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# Enhancing HIV Self-Testing Among Nigerian Youth: Feasibility and Preliminary Efficacy of the 4 Youth by Youth Study Using Crowdsourced Youth-Led Strategies

Juliet Iwelunmor, PhD,<sup>1,i</sup> Oliver Ezechi, MD, PhD,<sup>2</sup> Chisom Obiezu-Umeh, MPH,<sup>1,ii</sup>  
Titilola Gbaja-Biamila, MBBS, MSc,<sup>1,2</sup> Adesola Z. Musa, PhD,<sup>2</sup> Ucheoma Nwazuru, MS, PhD,<sup>3</sup>  
Hong Xian, PhD,<sup>1</sup> David Oladele, MBBS, MSc,<sup>1,2</sup> Collins O. Airhienbuwa, PhD,<sup>4</sup>  
Kathryn Muessig, PhD,<sup>5</sup> Nora Rosenberg, PhD,<sup>5</sup> Donaldson F. Conserve, PhD,<sup>6</sup>  
Jason J. Ong, PhD, MMed, MBBS,<sup>7-9</sup> Susan Nkengasong, MS,<sup>9</sup> Suzanne Day, PhD,<sup>10</sup>  
Kadija M. Tahlil, MPH,<sup>5</sup> Rhonda BeLue, PhD,<sup>1</sup> Stacey Mason, MPH,<sup>1</sup> Weiming Tang, MD, PhD,<sup>10</sup>  
Gbenga Ogedegbe, MD, MPH,<sup>11</sup> and Joseph D. Tucker, MD, PhD<sup>10,12</sup>

## Abstract

Although HIV self-testing (HIVST) has expanded in many regions, a few HIVST services have been tailored for and organized by youth. Innovative HIVST models are needed to differentiate testing services and generate local demand for HIVST among youth. The current pilot study aimed at examining the feasibility and efficacy of crowdsourced youth-led strategies to enhance HIVST as well as sexually transmitted infection (STI) testing. Teams of youth iteratively developed HIVST interventions using crowdsourcing approaches and apprenticeship training. Five interventions were selected and then evaluated among youth (ages 14–24) from September 2019 to March 2020. Given the similar outcomes and approaches, we present cumulative data from the completed interventions. We assessed HIVST uptake (self-report), STI uptake (facility reports for gonorrhea, syphilis, hepatitis B, and chlamydia testing), and quality of youth participation. Mixed-effect logistic regression models estimated intervention effects at baseline and 6 months. Of the 388 youths enrolled, 25.3% were aged 14–19, 58.0% were male, and 54.1% had completed secondary education. We observed a significant increase in HIVST from 3 months compared with 6 months (20% vs. 90%;  $p < 0.001$ ). Among those who received an HIVST at

<sup>1</sup>College for Public Health & Social Justice, Saint Louis University, Saint Louis, Missouri, USA.

<sup>2</sup>Clinical Sciences Department, Nigerian Institute of Medical Research, Lagos, Nigeria.

<sup>3</sup>Division of Public Health Sciences, Department of Implementation Science, Wake Forest School of Medicine, Winston-Salem, North Carolina, USA.

<sup>4</sup>Health Policy and Behavioral Sciences, School of Public Health, Georgia State University, Atlanta, Georgia, USA.

<sup>5</sup>Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA.

<sup>6</sup>Department of Prevention and Community Health, Milken Institute School of Public Health, The George Washington University, Washington, District of Columbia, USA.

<sup>7</sup>Central Clinical School, Monash University, Melbourne, Australia.

<sup>8</sup>Melbourne Sexual Health Centre, Alfred Health, Melbourne, Australia.

<sup>9</sup>Clinical Research Department, London School of Hygiene and Tropical Medicine, London, United Kingdom.

<sup>10</sup>Department of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA.

<sup>11</sup>Center for Healthful Behavior Change, Division of Health and Behavior, Department of Population Health, New York University School of Medicine, New York, New York, USA.

<sup>12</sup>Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, London, United Kingdom.

<sup>i</sup>ORCID ID (<https://orcid.org/0000-0003-1376-5443>).

<sup>ii</sup>ORCID ID (<https://orcid.org/0000-0003-3881-9313>).

3 months, 324 out of 388 were re-tested at 6 months. We also observed significant increases in testing for all four STIs: syphilis (5–48%), gonorrhea (5–43%), chlamydia (1–45%), and hepatitis B testing (14–55%) from baseline to the 6-month follow-up. Youth participation in the intervention was robust. Youth-led HIVST intervention approaches were feasible and resulted in increased HIV/STI test uptake. Further research on the effectiveness of these HIVST services is needed.

**Keywords:** HIV, sexually transmitted infection, self-testing, youth, crowdsourcing, Nigeria

## Introduction

**Y**OUTH (AGED 14–24) are often excluded from meaningful involvement in developing, implementing, and evaluating research and programs that impact their health and well-being.<sup>1</sup> There remains an urgent need to engage youth across the HIV prevention and treatment continuum, particularly in sub-Saharan Africa (SSA) where there is an increasing youth population and sub-optimal health service utilization.<sup>2</sup> SSA also accounts for 72% of new HIV infections among adolescents and young people, and the death rates attributable to HIV among this age group are on the rise.<sup>3,4</sup>

More alarming is the current low rates of HIV diagnosis among youth in this region, as many of the undiagnosed youth do not use essential HIV prevention services, including HIV testing services and other sexually transmitted infection (STI) testing.<sup>5</sup> In Nigeria, for example, youth have low testing uptake such that only 16% of young women and 9% of young men had ever tested for HIV in 2013, with minimal progress in ensuing years.<sup>6</sup> Contributing to the low test uptake is a complex array of individual (fear, and low perceived risk),<sup>7,8</sup> social (insufficient social support),<sup>8</sup> and structural level (poor access to testing) barriers that persist in traditional approaches to HIV testing that often ignore developmental stages and the diverse needs of young people. Eliminating these barriers to promote HIV testing among youth would require novel approaches. Moreover, for such novel approaches to be appealing and sustainable, the designed and implemented interventions should be in partnership with the youth themselves, as this has been found to be effective.<sup>1,9,10</sup>

HIV self-testing (HIVST), a process whereby an individual performs their own HIV test and interprets their test result discretely without presenting to a health facility,<sup>11</sup> has shown potential to reach youth who may not otherwise test.<sup>12,13</sup> Due to the large body of evidence that points to its effectiveness and benefits, the World Health Organization (WHO) as well as the Nigerian National HIV and AIDS strategic framework 2019–2021<sup>14</sup> recommends HIVST as an alternative to traditional HIV testing services as one way to increase uptake of testing in young people. However, despite the release of country-specific guidelines,<sup>14</sup> increased donor investment, and price reductions of HIVST kits in the public sector,<sup>15</sup> significant barriers remain to uptake.

Having youth actively engaged in developing and implementing strategies to promote HIVST is an appealing approach that may enhance uptake. Participatory approaches provide an enabling environment to generate needed innovations that better reflect youth's needs while improving acceptability, effectiveness and sustainability.<sup>16</sup> Although there are increasing efforts to engage youth in improving HIV prevention outcomes, very few studies have actively involved youth in developing and implementing strategies to promote HIV testing.<sup>1</sup>

Crowdsourcing, using open contests, is one such participatory approach where a group of individuals attempt to solve a problem and then share their solutions with the public.<sup>17–19</sup> This approach has been used increasingly in public health<sup>20</sup> and may be useful in engaging youth in the development of HIVST services and could ultimately spur HIV test uptake.<sup>21</sup> Once participants are engaged, an apprenticeship training strategy pairs them with local experts to further build capacity for developing and implementing new youth-friendly HIVST services in real-world settings. Apprenticeship also provides the practical skills, direct mentorship, and supportive environment to increase the likelihood of launching successful HIVST services targeting youth populations. Moreover, delivering such services will involve lay and trained youth-friendly health workers in both facility and community settings.<sup>22</sup> By engaging youth in crowdsourcing activities and apprenticeship training, the interventions developed and implemented for youth by youth may hold key for local ownership and long-term sustainability of services over time.

In the context of HIV testing, crowdsourcing and apprenticeship training may enhance demand, reach, and uptake of HIVST by modifying individual, social, and structural barriers to testing. Thus, this pilot, quasi-experimental study aims at (1) determining the feasibility of enrolling youth, aged 14–24 years into five pilot intervention studies; (2) establishing the feasibility of retaining participants through a 6-month follow-up period; and (3) obtaining a preliminary estimate of efficacy of youth-led strategies, developed through crowdsourcing and apprenticeship training, to enhance the uptake of HIVST among youth in Nigeria.

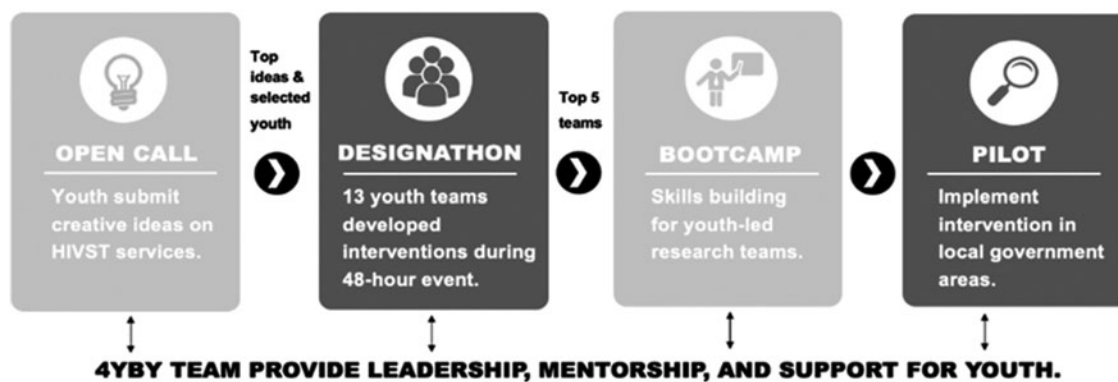
## Methods

### *Study design*

We conducted a pilot, quasi-experimental cohort study from September 2019 to March 2020 to evaluate five different models of service delivery across seven sites as part of the Innovative Tools to Expand Youth-friendly HIV Self-Testing (I-TEST) study, known locally as 4 Youth by Youth (4YBY). We followed the template for Social Innovation in Health Research Checklist<sup>23</sup> to provide a detailed description of the interventions and ultimately replicability (Supplementary Table S1). The trial was registered with ClinicalTrials.gov (NCT04070287).

### *Intervention development procedures*

The steps for the intervention development are shown in Fig. 1. Guided by a youth participatory action research (YPAR) framework,<sup>24</sup> three participatory activities were implemented from October 2018 to July 2019 to inform the content and structure of the intervention. First, we conducted



**FIG. 1.** The steps for the 4YBY intervention development process. 4YBY, 4 Youth by Youth.

a crowdsourcing open call over a 7-week period, where we solicited concepts and strategies to promote HIVST. We used the WHO/TDR practical guide on crowdsourcing to inform the open call.<sup>25</sup>

Next, we conducted a 48-h designathon in which pre-formed teams collaborated to design youth-friendly HIVST service strategies in a sprint-like event. A designathon is a crowdsourced approach in which small groups of people collaborate to solve a problem.<sup>26</sup> Both the crowdsourcing open call and designathon were judged by an expert panel of Nigerian professionals in public health, communications, civil society, and product design based on desirability to young people, feasibility to implement, and potential for impact (described in details elsewhere).<sup>6,27,28</sup>

Finally, during our 4-week apprenticeship training (which we called an innovation bootcamp<sup>28</sup>) aimed at building capacity for research and entrepreneurship, a select group of teams refined and finalized their service strategies for improving HIVST among young Nigerians. The five best-scoring strategies, in collaboration with the Nigerian Institute of Medical Research (NIMR), pilot-tested their HIVST packages across seven local government areas in Nigeria.

#### *Intervention components and implementation*

We implemented a quasi-experimental study comparing five different models of service delivery developed and implemented by trained youth research facilitators. Detailed descriptions of all five interventions' components are available in Supplementary Table S1. Common elements across the five interventions included HIVST service packages, as well as STI testing, that were sold for <1500-naira (3 USD) and youth-led organization. Participants were asked to test twice within the 6-month time period (once at 3 months and once at 6 months after baseline).

- Intervention 1 (Lagos State): This intervention repackaged the standard HIVST kit to be more appealing to youth and rebranded it as a “SMART Pack.” The pack included oral HIVST kits, educational pamphlets, a referral coupon (for linkage to youth-friendly clinics for STI testing), and a wristband (to normalize HIV testing). The package was promoted at social gatherings and outreach events.

- Intervention 2 (Lagos State): This intervention created a self-care box called “LUVBOX” that included HIVST kits, condoms, referral coupons (for linkage to youth-friendly clinics for STI testing), and hygiene products (panty liners for females and beard care kit for males). It was promoted at in-person outreach events in schools and local market squares.
- Intervention 3 (Enugu State): HIVST kits were promoted at social community events (soccer games and dance competitions) and on social media platforms. The kits included a USSD (unstructured supplementary service data) code for users to access on their mobile phone a set of step-by-step instructions on how to use the kit in the local language, Igbo. The study team used mobile clinics to provide youth-friendly services, including STI testing.
- Intervention 4 (Ondo State): The intervention repackaged the HIVST kit to also include access to local skill acquisition programs while drawing on youth ambassadors to distribute the kits in student communities and via WhatsApp messages. The youth ambassadors included individuals aged 14–24 who were able to commit to the role for the designated time period and are connected to other youths in the communities in varying capacities such as youth leaders or social influencers in public health. These individuals were well positioned to share information with their peers about the HIVST services while building community support to extend the reach and demand for HIVST among youth. They used mobile clinics to provide youth-friendly services, including STI testing.
- Intervention 5 (Oyo State): The intervention provided an oral HIVST kit and an access pin code that gave the users access to a program website. This site allowed participants to redeem prizes and an opportunity to speak to a counselor trained on how to conduct the test, understand the result, and support linkage to youth-friendly clinics for STI testing.

#### *Study population and procedures*

The interventions were implemented in 4 out of the 36 states in Nigeria, namely, Lagos, Enugu, Ondo, and Oyo states across 7 geographical distinct catchment areas. For

each intervention, our goal was to recruit at least 80 participants. Each state had established two youth-friendly health facilities, where participants were referred for follow-up visits that included STI testing and facility-based confirmatory HIV testing. The criteria for selecting the youth-friendly health facilities included the clinic’s proximity to the study site location, the number of young clients they serve and whether they offer comprehensive sexual and reproductive health services (including STI testing) to youth.

Study participants eligibility criteria included (1) being 14–24 years old; (2) self-reported HIV negative or unknown HIV status; (3) able to speak and understand English; (4) willing and able to provide informed consent; and (5) have a mobile phone. Recruitment occurred through a combination of community-based events, social media platforms, and peer referral. The studies were organized by groups of 3–5 paid trained youth research facilitators at each site. The trained youth research facilitators were responsible for recruiting study participants, facilitating intervention delivery and data collection.

In addition, each site received supportive supervision and mentorship through a series of participatory learning community (PLC) sessions. Guided by the Institute of Health Breakthrough Series,<sup>29</sup> the PLC was organized around the Plan-Do-Study-Act (PDSA) cycles wherein teams across all the study sites collaborated to identify problems and barriers to implementation, define a strategy that can produce change, test the strategy, and use locally generated data to determine and compare across sites if the change yielded a process improvement. The PLC sessions were also used to enhance ongoing implementation across the study sites and evaluate adherence and fidelity to the study protocol. The PLC sessions were co-organized by NIMR technical staff and youth research facilitators.

Potential participants were approached by a trained youth research facilitator and asked permission to screen them for study eligibility. Interested eligible participants were given an appointment for an intake where they were enrolled and underwent baseline assessment after providing informed consent. On completing the baseline assessment, participants received either one of the five package of services based on the catch-

ment area (Lagos, Oyo, Ondo, or Enugu state) in which the participant reside and the intervention is implemented. All enrolled participants were followed for 6 months.

*Retention and follow-up*

Participants were contacted via SMS (short message service) text message and phone calls 3 and 6 months after baseline. Participants were also asked to complete a follow-up evaluation that included facility-based STI testing and a survey. Those with a positive HIVST result during the study assessments were encouraged to link to care for confirmatory HIV testing by a study team member.

*Outcomes*

The primary outcome was uptake of HIVST that was assessed at 3 and 6 months post-intervention based on self-reported data collected through a structured questionnaire. The STI testing uptake, including testing for chlamydia, gonorrhea, syphilis, and hepatitis B, was a secondary outcome. The STI testing uptake was assessed at baseline and 6 months through self-reported data and administrative records at the participating youth-friendly clinics.

Baseline and follow-up assessments also included question about sexual behaviors, including condom use, HIV and STI testing history, and youth participation quality and experience. We used the modified 12-item Tiffany-Eckenrode Program Participation Scale<sup>30</sup> to assess the extent to which youth were substantially engaged and valued. The intervention feasibility is described in a Consolidated Standards of Reporting Trials (CONSORT) diagram,<sup>31</sup> which illustrates results for enrollment and retention. Definitions of primary and secondary outcomes and detailed methods of assessments can be found in Table 1.

*Statistical analysis*

Given that this pilot data was meant to inform the subsequent randomized controlled trial (RCT), we did not conduct a formal size calculation and the analyses were not designed to have a specified level of statistical power.<sup>32</sup> Descriptive statistics were calculated as frequencies and percentages for

TABLE 1. DEFINITIONS OF PRIMARY AND SECONDARY OUTCOMES

	<i>Definition</i>
Primary outcome	
Uptake of HIV testing	Proportion of participants who reported to have self-tested for HIV at 3 and 6 months after baseline.
Secondary outcomes	
Uptake of STI testing	Proportion of participants who reported STI testing (including testing for gonorrhea, chlamydia, syphilis, and hepatitis B) at baseline and 6 months. These data were obtained from administrative records at the youth-friendly health clinics.
Condomless sex	Proportion of participants who report using condoms consistently in the past 3 months at 3 and 6 months after baseline.
Quality of youth participation	Using the modified 12-item Tiffany-Eckenrode Program Participation Scale, we assessed the overall participation experience at 6 months, including the extent to which young people felt included and valued in the intervention. Sample statements “the program’s activities are interesting” or “I learnt a lot from participating in the program.” The responses were measured on a 5-point Likert scale (0–4) and summed; higher mean scores indicating more highly engaged program participation.

STI, sexually transmitted infection.

categorical variables and means and standard deviations (SDs) for continuous variables. Changes in primary and secondary outcomes between baseline and 6-month follow-up were assessed by using  $\chi^2$  tests for categorical variables. Youth participation measures are presented as mean  $\pm$  SD, with higher mean scores (maximum of 4) indicating more highly engaged program participation.

Mixed-effect logistic regression models (SAS procedure glimmix) with logit as the link function was applied, while controlling for age, gender, education, employment, income, ethnicity and ever had sex. An interaction term between intervention and time was included in the model to compare study outcomes between baseline and follow-up. The generalized linear mixed model uses random effects to account for the correlated repeated measures at the baseline and follow-up. *p* Values were two-tailed and considered statistically significant at  $<0.05$ . Missing data for any reason, including refusal to answer question or noncompletion of follow-up assessment, were treated as non-event occurrence (i.e., zero). All analyses were performed by using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

#### Ethical consideration

Ethical approvals for the study were granted by the Saint Louis University and the NIMR Institutional Review Boards.

#### Results

Of the 950 individuals assessed for eligibility, 407 were deemed eligible, of whom 388 were enrolled and completed baseline assessments (Fig. 2). Intervention 5 withdrew from the study at 2 months and did not complete the study. However, the enrolled participants ( $n=11$ ) were followed throughout the duration of the study. The baseline participants' characteristics are shown in Table 2. The mean age of participants was 21.1 years ( $SD=2.3$ ). The majority of the

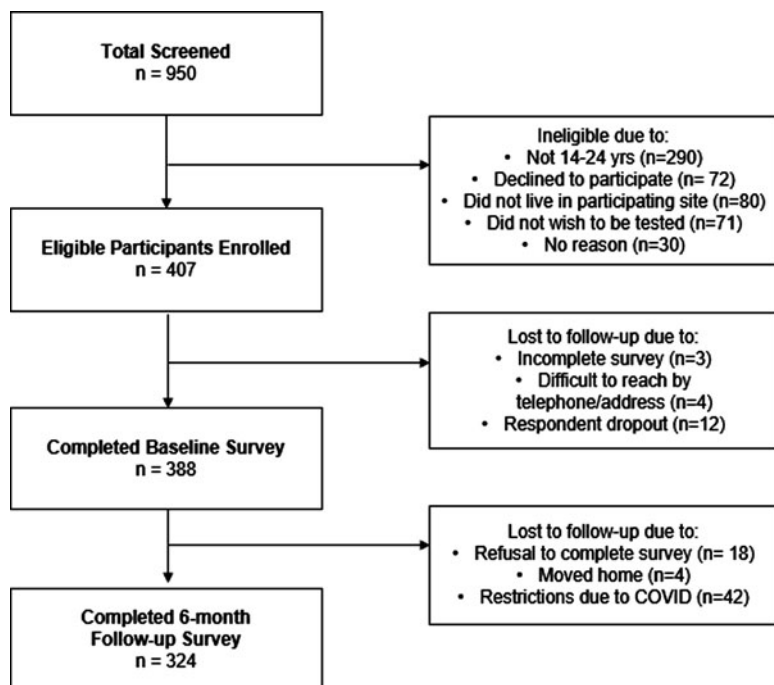
study participants were male (58.0%), had completed secondary education (54.1%), were students (62.1%), and had never been married (98.2%).

About three-quarter (75.0%) earned an average monthly income of less than ₦50,000 as compared with the national average monthly income of ₦43,200 (USD 111) in 2020.<sup>33</sup> At baseline, 168 (43.3%) youth had ever had any form of sexual intercourse (oral, anal, or vaginal), and 59 (15.2%) reported consistent condom use during sexual intercourse in the past 3 months before the study. At baseline, the overall proportion of first-time testers (with no previous testing history) was 84.0% ( $n=326$ ).

Retention was high, with 83.5% (324/388) of enrolled participants completing the final study assessment at 6 months. Primary reasons for non-retention included restrictions due to COVID-19, being non-locatable and relocating as the majority of our study participants were students.

Statistically significant positive increases were observed for HIVST as well as STI testing (Fig. 3). The uptake of HIVST increased from 19.9% ( $n=76$ ) at 3-month to 89.5% ( $n=289$ ) at the 6-month follow-up ( $p<0.01$ ). Comparing STI testing from baseline to the 6-month follow-up, gonorrhea testing increased from 4.7% to 43.1% ( $p<0.01$ ), syphilis testing increased from 4.7% to 47.9% ( $p<0.01$ ), Hepatitis B testing increased from 14.0% to 55.4% ( $p<0.01$ ), and chlamydia testing increased from 1.3% to 45.4% ( $p<0.01$ ) (see Supplementary Table S2 for comparisons by intervention group).

There was no statistically significant difference in the past 3-month self-reported condomless sex between 3- and 6-month follow-up (33.2% vs. 31.2%,  $p=0.88$ , analyses not shown). After adjusting for age, gender, education, employment, income, ethnicity, and ever had sex, the odds of testing for HIV at 6 months was 35 times higher (adjusted odds ratio 35.5, 95% confidence interval: 21.5–58.6) compared with 3 months. Findings were similar for all STI testing at 6 months compared with baseline (Table 3).



**FIG. 2.** Flow diagram of participant recruitment process and follow-up for the I-TEST/4YBY study. 4YBY, 4 Youth by Youth; I-TEST, Innovative Tools to Expand Youth-friendly HIV Self-Testing.

TABLE 2. BASELINE SOCIODEMOGRAPHIC CHARACTERISTICS, SEXUAL BEHAVIORAL FACTORS, HIV, AND SEXUALLY TRANSMITTED INFECTION TESTING BEHAVIORS AMONG 388 YOUTH ENROLLED IN THE INNOVATIVE TOOLS TO EXPAND YOUTH-FRIENDLY HIV SELF-TESTING STUDY, 2019–2020

<i>Measures</i>	<i>Overall (N=388)</i>
<b>Sociodemographic factors</b>	
Age, mean (SD; range), years	21.1 (2.3; 14–24)
Age, years	
14–19	98 (25.3)
20–24	290 (74.7)
Sex	
Female	163 (42.0)
Male	225 (58.0)
Highest level of education	
Primary or less	5 (1.3)
Secondary	210 (54.1)
Tertiary	164 (42.3)
Ethnicity	
Yoruba	187 (48.2)
Igbo	130 (33.5)
Other	66 (17.0)
Employment status	
Unemployed	13 (3.4)
Employed	122 (31.4)
Student	241 (62.1)
Monthly income (Naira)	
Less than or equal 50,000	291 (75.0)
51,000–100,000	26 (6.7)
Over 100,000	14 (3.6)
Marital status	
Never married	381 (98.2)
Ever married	7 (1.8)
<b>Sexual behavior factors</b>	
No. of sex partners, past 3 months, mean (SD; range)	2.1 (3.4; 0–34)
Ever had sex	
Yes	168 (43.3)
No	218 (56.2)
Age of sexual debut, mean (SD; range), years	17.8 (3.3; 0–24)
Previous HIV testing	
Yes	76 (19.6)
No	306 (78.9)
Previous Syphilis testing	
Yes	18 (4.6)
No	362 (93.3)
Previous Gonorrhoea testing	
Yes	18 (4.6)
No	363 (93.6)
Previous Chlamydia testing	
Yes	5 (1.3)
No	372 (95.9)
Previous Hepatitis B testing	
Yes	53 (13.7)
No	326 (84.0)
Condomless sex	
All sexual acts	59 (15.2)
Some sexual acts	82 (21.1)
No sexual act	70 (18.0)

SD, standard deviation.

Table 4 summarizes the mean ratings for quality of youth participation. The mean participation rating was 3.1 (SD = 0.6), which represented strong agreement that the interventions promoted youth ownership, voice/influence, support, and engagement in HIVST services (see Supplementary Table S3 for full scale ratings).

**Discussion**

Findings from our pilot study provide promising evidence of efficacy that youth-led, crowdsourced strategies led to higher uptake of HIV and STI testing. Our study extends the existing literature by applying crowdsourcing to implement youth-developed strategies to promote HIV/STI test uptake, as well as apprenticeship training to build capacity and provide mentorship necessary to implement and evaluate their strategies among other young people in real-world settings. Most HIV testing programs for youth have been adapted from adult testing assumptions, and many suffer from limited youth engagement.<sup>1</sup>

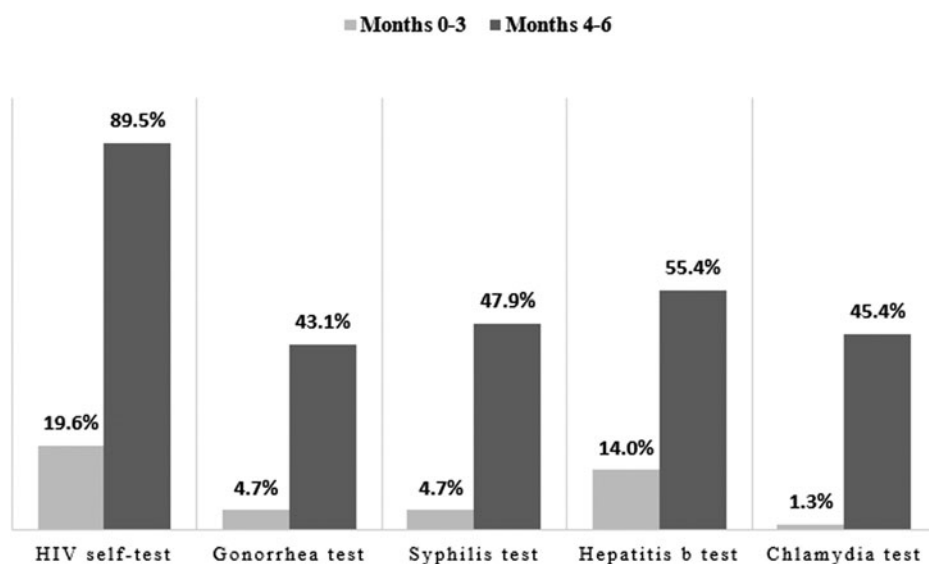
Our pilot trial addresses this important gap by providing much-needed evidence and mechanisms that foster meaningful youth engagement in HIV prevention research among high-risk population in sub-Saharan African settings. Although Nigeria is already close to reaching the 90% target of HIV diagnosis in adults, it is unlikely to achieve the 95% target among youth (10–24 years) by 2030 in the absence of youth-friendly HIV prevention service strategies such as youth-led, community-based HIVST service delivery.

Preliminary efficacy data suggest that the interventions were associated with a substantial increase in HIVST uptake and retesting at the 6-month follow-up. Specifically, data from the 6-month follow-up visit show high readiness to retest, as well as a reduced number of first-time testers. The proportions of HIVST uptake are also similar to that reported in previous community-based HIVST studies conducted in South African and Malawi, where rates among youth were reported to be 90–100%.<sup>34,35</sup> The retesting rate in the South African study was comparable to our study, with most participants (96%) reporting to have repeated HIVST at 9 months.<sup>35</sup>

Our results, together with previous research studies, suggest that youth-led HIVST interventions are feasible and could be an effective strategy to generate demand for HIV testing services among youth population. In addition, the ability of the youth-led HIVST distribution strategy to reach first-time testers or infrequent testers suggests the potential for increasing testing coverage among those that conventional, facility-based testing services do not reach.

Our study findings demonstrate that the youth-led, HIV prevention services significantly increased uptake of STI testing at 6 months. However, previous research reported mixed evidence on improving access to and uptake of STI testing with HIVST,<sup>36</sup> with two studies reporting no effect between intervention and control groups<sup>37,38</sup> and one study reporting significant reductions in STI testing.<sup>39</sup> The increase in uptake of STI testing in our study may be attributable to the availability of information, education, and communication materials for the participants and the relative integration of STI testing as part of the HIVST services.

In low- and middle-income countries (LMICs), utilization of facility-based testing services among youth is suboptimal and youth often face sociocultural and structural barriers to



**FIG. 3.** Increase in HIV and STI testing. STI, sexually transmitted infection.

accessing services, including lack of convenience, stigma, cost of services, and poor health literacy.<sup>40</sup> Although young people in this setting are regularly exposed to information on HIV through school curriculum programs or other community outreach events, much less attention has been paid to STIs. Moreover, studies conducted in Nigeria among young people suggest moderate to low levels of knowledge about STI prevention, symptoms, and transmission.<sup>41,42</sup>

These findings suggest an opportunity to leverage the wide availability of HIV services by integrating STI preventive services and more generally sexual and reproductive health services designed for youth by youth themselves.

Our results point to the significant potential benefits of youth having substantial decision-making power while engaging them extensively in intervention development, planning, and implementation. The strength of HIVST is heightened by using novel youth participatory approaches whereby the youth themselves developed HIVST interventions through crowdsourcing open calls and were further trained in a 4-week innovation bootcamp to implement and evaluate the intervention in real-world settings. Our approaches demonstrate that by simultaneously engaging youth while addressing their unique care-seeking needs, it is possible to substantially spur uptake of HIV/STI testing, even in a resource-constrained setting.

**TABLE 3.** CHANGE IN UPTAKE OF HIV AND SEXUALLY TRANSMITTED INFECTION TESTING SERVICES AMONG PARTICIPANTS DURING 6-MONTH FOLLOW-UP

Measures	Unadjusted OR (95% CI)	Adjusted OR <sup>a</sup> (95% CI)
HIV test	34.2 (22.1–53.0)	35.5 (21.5–58.6)
Syphilis test	19.1 (11.2–32.3)	20.0 (10.9–36.9)
Gonorrhea test	15.4 (9.1–26.0)	15.7 (8.6–28.4)
Hepatitis B test	8.2 (5.6–12.0)	8.3 (5.4–12.8)
Chlamydia test	61.9 (24.8–154.4)	65.9 (23.5–185.0)

There were 311 participants with at least 1 measurement in unadjusted (bivariable) analyses.

<sup>a</sup>Adjusted for age, gender, education, employment, income, ethnicity, and ever had sex.

CI, confidence interval; OR, odds ratio.

Combining HIV and STI testing with effective follow-up strategies is important to ensure that individuals remain HIV-uninfected or facilitate linkage to appropriate services following a positive diagnosis.<sup>43,44</sup> Across the intervention groups, individual-level follow-up (i.e., referral coupons) and digital tools (i.e., USSD, WhatsApp, and other social media platforms) were leveraged to collect HIVST usage and provide linkage information to study participants.

These strategies are timely in the light of increased recognition on the importance of developing pragmatic approaches to monitor HIVST usage and linkage as countries consider scale-up and adoption of HIVST policies.<sup>45</sup> In future iterations of the intervention, we plan to utilize mobile applications to confirm test uptake across larger geographical regions, as well as incorporate other mhealth platforms, such as the USSD, for individuals who may have limited access to internet connectivity.

Our study has several limitations. First, the study was designed as a pilot and did not have a control group. This limits the inferences that can be made about the study findings. However, the similarity of the interventions and outcomes allowed us to pool results. Second, the use of self-report measures to assess some outcomes may have introduced recall and social desirability bias. At the same time, our primary outcome was assessed by administrative records. Third, COVID-19 complicated the timing of the 6-month

**TABLE 4.** RATINGS FOR YOUTH PARTICIPATION SUB-SCALES

Youth participation subscales	No. of items	Cronbach's alpha	Mean	SD
Youth ownership	6	0.85	3.2	0.6
Voice/Influence	3	0.81	2.9	0.8
Support	1	—	3.2	0.9
Engagement	2	0.81	3.1	0.8
Total	12	0.85	3.1	0.6

All Likert responses ranged from 0 to 4, with higher scores indicating strong agreement (0, Strongly disagree; 1, Disagree; 2, Neither agree nor disagree; 3, Agree; 4, Strongly agree).

SD, standard deviation.

follow-up, making the exact timing of the final follow-up not uniform across all youth. Finally, given that the aim of the pilot study was to provide evidence of preliminary efficacy, the sample size was relatively small, which limits any conclusions being made regarding the generalizability of findings.

Our data have implications for research and programs. In terms of research, this demonstrates that youth-led research pilots are feasible in the Nigerian context. Youth can have a key role in all stages of developing and implementing research studies. In addition, our pilot data suggest that larger trials are warranted to understand how this intervention can be implemented on a larger scale. In terms of programs, our data show how participatory approaches such as crowdsourcing open calls provide a structured mechanism for community engagement.

These activities provided a way to harness youth voices, building local ownership of the project. Nonetheless, participatory-based approaches, which promote shared decision-making between youth and researchers on intervention development and implementation. Findings from our pilot study demonstrated sufficient feasibility and preliminary effectiveness to justify progress to a full-scale implementation trial, with some amendments necessary. The lessons learned from the pilot study provide key insights into working with young people as partners and leaders in HIV prevention research in LMICs.

#### Author Disclosure Statement

The authors report no conflicts of interest. The sponsor played no role in the (1) study design; (2) the collection, analysis, and interpretation of data; (3) the writing of the report; and (4) the decision to submit the article for publication. No authors received payment to produce the article.

#### Funding Information

The study is funded by Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Grant number: UG3HD096929. The authors are also funded by the National Institute of Mental Health (R00MH104154, R34MH109359, and R34MH119963) and the National Institute of Allergy and Infectious Diseases (P30AI50410 and K24AI143471).

#### Supplementary Material

Supplementary Table S1  
Supplementary Table S2  
Supplementary Table S3

#### References

- Asuquo SE, Tahlil KM, Muessig KE, et al. Youth engagement in HIV prevention intervention research in sub-Saharan Africa: A scoping review. *J Int AIDS Soc* 2021;24:e25666.
- Kabiru CW, Izugbara CO, Beguy D. The health and well-being of young people in sub-Saharan Africa: An under-researched area? *BMC Int Health Hum Rights* 2013;13:11.
- Khalifa A, Stover J, Mahy M, et al. Demographic change and HIV epidemic projections to 2050 for adolescents and young people aged 15–24. *Glob Health Action* 2019;12:1662685.
- Mokdad AH, Forouzanfar MH, Daoud F, et al. Global burden of diseases, injuries, and risk factors for young people's health during 1990–2013: A systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2016;387:2383–2401.
- Koenig LJ, Hoyer D, Purcell DW, et al. Young people and HIV: A call to action. *Am J Public Health* 2016;106:402–405.
- Rosenberg NE, Obiezu-Umeh CS, Gbaja-Biamila T, et al. Strategies for enhancing uptake of HIV self-testing among Nigerian youths: A descriptive analysis of the 4Youth-ByYouth crowdsourcing contest. *BMJ Innov* 2021;7:590–596.
- Asaolu IO, Gunn JK, Center KE, et al. Predictors of HIV testing among youth in Sub-Saharan Africa: A cross-sectional study. *PLoS One* 2016;11:e0164052.
- Sam-Agudu NA, Folayan MO, Ezeanolue EE. Seeking wider access to HIV testing for adolescents in sub-Saharan Africa. *Pediatr Res* 2016;79:838–845.
- Gruen RL, Elliott JH, Nolan ML, et al. Sustainability science: An integrated approach for health-programme planning. *Lancet* 2008;372:1579–1589.
- Halpaap BM, Tucker JD, Mathanga D, et al. Social innovation in global health: Sparking location action. *Lancet Glob Health* 2020;8:e633–e634.
- Guidelines on HIV Self-Testing and Partner Notification: Supplement to Consolidated Guidelines on HIV Testing Services. HIV Self-Testing. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK401675> (Last accessed July 23 2019).
- World Health Organization (WHO). HIV self-testing strategic framework: A guide for planning, introducing and scaling up. Geneva: World Health Organization, 2018. CC BY-NC-SA 3.0 IGO.
- Hatzold K, Gudukeya S, Mutseta MN, et al. HIV self-testing: Breaking the barriers to uptake of testing among men and adolescents in sub-Saharan Africa, experiences from STAR demonstration projects in Malawi, Zambia and Zimbabwe. *J Int AIDS Soc* 2019;22(Suppl 1):e25244.
- Nigeria National Agency for the Control of AIDS (NACA). Revised National HIV and AIDS Strategic Framework 2019–2021. Abuja: Nigeria National Agency for the Control of AIDS, 2019.
- Ingold H, Mwerinde O, Ross AL, et al. The Self-Testing Africa (STAR) Initiative: Accelerating global access and scale-up of HIV self-testing. *J Int AIDS Soc* 2019;22(Suppl 1):e25249.
- Oliveras C, Cluver L, Bernays S, et al. Nothing about us without RIGHTS-meaningful engagement of children and youth: From research prioritization to clinical trials, implementation science, and policy. *J Acquir Immune Defic Syndr* 2018;78(Suppl 1):S27–S31.
- Tucker JD, Day S, Tang W, et al. Crowdsourcing in medical research: Concepts and applications. *PeerJ* 2019;7:e6762.
- Tucker JD, Tang W, Li H, et al. Crowdsourcing designation: A new model for multisectoral collaboration. *BMJ Innov* 2018;4:46–50.
- WHO/TDR. Crowdsourcing in Health and Health Research: A Practical Guide. Geneva: World Health Organization, 2018. TDR/STRA/18.4.



20. Wang C, Han L, Stein G, et al. Crowdsourcing in health and medical research: A systematic review. *Infect Dis Poverty* 2020;9:8.
21. Tang W, Ritchwood TD, Wu D, et al. Crowdsourcing to improve HIV and sexual health outcomes: A scoping review. *Curr HIV/AIDS Rep* 2019;16:270–278.
22. Krishnaratne S, Bond V, Stangl A, et al. Stigma and judgment toward people living with HIV and key population groups among three cadres of health workers in South Africa and Zambia: Analysis of data from the HPTN 071 (PopART) trial. *AIDS Patient Care STDs* 2020;34:38–50.
23. Kpokiri E, Chen E, Li J, et al. Social innovation research checklist: A crowdsourcing open call and digital hackathon to develop a checklist for research to advance social innovation in health. *medRxiv* 2020:2020.11.03.20225110.
24. Ozer EJ. Youth-led participatory action research: Developmental and equity perspectives. *Adv Child Dev Behav* 2016;50:189–207.
25. WHO/TDR/SESH/SIHI. *Crowdsourcing in Health and Health Research: A Practical Guide*. Geneva: WHO/TDR, 2018.
26. Tucker JD, Tang W, Li H, et al. Crowdsourcing designation: A new model for multisectoral collaboration. *BMJ Innov* 2018;4:46–50.
27. Tahlil KM, Obiezu-Umeh C, Gbajabiamila T, et al. A designation to co-create community-driven HIV self-testing services for Nigerian youth: Findings from a participatory event. *BMC Infect Dis* 2021;21:505.
28. Nwaozuru U, Gbajabiamila T, Obiezu-Umeh C, et al. An innovation bootcamp model to develop HIV self-testing social enterprise among young people in Nigeria: A youth participatory design approach. *Lancet Glob Health* 2020;8:S12.
29. Institute for Healthcare Improvement. *The Breakthrough Series: IHI's collaborative model for achieving breakthrough improvement*. Boston, MA: Institute for Healthcare Improvement, 2003.
30. Tiffany JS, Exner-Cortens D, Eckenrode J. A new measure for assessing youth program participation. *J Commun Psychol* 2012;40:277–291.
31. Begg C, Cho M, Eastwood S, et al. Improving the quality of reporting of randomized controlled trials. The CONSORT statement. *JAMA* 1996;276:637–639.
32. Browne RH. On the use of a pilot sample for sample size determination. *Stat Med* 1995;14:1933–1940.
33. Monthly living wage in Nigeria for individuals and families in 2020. Statista 2020. Available at: <https://www.statista.com/statistics/1119087/monthly-living-wage-in-nigeria/> (Last accessed December 10, 2021).
34. Choko AT, MacPherson P, Webb EL, et al. Uptake, accuracy, safety, and linkage into care over two years of promoting annual self-testing for HIV in Blantyre, Malawi: A community-based prospective study. *PLOS Med* 2015;12:e1001873.
35. Pettifor A, Lippman SA, Kimaru L, et al. HIV self-testing among young women in rural South Africa: A randomized controlled trial comparing clinic-based HIV testing to the choice of either clinic testing or HIV self-testing with secondary distribution to peers and partners. *EClinical-Medicine* 2020;21:100327.
36. Witzel TC, Eshun-Wilson I, Jamil MS, et al. Comparing the effects of HIV self-testing to standard HIV testing for key populations: A systematic review and meta-analysis. *BMC Med* 2020;18:381.
37. Jamil MS, Prestage G, Fairley CK, et al. Effect of availability of HIV self-testing on HIV testing frequency in gay and bisexual men at high risk of infection (FORTH): A waiting-list randomised controlled trial. *Lancet HIV* 2017;4:e241–e250.
38. Wray TB, Chan PA, Simpanen E, et al. A pilot, randomized controlled trial of HIV self-testing and real-time post-test counseling/referral on screening and preventative care among men who have sex with men. *AIDS Patient Care STDs* 2018;32:360–367.
39. Katz DA, Golden MR, Hughes JP, et al. HIV self-testing increases HIV testing frequency in high-risk men who have sex with men: A randomized controlled trial. *J Acquir Immune Defic Syndr* 2018;78:505–512.
40. Tylee A, Haller DM, Graham T, et al. Youth-friendly primary-care services: How are we doing and what more needs to be done? *Lancet* 2007;369:1565–1573.
41. Oluwole EO, Oyekanmi OD, Ogunyemi DO, et al. Knowledge, attitude and preventive practices of sexually transmitted infections among unmarried youths in an urban community in Lagos State, Nigeria. *Afr J Prim Health Care Fam Med* 2020;12:e1–e7.
42. Amu EO, Adegun PT. Awareness and knowledge of sexually transmitted infections among secondary school adolescents in Ado Ekiti, South Western Nigeria. *J Sex Transm Dis* 2015;2015:260126.
43. McNairy ML, El-Sadr WM. A paradigm shift: Focus on the HIV prevention continuum. *Clin Infect Dis* 2014;59(Suppl 1):S12–S15.
44. Horn T, Sherwood J, Remien RH, et al. Towards an integrated primary and secondary HIV prevention continuum for the United States: A cyclical process model. *J Int AIDS Soc* 2016;19:21263.
45. Choko AT, Jamil MS, MacPherson P, et al. Measuring linkage to HIV treatment services following HIV self-testing in low-income settings. *J Int AIDS Soc* 2020;23:e25548.

Address correspondence to:

*Juliet Iwelunmor, PhD  
Behavioral Science & Health  
College for Public Health & Social Justice  
Saint Louis University  
3545 Lafayette Avenue  
Saint Louis, MO 63104  
USA*

*E-mail: juliet.iwelunmor@slu.edu*