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ORIGINAL PAPER

HiSTEP: A Single-Arm Pilot Study of a Technology-Assisted HIV Self-testing Intervention in Kampala, Uganda

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Abstract

We developed and pilot tested a 3-month HIV self-testing intervention called *HiSTEP* ("HIV Self-testing Engagement Project") among 95 adult (18+ years) at-risk (condomless sex < 3 months) adults in Kampala, Uganda. *HiSTEP* leverages theoretically-grounded (in the Information-Motivation-Behavioral Skills model) text messages, a telehealth centre with live support, and "last-mile" HIV self-testing kit delivery to a location chosen by the participant. Nearly 94% of participants were retained at month 3. HIV self-testing was highly acceptable across age and gender groups (94% very satisfied), although older women had slightly lower acceptability ratings (92% very satisfied). Only 13% of participants used HIV self-testing prior to enrollment. Over the 3-month study period, 86% of participants ordered a total of 169 HIV self-testing kits (69% for participant use; 31% for use by others). Findings show that the intervention approach taken in *HiSTEP* may be particularly valuable for engaging at-risk Ugandan adults in HIV self-testing using a novel technology-assisted promotion and delivery method.

Keywords HIV/AIDS · Technology · HIV self-testing · Uganda

Introduction

It is estimated that 1.4 million Ugandan adults 15–49 years of age were living with HIV as of 2018, constituting 5.7% of the total population (approximately 42 million) of Uganda [1]. Ugandan adolescents and young adults continue to be disproportionately affected by HIV, with an estimated 22,000 annual new HIV infections among these groups [1]. Altogether, 18,000 deaths were attributed to HIV in this same year, suggesting continued efforts are needed to stem the tide of new HIV infections.

HIV testing is critical to achieving the HIV treatment targets by 2030, which include 95% of people living with HIV knowing their HIV status, 95% of people who know their status receiving treatment and 95% of people on HIV treatment having a suppressed viral load [2]. Access to HIV testing services is the first step in the HIV prevention and treatment continuum, as the other steps rely on knowing one's HIV status [3]. Just over 6 million adults in Uganda were tested for HIV in 2018 [4], accounting for approximately 15.5% of the total population. However, over one-fifth (16%) of people living with HIV in Uganda are not aware of their HIV-positive status [4], which may be driving a disproportionate amount of vertical (i.e., mother-to-child) and horizontal (i.e., sexual transmission between partners) transmission. Timely identification and subsequent linkage to appropriate HIV care services is critical to reduce new infections.

A number of studies demonstrate the potential for in-person behavioral HIV testing interventions [5–7]; however, these interventions are limited by their need for intensive staffing, their inability to reach beyond in-person clinic populations, and the unwillingness of at-risk persons (i.e., those engaging in condomless vaginal or anal sex) who may experience high levels of stigma [8, 9] to test for HIV in these settings. HIV self-testing is a potential alternative to address these shortcomings of traditional HIV testing options. In September 2018, the Ugandan Ministry of Health officially

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included HIV self-testing as part of the guidelines for the prevention and treatment of HIV/AIDS [10], and 1 year later launched a program to make HIV self-testing kits freely available at public clinics and hospitals, and for sale at private pharmacies. A scoping review of 11 studies published between August 2015 and January 2017 of the acceptability of HIV self-testing interventions in Sub-Saharan Africa showed wide variability in acceptability (22–94%), although most (4/5) studies of male and female end users showed that greater than two-thirds of participants found HIV self-testing acceptable [8]. In the same review, lower acceptability ratings were shown among women than men [8]. Since the time of the review, a number of studies showed the promise for HIV self-testing interventions to increase testing in Uganda among peers of men who have sex with men [11], partners of pregnant women [12], and female sex workers [13].

While most studies described above noted participants' general acceptance of HIV self-testing kits and satisfaction with the privacy the kits provided, there remains significant barriers to the successful implementation of HIV self-testing. These include concerns about distributing HIV self-testing kits at health facilities, worries of overburdening health workers, and concerns of judgmental healthcare workers [14]. In addition, a three-country study in Africa where 150 lay-users were video recorded conducting HIV self-testing showed that participants found instructions difficult and confusing, with most (75%) failing to perform all steps correctly, and many had difficulty interpreting the results [15]. There is a growing use of technology to overcome these privacy and stigma concerns, as well as provide logistical support and assistance with interpreting the results. In a recent systematic review of 18 technology-assisted HIV testing interventions [16], four were completed in Sub-Saharan Africa and involved the use of HIV self-testing kits; these included the use of text messaging to promote HIV self-testing [17–19], and an HIV self-testing mobile app [20]. The importance of technology in promoting and supporting HIV self-testing is expected to grow given that Uganda has approximately 25.6 million mobile subscribers, and an overall tele-density (i.e., the penetration of mobile phones) of 64% [21]. The high degree of mobile phone ownership provides unique opportunities to leverage mobile health technology for remote HIV counseling and testing, real time HIV self-testing kit support, coordination of referral and linkage to treatment, and ongoing preventive messaging.

Given the need for effective and scalable technology-based HIV self-testing interventions, we developed the "HIV Self-testing Engagement Project" (or *HiSTEP*) intervention that leverages theoretically-grounded messaging, a telehealth centre with live support, and "last-mile" HIV self-testing kit delivery to a location chosen by the participant. We report the results of a single-arm pilot trial of the *HiSTEP* intervention among at-risk Ugandan adults, with primary aims of assessing the feasibility and acceptability of this approach and, secondarily, to examine preliminary impact of the intervention on HIV self-testing uptake. The intervention is unique in that it combines options for participants to use multiple communications channels (e.g., SMS, Facebook Messenger) to seek telehealth support from medical providers, and have HIV self-testing kits delivered directly to them to circumvent traditional barriers to HIV testing.

Methods

The *HiSTEP* Intervention

HiSTEP intervention components are shown in the Supplementary Figure. The intervention has three primary components: (1) theoretically-grounded (see description below) messages delivered through a channel of the participants choice (e.g., SMS, Facebook messenger, Twitter direct messaging) that begins upon study enrollment; (2) access to an existing 24/7 telehealth centre staffed by medical professionals who provide real-time support for HIV self-testing kit ordering, instructions for use, results interpretation, and referrals; and (3) free HIV self-testing kits that can be ordered through the telehelath centre via a private communication channel (e.g., telephone call, SMS, Facebook Messenger) and delivered to a location of the participant's choice (e.g., home, office, or school). The telehealth centre is operated by The Medical Concierge Group (TMCG), which is a digital health and telemedicine company located in Kampala, Uganda that uses both traditional (i.e., mobile phone calls) and alternative (e.g., SMS; Facebook Messenger) communication channels to communicate with patients and research participants.

HiSTEP is grounded in the Information-Motivation-Behavioral Skills Model [22–25]. The IMB model proposes that health behavior change is the product of accurate information, personal and social motivation to engage in the behavior, and developing appropriate behavioral skills and self-efficacy to use them. A library of 36 IMB-related HIV self-testing messages were developed—with roughly equal numbers of informational, motivational, and behavioral skills messages—and iteratively refined by the study team. The messages were delivered over the 3-month intervention period to participants (who were given the option of having messages sent via SMS, Facebook Messanger, or Twitter direct message) in either English or Luganda, which are both official languages in Uganda and the most commonly used languages in Kampala. Example IMB-related messages that were developed as part of the single-arm trial of *HiSTEP* are shown in the Supplementary Table.

Participants and Study Location

Participants who met the following self-reported inclusion criteria were enrolled: (a) ≥ 18 years old; (b) HIV-negative or unknown HIV status; (c) reported condomless sex in the past 3 months; (d) owned or had access to a mobile phone (i.e., basic feature phone or an Android, Windows OS, or iOS mobile phone; (e) resided or worked in or near Kampala; and (f) had not used the TMCG telehealth services prior to enrollment. We set a goal to enroll roughly equal numbers of younger women (18–29 years of age), younger men (18–29 years of age), older women (30 or more years of age), and older men (30 or more years of age) into *HiSTEP* to better understand how the intervention would be perceived across a spectrum of genders and ages. Thirty was chosen as the age cut-off to differentiate between younger and older participants since persons younger than 30 years of age are less likely to be in a primary relationship, which could impact their experiences with HIV self-testing. Additionally, the age cut-off was reasonable given that three-quarters of the Ugandan population are below the age of 30. While TMCG has a large database of patients who currently use their healthcare services, we did not use this database as a recruitment source since these patients may have already had high familiarity with telehealth services. Recruitment was conducted at community and university activities, taxi stands, churches, gambling centers, and sports events in Kampala, Uganda. Kampala is the capital and largest city of Uganda and has a rapidly growing population, estimated at 6,709,900 people in 2019 by the Uganda Bureau of Statistics [26]. TMCG is headquartered in Kampala, and have a logistics network to optimize "last mile" delivery of medications and other health-related goods, such as HIV self-testing kits, to patients in the Kampala district.

Study Procedures

HiSTEP is a single-arm pilot trial, with all enrolled participants undergoing the same study procedures. We considered conducting a two-arm pilot randomized controlled trial, however ultimately decided not to do so because HIV self-testing was not widely known or used in Uganda at the beginning of the study. Study data were collected and managed using REDCap electronic data capture tools [27, 28]. HIV self-testing kits were procured prior beginning enrollment at a cost of UGX 15,000 (approximately US $4.5 at the time of procurement). Participants were recruited in-person within communities to meet them in their "comfort zone" and to increase confidence in the study and study team through in-person engagement prior to the remote procedures following initial contact. During community recruitment, a temporary station was set up from which the study team approached potential participants to ask for their interest in screening for study eligibility. Flyers providing basic information about the study were also distributed in the vicinity to direct those interested in the study to seek further information from the temporary study station. Persons were given a brief description of the study and answered screening questions by themselves on a tablet computer or were assisted by study staff to answer the items. Potential participants were given the option to respond to screening items in either English or Luganda. After answering screening questions, a research assistant informed the person whether s/he was eligible or ineligible. If eligible, the potential participant completed the consent process, including information about the limitations of the oral HIV self-testing kits, and were administered a brief baseline questionnaire.

Following the baseline survey, participants were shown a brief demonstration for how to use the HIV self-testing kit, informed of an existing instructional video for proper kit use in case the accompanying infographics enclosed with the kit were unclear, and encouraged to contact the TMCG telehealth centre for further guidance on kit use. Next, participants were asked whether they would like the messages to be received in English or Luganda and by which communication channel (SMS; Facebook Messenger; or Twitter direct message). A test message was sent at that time to the participant to ensure that they were able to receive automated messages. Once receipt of the message was verified, participants were considered fully enrolled in the study.

Once enrolled, participants began receiving the IMB-related messages (most of which contained the telephone number for how to reach the TMCG telehealth centre) for the duration of the study (3 months). Up to four free HIV self-testing kits (placed in a plain paper bag to disguise the contents) could be ordered by *HiSTEP* participants and delivered to them by a staff member using a motorcycle to a location of the participant's choice. We recorded how many kits were ordered for the participants personal use and for use by other persons (e.g., spouses, sexual partners, family members). At the time of delivery, delivery staff reminded the participant to call or message the TMCG telehealth centre if they needed assistance and to also report the results of the test once completed. The same information was also shared via SMS to all participants who ordered for HIV self-testing kits. The delivery personnel confirmed with TMCG that the HIV self-testing kit was delivered.

We collected data during the follow-up period in several ways. First, participants who ordered an HIV self-testing kit but had not reported the result of that HIV self-testing within 2 weeks of ordering were contacted by study staff by telephone. This allowed us to capture data about HIV testing throughout the study period and identify early any problems with re-contacting participants (e.g. loss of phone, change of number). Second, follow-up telephone-based assessments occurred at 1- and 3-months after enrollment, during which

participants were called and asked to complete a more thorough assessment of HIV testing behaviors, sexual activity, and intervention acceptability. Participants were offered UGX 20,000 (approximately US $6) for completing each survey assessment through a remittance to their mobile money wallets.

Measures

The following measures were collected during the study period.

HiSTEP Feasibity

To assess feasibility, we examined the number of participants recruited and the percentage retained at each assessment time point.

HiSTEP Acceptability

At months 1 and 3, we asked four 5-point Likert scale items, that included asking participants to rate: (1) the ease of completing HIV self-testing; (2) the clarity of instructions for HIV self-testing; (3) their satisfaction with HIV self-testing; and (4) whether they would recommend HIV self-testing to a friend or family member. Month 3 acceptability measures are reported here.

Sociodemographics

Participant were asked to self-report age, education, occupation, marital status, and religion.

Sexual Behavior

Participants answered questions about the number of sexual partners they had in the preceding 3 months, whether they currently had a main partner, and whether they engaged in condomless sex with main and casual partners in the past 3 months.

Prior Experience with HIV Testing, HIV Self-testing Kit Use, and HIV Knowledge

Participants were asked to report whether they had ever been tested for HIV and if they had a typical testing pattern (e.g., every 3 months vs testing only when they feel at risk). They also reported when they were last tested for HIV and how likely they were to test for HIV in the next 3 months. Next, participants were asked if they ever heard of HIV self-testing and, if so, if they had ever used an HIV self-testing kit. All participants were asked how likely they were to use HIV self-testing on a 5-point Likert scale (from Very Unlikely to Extremely Likely). HIV Knowledge was assessed using the 18 item HIV Knowledge Questionnaire (HIV-KQ-18) [29]. Lastly, participants individual perception of HIV risk was assessed, with one item.

HIV Self-testing Kits Ordered and Delivered and HIV Self-testing Kit Results

TMCG telehealth centre staff kept records of the number of, and date that, HIV self-testing kits were ordered, and whether the kits were ordered for the study participant or for others (e.g., family or friends). While TMCG staff logged how many HIV self-testing kits participants ordered, we capped the number of HIV self-testing kits that could be delivered to four given the limited number of kits that were available for the study. The number of HIV self-testing kits that were delivered was also recorded. Upon ordering, participants were asked to call or message study staff to report the results of the HIV self-testing kit test that they had taken (information on the results of HIV self-testing kits used by non-primary study participants was not collected). If a participant who ordered an HIV self-testing kit for themselves did not proactively contact the TMCG telehealth centre to report the result of that test, TMCG telehealth centre staff made up to three telephone attempts within 2 weeks after the order to obtain the result from participant's own use of the kit.

Analysis

Means, proportions and standard deviations were used to describe demographic, social and clinical variables of the study population. We conducted descriptive analysis using chi square, Fisher's exact and ANOVA to test for differences between age and gender groups for categorical and continuous variables. Total number of HIV self-testing kits ordered for by participants for themselves and for others were calculated as well as total kits actually delivered to study participants. Differences in acceptability at Month-3 by age and gender groups were assessed using Fisher's exact test.

Results

A total of 100 participants were recruited between April and July, 2019, with complete data collected on 99 of them. Four additional participants were excluded after data collection after a review of data showed that they failed to meet all inclusion criteria. Among the remaining 95 participants, we enrolled 32 younger (18–29 years of age) women, 24 younger (18–29 years of age) men, 16 older (30 or more years of age) women, and 23 older (30 or more years of age) men (Fig. 1). All study participants chose SMS as their

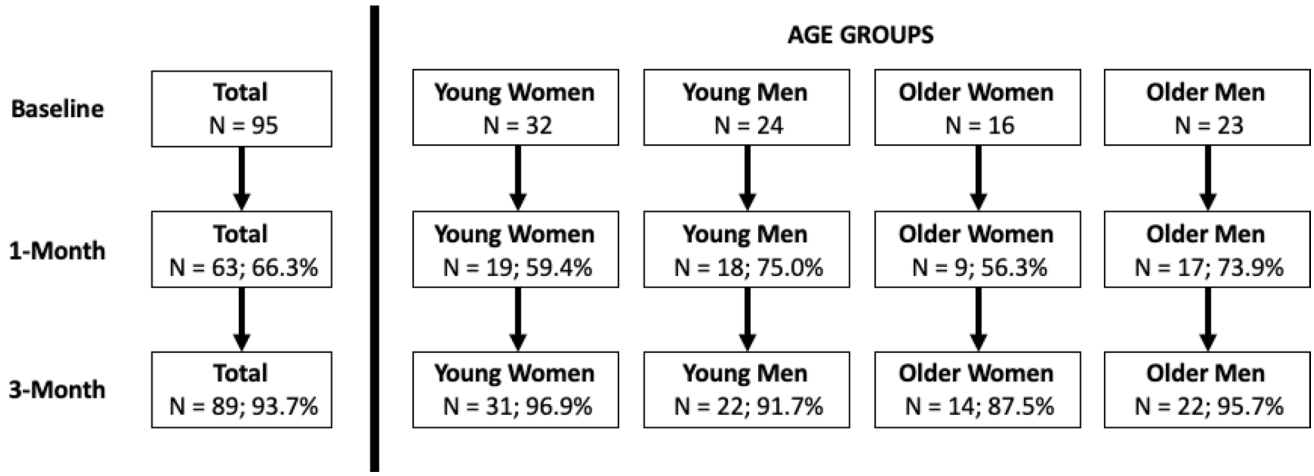

Fig. 1 Study retention by assessment timepoint and gender and age group

message preference when given the choice of SMS, Facebook Messenger, or Twitter direct message. Although the average study retention was 66% at the 1-month assessment timepoint, it was high (94%) at the final 3-month assessment in which young women demonstrated the highest retention (97%) and older women the lowest retention (88%; Fig. 1).

Socio-demographics are shown in Table 1. Participants were on average 26 years of age (standard deviation (SD) of 6.2 years) and majority were single (70%). Just over half of participants were students (50.5%) and three-quarters had a University or other higher education degree (74.7%). Only one older woman was a student, and a smaller percentage of older men (34.8%) and women (56.3%) reported a university degree or other higher education degree compared to younger participants (women: 100%; men: 91.7%). A diversity of religious practices were reflected in the sample.

Baseline Sexual Behavior, HIV Testing, and HIV Self-testing Knowledge and Use

Baseline sexual behavior in the past 3 months, experience with HIV testing, HIV self-testing kit awareness and use, and HIV knowledge among the 95 participants is presented in Table 1. The majority (84%) of participants had 1 sexual partner in the preceding 3 months, with another 15% reporting 2–3 sexual partners in the same period of time. A higher percentage (39%) of older men reported having 2–3 sex partners in the past 3 months than other gender and age groups. Two-thirds of participants had a main sex partner, with a higher percentage of older participants reporting a main partner. Among participants who reported a main partner, condomless sex with a main partner was reported by everyone in all groups with the exception of young males. Two thirds of all participants reported condomless sex with a casual partner, with rates of condomless sex higher among older men (100%) and women (75%) than younger men (58%) and women (47%).

Almost all (94%) participants, including all older participants, had been tested for HIV in their lifetime (Table 1). Over one-third (37%) of participants said that they get tested for HIV about every 3–4 months, with a higher percentage of older men (57%) reporting so compared to other gender and age groups. Approximately one-quarter (26%) of participants reported getting tested for HIV when they feel they are at risk, although this was less common among younger women (14%). Sixty-three percent of participants reported being tested for HIV in the past 6 months, with the highest percentage among young men (77%). One-fifth of the sample (22%) reported being tested for HIV more than 1 year ago, which was disproportionally higher among older women (31%). Only thirty percent of participants had heard of HIV self-testing at baseline, with the highest percentage among older men (48%). In total, only 12 of 95 (13%) participants had ever used HIV self-testing at baseline.

Follow-Up HIV Self-testing Kit Ordering, Use, and Results

Over the 3-month period, 86% of participants ordered a total of 169 HIV self-testing kits (Table 2); most HIV self-testing kits (n = 141; 83%) were ordered in the 1st month after enrollment. A total of 116 kits (69%) were ordered for use by the participant and 53 kits (31%) were ordered for other people such as family members, partners, and friends. Although over 80% of participants in each of the gender and age groups ordered kits, the highest proportion of participants who ordered kits for themselves was among young men (92%), while the lowest proportion was among older men (83%). Of the 82 participants who ordered kits for their personal use, 32 (39%) reported at baseline that

Table 1 Baseline participant demographics, sexual behavior, and HIV testing patterns, *HiSTEP* study, 2019

Variable	Overall (n = 95)	Young women n = 32 (34%)	Young men n = 24 (25%)	Older women n = 16 (17%)	Older men n = 23 (24%)	p value
Demographics						
Age in years, mean (sd)	25.9 (6.2)	21.1 (1.5)	22.8 (1.3)	30.3 (5.0)	32.8 (5.8)	< 0.001
Marital status, n (%)						< 0.001
Single	65 (68.4)	29 (90.6)	23 (95.8)	6 (37.5)	7 (30.4)	
Married	29 (30.5)	3 (9.4)	1 (4.2)	10 (62.5)	15 (65.2)	
Other	1 (1.1)	0 (0)	0 (0)	0 (0)	1 (4.4)	
Current occupation, n (%)						< 0.001
Farming	1 (1.1)	0 (0)	0 (0)	0 (0)	1 (4.4)	
Student	48 (50.5)	27 (84.4)	20 (83.3)	1 (6.3)	0 (0)	
Civil servant/gov't worker	6 (6.3)	0 (0)	0 (0)	1 (6.3)	5 (21.7)	
Business	6 (6.3)	0 (0)	1 (4.2)	2 (12.5)	3 (13.0)	
Military	5 (5.3)	0 (0)	0 (0)	2 (12.5)	3 (13.0)	
Private employee	9 (9.5)	2 (6.3)	1 (4.2)	5 (31.3)	1 (4.4)	
Other	20 (21.1)	3 (9.4)	2 (8.3)	5 (31.3)	10 (43.5)	
Education level, n (%)						< 0.001
Primary level	2 (2.1)	0 (0)	0 (0)	1 (6.3)	1 (4.4)	
Secondary level	22 (23.2)	0 (0)	2 (8.3)	6 (37.5)	14 (60.9)	
Tertiary/university or higher	71 (74.7)	32 (100)	22 (91.7)	9 (56.3)	8 (34.8)	
Religion, n (%)						0.69
Protestant	34 (35.8)	14 (43.8)	9 (37.5)	3 (18.8)	8 (34.8)	
Catholic	29 (30.5)	6 (18.8)	8 (33.3)	6 (37.5)	9 (39.1)	
Muslim	10 (10.5)	5 (15.6)	1 (4.2)	2 (12.5)	2 (8.7)	
Born again Christian	19 (20.0)	6 (18.8)	4 (16.7)	5 (31.3)	3 (17.4)	
SDA	2 (2.1)	1 (3.1)	1 (4.2)	0 (0)	0 (0)	
Other	1 (1.1)	0 (0)	1 (4.2)	0 (0)	0 (0)	
Sexual behavior (past 3 months)						
Number of sexual partners, n (%)						0.004
1 partner	80 (84.2)	29 (90.6)	21 (87.5)	16 (100)	14 (60.9)	
2–3 partners	14 (14.7)	3 (9.4)	2 (8.3)	0 (0)	9 (39.1)	
4+ partners	1 (1.1)	0 (0)	1 (4.2)	0 (0)	0 (0)	
Have main partners, n (%)	63 (66.3)	17 (53.1)	12 (50.0)	13 (81.3)	21 (91.3)	0.003
Condomless sex with main partner, n (%)	62 (98.4)	17 (100)	11 (91.7)	13 (100)	21 (100)	0.19
Condomless sex with casual partner, n (%)	64 (67.4)	15 (46.9)	14 (58.3)	12 (75.0)	23 (100)	< 0.001
HIV testing, HIV self-testing, and HIV intentions						
Ever tested for HIV, n (%)	89 (93.7)	28 (87.5)	22 (91.7)	16 (100)	23 (100)	0.24
HIV testing pattern**, n (%)						0.01
Every 3–4 months	33 (37.1)	7 (25.0)	8 (36.4)	5 (31.3)	13 (56.5)	
Every 6 months	3 (3.4)	3 (10.7)	0 (0)	0 (0)	0 (0)	
Once a year	12 (13.5)	6 (21.4)	6 (27.3)	0 (0)	0 (0)	
If I feel I am at risk	23 (25.8)	4 (14.3)	7 (31.8)	5 (31.3)	7 (30.4)	
If I get a testing opportunity	10 (11.2)	4 (14.3)	1 (4.5)	3 (18.8)	2 (8.7)	
No pattern	7 (7.9)	4 (14.3)	0 (0)	2 (12.5)	1 (4.4)	
During pregnancy [women]	1 (1.1)	0 (0)	–	1 (6.3)	–	
Last tested for HIV**, n (%)						0.67
Less than 6 months ago	56 (62.9)	16 (57.1)	17 (77.3)	9 (56.3)	14 (60.9)	
6–12 months ago	13 (14.6)	5 (17.9)	1 (4.5)	2 (12.5)	5 (21.7)	
1–2 years ago	14 (15.7)	6 (21.4)	3 (13.6)	3 (18.8)	2 (8.7)	
More than 2 years ago	6 (6.7)	1 (3.6)	1 (4.5)	2 (12.5)	2 (8.7)	

Table 1 (continued)

Variable	Overall (n = 95)	Young women n = 32 (34%)	Young men n = 24 (25%)	Older women n = 16 (17%)	Older men n = 23 (24%)	p value
Likely to HIV test (next 3 months), n (%)						0.552
Very/somewhat unlikely/undecided	7 (7.4)	4 (12.5)	1 (4.2)	1 (6.3)	1 (4.4)	
Somewhat likely	(11.6)	1 (12.5)	5 (20.8)	1 (6.3)	1 (4.4)	
Extremely likely	77 (81.1)	24 (75.0)	18 (75.0)	14 (87.5)	21 (91.3)	
Heard of self-testing, n (%)	29 (30.5)	3 (9.4)	10 (41.7)	5 (31.3)	11 (47.8)	0.006
Used self-testing***, n (%)	12 (41.4)	1 (33.3)	4 (40.0)	0 (0)	7 (63.6)	0.119
Likely to use HIV self-testing (next 3 months), n (%)						0.149
Very or somewhat unlikely/undecided	2 (2.1)	0 (0)	0 (0)	1 (6.3)	1 (4.4)	
Somewhat likely	9 (9.5)	5 (15.6)	0 (0)	2 (12.5)	2 (8.7)	
Extremely likely	84 (88.4)	27 (84.4)	24 (100)	13 (81.3)	20 (87.0)	
HIV knowledge, mean (sd)	14.6 (2.0)	14.6 (1.9)	15.2 (2.1)	14.1 (2.0)	14.4 (2.0)	0.97
Self-reported risk of HIV, n (%)	38 (40.0)	11 (34.4)	11 (45.8)	5 (31.3)	11 (47.8)	0.63

*Among individuals who indicated a main partner [total: 63; young women: 17; young men: 12; older women: 13; older men: 21]

**Among individuals who reported ever testing for HIV [total: 89; young women: 28; young men: 22; older women: 16; older men: 23]

***Among individuals who reported having heard of self-testing [total: 29; young women: 3; young men: 10; older women: 5; older men: 11]

Table 2 Number of HIV self-testing kits requested in the 3-month *HiSTEP* Study, 2019

Variable	Overall (n = 95)	Young women (n = 32)	Young men (n = 24)	Older women (n = 16)	Older men (n = 23)
Ordered kits for participants, n (%)*	82 (86.3)	27 (84.3)	22 (91.7)	14 (87.5)	19 (82.6)
Avg number of kits ordered for participants[#]	1.4 (0.6)	1.3 (0.5)	1.5 (1.0)	1.2 (0.4)	1.5 (0.5)
Total number of kits ordered for participants	116	36	34	17	29
Ordered kits for others, n (%)**	46 (48.4)	17 (53.1)	10 (41.7)	8 (50.0)	11 (47.8)
Avg number of kits ordered for others[±]	1.2 (0.4)	1.1 (0.3)	1 (0)	1.3 (0.5)	1.3 (0.6)
Total number of kits ordered for others	53	19	10	10	14
Total kits ordered	169	55	44	27	43
Total kits delivered	157	55	40	26	36

*Percent of participants that ordered HIV self-testing kits for themselves

**Percent of participants that ordered HIV self-testing kits for others

[#]Averaged among those who ordered kits for themselves

[±]Averaged among those who ordered kits for other individuals (line above)

they last tested for HIV more than 6 months ago. In contrast, the greatest proportion of ordering HIV self-testing kits for others was among young women (53%), and lowest among young men (42%). Not all of the kits that were ordered were delivered, primarily because we placed a cap (maximum of four) on the number of kits that could be delivered. Of the 169 HIV self-testing kits ordered, 11 were not sent out for delivery due to this cap on HIV self-testing kits, 1 was not delivered because the participant could not be contacted after the order, and 157 were successfully delivered.

Participants who ordered kits for themselves and had them delivered were contacted within 2 weeks of ordering to determine if they had used the HIV self-testing and what the result was (Table 2). Of the 82 participants who had ordered an HIV self-testing kit for themselves, TMCG telehealth centre staff were able to contact 75 of them to confirm their use of the kit. Among those 75 participants, 97% (n = 73) completed at least one HIV self-testing kit over the 3 months of the intervention, including 96% of young women (n = 27 of 28), 95% of young men (n = 19 of 22), and 100% of older women (n = 15) and older men (n = 12). One younger man tested positive for HIV using the HIV self-testing kit and was successfully linked to HIV care by the TMCG telehealth centre staff; all other test results were reported as HIV-negative. Most (88%) participants at the 3-month timepoint assessment stated that they were

somewhat or extremely likely to conduct HIV self-testing in the next 2 months, with 100% of older women, 90% of young women, 82% of young men; and 82% of older men.

Intervention Acceptability

Acceptability of the *HiSTEP* intervention was high among the 70 participants who completed the 3-month survey and reported that they used HIV self-testing during the intervention period (Table 3). Most (74%) participants reported that the HIV self-testing was very easy to complete, 93% that the instructions were very clear, 94% were very satisfied with HIV self-testing, and 99% would recommend it to a friend. A lower percentage of older women found HIV self-testing very easy to complete (58.3%) and reported that the instructions for HIV self-testing were very clear (83.3%) compared to other gender and age groups. Despite that, 92% of older women reported that they were very satisfied with HIV self-testing.

Discussion

We sought to test the feasibility, acceptability, and use of a novel mHealth and call-in centre HIV self-testing intervention in Kampala, Uganda. Overall, the feasibility of *HiSTEP* was demonstrated with a 94% retention rate at the final assessment timepoint among study participants, as well the successful delivery of all but one HIV self-testing kit that went out for delivery. Across all participants, we also showed a high level of acceptability, such that 94% of participants reported being very satisfied with HIV self-testing. Although the single-arm study design precludes a direct comparison of outcomes to a control group, 86% of participants ordered HIV self-testing kits in this study. In sum, these findings show that the intervention approach taken in *HiSTEP* may be particularly valuable for engaging adults at risk for HIV in Uganda and disseminating HIV self-testing kits. Findings and lessons learned related to intervention feasibility, acceptability, and use are discussed in greater detail below.

Although the *HiSTEP* intervention showed good feasibility, several lessons were learned from this pilot trial to improve the overall conduct of the study and to improve the experience of some participants. First, we found relatively low levels of completion of the 1-month follow-up survey compared to the 3-month survey (66% vs. 94%). This difference may be due to the timing of data collection efforts in our study. Most participants ordered HIV self-testing kits within the 1st month of the intervention; study staff called participants who ordered a kit(s) within 2 weeks after the order to ask them about whether those kits were used and what the results were. While we were able to contact 91% of participants who had ordered a kit to determine use and personal results, these brief follow-up calls may have interfered with data collection for the

Table 3 Acceptability of HIV self-testing among participants in the *HiSTEP* Study who completed the 3-month assessment and used the HIV self-testing kit (n = 70), 2019 (month-3)

Variable	Overall (n = 70)	Young women n = 25 (34%)	Young men n = 18 (27%)	Older women n = 12 (15%)	Older men n = 15 (24%)	p value
Easy to complete HIV self-test, n (%)						
Very easy	52 (74.3)	19 (76.0)	14 (77.8)	7 (58.3)	12 (80.0)	
Easy	17 (24.3)	6 (24.0)	4 (22.2)	4 (33.3)	3 (20)	0.61
Difficult	1 (1.4)	0 (0)	0 (0)	1 (8.3)	0 (0)	
Very difficult	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Instructions were clear for HIV self-test, n (%)						
Very clear	65 (92.9)	25 (96.0)	17 (94.4)	10 (83.3)	14 (93.3)	
Somewhat clear	4 (5.7)	1 (4.0)	1 (5.6)	1 (8.3)	1 (6.7)	0.64
Somewhat unclear	1 (1.4)	0 (0)	0 (0)	1 (8.3)	0 (0)	
Very unclear	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Satisfaction with HIV self-test, n (%)						
Very satisfied	66 (94.2)	24 (96.0)	17 (94.4)	11 (91.7)	14 (93.3)	
Moderately satisfied	4 (5.7)	1 (4.0)	1 (5.6)	1 (8.3)	1 (6.7)	1.0
Slightly satisfied	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Not satisfied	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Recommend HIV-self-test, n (%)						
No	1 (1.4)	0 (0)	0 (0)	0 (0)	1 (6.7)	0.39
Yes	69 (98.6)	25 (100)	18 (100)	12 (100)	14 (93.3)	

1-month survey, as participants may have been confused or fatigued by multiple calls to collect information within a short timeframe. Future studies may wish to consider waiting longer after the baseline survey to administer the first formal assessment, while retaining the check-in on participants who ordered HIV self-testing kits in order to collect timely data on HIV self-testing kit use.

The results also showed that many participants ordered more than one HIV self-testing kit for themselves, and also ordered additional kits to be used by someone else. Among participants who ordered at least one HIV self-testing kit for themselves during the study period (n = 82), 34 additional kits were ordered after the original HIV self-testing kit order to be used by participants. Moreover, just under half (48%) of participants ordered 53 kits for others (typically family members, spouse, or sexual partners), with a larger proportion of women doing so than men in this sample. Because of a limit on the number of HIV self-testing kits that the study participants could order (up to four), we were not able to distribute all of the kits requested. A prior HIV self-testing study in South Africa showed that among 127 MSM who were given up to 9 HIV self-testing kits to distribute to their network members, a total of 728 were distributed to sexual partners, friends, and family members [30]. A recent qualitative study in Uganda showed that distribution of HIV self-testing kits among MSM (n = 74) and their peer networks is acceptable, with many men believing it would address the barriers to in-person testing [31]. Taken together, a second lesson for future iterations of *HiSTEP* and similar interventions is that the potential impact of the intervention could be optimized by procuring a large number of HIV self-testing kits for repeat testing by the participant and for distribution of those kits to participants' network members, as well as tracking the use and results of those kits in networks.

The acceptability of *HiSTEP* was assessed by asking participants to rate their experiences with HIV self-testing in this study. A prior review of the acceptability of 11 HIV self-testing studies in Sub-Saharan Africa showed wide variability in acceptability, ranging from 23 to 94%, with men reporting higher acceptability than women [8]. The results of the *HiSTEP* study showed a high level of acceptability of our approach. Overall, nearly all (99%) of participants found HIV self-testing easy/very easy to complete and the instructions clear/very clear, while 94% of participants reported being very satisfied with HIV self-testing. Only one older male would not recommend HIV self-testing to a friend. Overall, these findings are similar to those of an earlier study conducted in Lesotho, in which a high proportion of men and women reported that home-based HIV self-testing kits were very easy to use, they would recommend it to others, and they were overall very satisfied [32]. The high acceptability ratings in the *HiSTEP* study suggest that the approach used here may provide a novel way to engage at-risk Ugandan adults in HIV self-testing.

That said, older women appeared to have somewhat lower acceptability ratings than the other age and gender groups. A lower percentage of older women reported that HIV self-testing was *very easy* to complete (58% vs. 76% of younger women, 80% of older men, and 78% of younger men) and that the instructions were *very clear* (83% vs. 93% of older men, 94% of younger men, 96% of younger women) compared to other groups. None of the older women in this study had used an HIV self-testing kit at the beginning of this study, and these results suggest that older women may need additional supports for navigating HIV self-testing kit use. For example, future iterations of *HiSTEP* could create video-based instructions in local languages that older women with internet access could view to improve their overall understanding and ease with the kits. Despite these challenges, 92% of older women reported that they were *very satisfied* with HIV self-testing at the end of the *HiSTEP* study.

The majority of participants (86%) ordered an HIV self-testing kit during the study, which is notable since 27% of the sample stated that they had never tested for HIV or lasted tested for HIV more than a year ago. Over 80% of men in our sample (83% of older men and 92% of young men) ordered HIV self-testing kits for themselves. It has been difficult to engage men in HIV prevention services in Sub-Saharan Africa [33], and therefore similar services that provide HIV self-testing kits discretely delivered to one's door may be more acceptable than in-person HIV testing options. Indeed, a recent review of HIV testing strategies for men in sub-Saharan Africa noted the high potential of HIV self-testing to increase HIV testing among men because of its ability to be more confidential, require less interaction with staff, and increase autonomy [33]. One younger man tested positive for HIV and was successfully linked to care through the TMCG call-in centre. Most women also ordered kits (84% of young women; 88% of older women) for themselves, with none reporting a positive HIV test result.

Taken together, this suggests that it is feasible to use a centralized system that uses various forms of technology for the promotion, distribution, and monitoring of HIV self-testing kits to reach high-risk adults in Kampala, Uganda. A prior study comparing three modes of providing access to HIV self-testing among female sex workers showed that direct provision (i.e., self-testing within peer education groups) promoted higher rates of repeat HIV testing than providing coupons to test at a later time in a healthcare facility or than the standard of care [13], which highlights the approach in *HiSTEP* of delivering HIV self-testing kits to participants as a way to reduce additional burdens of clinic-based testing. While relatively few, studies conducted in Sub-Saharan Africa that levered technology appear to have relatively poor uptake of self-testing compared to *HiSTEP*.

For example, Kelvin et al. [17] provided male truckers in Tanzania with three text messages spaced a week apart to promoted the availability of HIV self-testing kits; they used this same approach among female sex workers in Kenya [18]. While there were statistically significant differences in favor of the intervention condition in both studies, testing rates were only 1.8% for male truckers and 7.5% of female sex workers. A quasi-experimental study using text messaging to promote HIV testing found that 67% of Kenyan women who received the messages tested for HIV in next 6 months, compared to 51% of women who did tested but did not receive the messages [19], which represents lower uptake of testing than we found in our study. The finding that all participants in *HiSTEP* chose to receive messages using SMS rather than other communication channels (i.e., Twitter direct messages or Facebook Messenger) suggests that SMS delivery should be prioritized in future trials, especially given the very high rate of mobile phone penetration in Uganda and other parts of Sub-Saharan Africa [21, 34]. The approach taken in *HiSTEP* may be expanded to replicated in other areas of Sub-Saharan Africa, including reaching more remote regions by hiring drivers to deliver HIV self-testing kits ordered from a centralized call-in centre, via SMS, or other social media messaging applications.

Limitations

These results should be considered in light of the limitations. First, while we recruited in the community, it was a convenience sample and recruitment occurred face-to-face. Therefore, the results cannot be generalized to a broader population of adult at-risk Ugandans, and in-person recruitment may have discouraged some persons from disclosing sensitive information about themselves to qualify for the study. Future trials may wish to consider a variety of in-person and remote recruitment strategies to optimize reach. Second, some participants were not able to be contacted for all study data collection efforts, primarily because they were unresponsive to our contact efforts. The lack of responsiveness may have been due to loss of interest in the study or possibly a change of mobile phone number. A future study would benefit from collecting multiple forms of contact (e.g., social media contact information) to provide multiple avenues for reaching participants. Third, this was a single-arm trial that did not have a control condition for comparison and, as such, we cannot say affirmatively that the high uptake of HIV self-testing in this sample was the result of the intervention or other factors (e.g., greater promotion of HIV self-testing in Uganda). Future work would benefit from a control condition for comparison. Fourth, this study was conducted in Kampala, Uganda where research staff are located. While we anticipate that it is feasible to use a similar strategy in regions outside Kampala (i.e., a centralized reminder, ordering, and monitoring center with staff in remote areas to deliver HIV self-testing kits) given that TMCG already has country-wide reach and the ubiquity of mobile phones, establishing its feasibility and acceptability in other areas of Uganda (and possibly other areas of Sub-Saharan Africa) is needed. Finally, this was a pilot trial of the *HiSTEP* intervention and, therefore, a larger RCT is needed to determine the efficacy of this approach.

Conclusions

Despite efforts to engage adults at risk for HIV in Sub-Saharan Africa in HIV testing efforts, reaching established HIV testing targets has not been achieved [8]. A systematic review and meta-analysis in 2015 showed that community-based HIV testing and counseling strategies reached a greater number of groups at risk for HIV (e.g., men, young adults, first time testers) than facility-based HIV testing and, specifically, that a higher percentage of young adults (66%) were reached at home with HIV self-testing compared to other (e.g., home-based testing administered by staff and mobile testing, each at approximately 50% of sample being young adults) modalities [35]. The *HiSTEP* intervention reflects this potential for using HIV self-testing to test hard-to-reach populations and may represent a possible novel approach to improve uptake of HIV self-testing in Uganda and possibly other parts of Sub-Saharan Africa. Future studies are needed to both assess the efficacy of *HiSTEP* and to rigorously examine implementation of the intervention for future wider scale-up. A hybrid design approach that emphasizes the focus on efficacy and implementation outcomes may optimize our understanding of each [36]. Although there are a number of important questions to be answered regarding this approach, these results add to growing evidence that supports the use of technology to improve HIV testing [16] and, possibly, reduce rates of HIV.

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Declarations

Conflict of interest All authors declare that they have no conflict of interest.

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