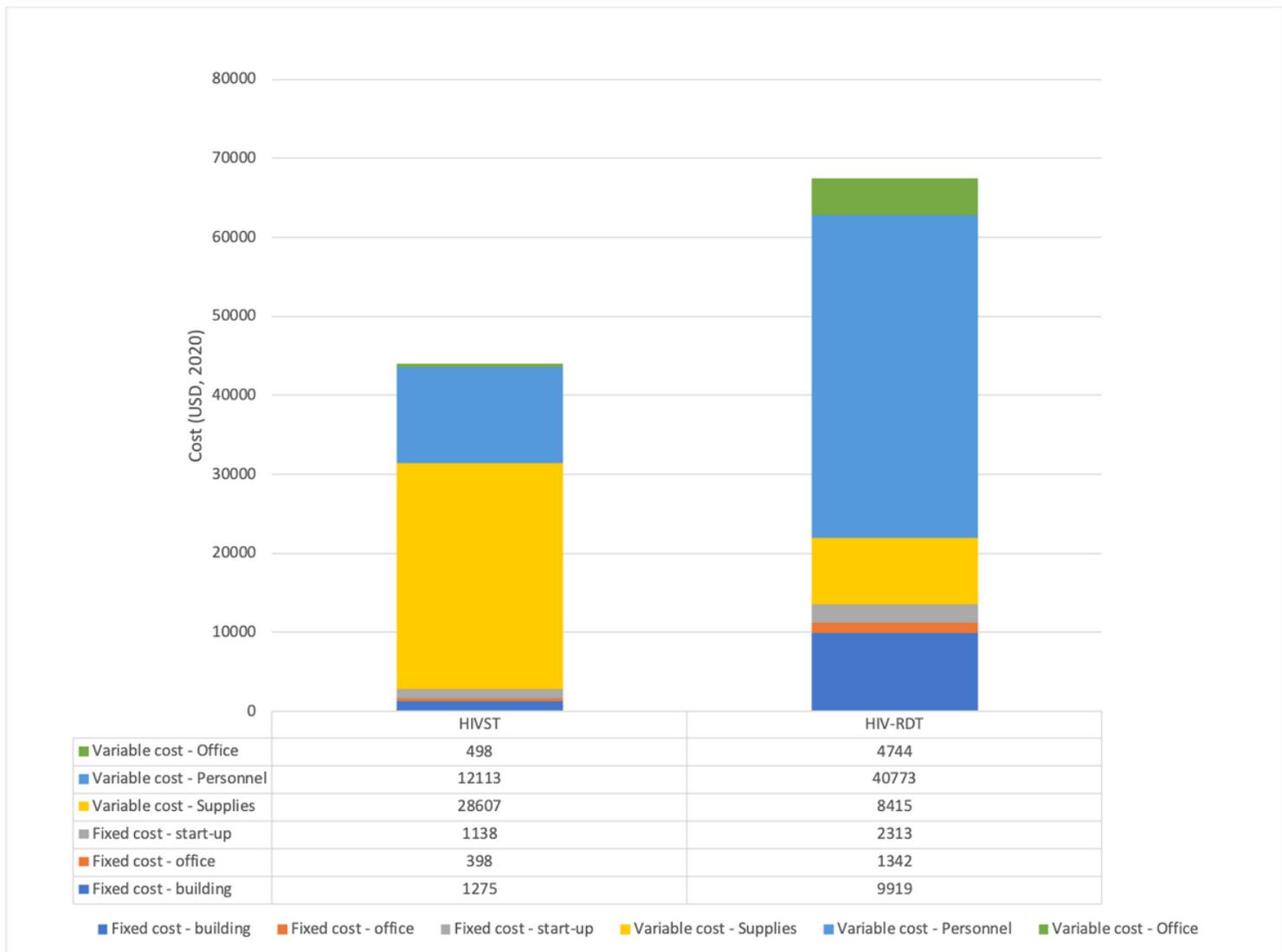


Figure 1

Cost comparison between HIV self-testing and facility-based HIV-rapid-diagnostic testing in Zhuhai, China.