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Contemporary strategies: Advancing healthcare for HIV, STIs, and beyond

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Contemporary strategies: Advancing healthcare for HIV, STIs, and beyond

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Editorial: Contemporary strategies: advancing healthcare for HIV, STIs, and beyond

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Editorial on the Research Topic
Contemporary strategies: advancing healthcare for HIV, STIs, and beyond

A crucial component of universal health coverage, is the promotion of sexual and reproductive health. The various dimensions which contribute to this particular health right being actualised, include disease screening, disease prevention, health management, education, and counselling services (1). As a result, sexual and reproductive health interventions require integrated participation across several levels; from individual to policy levels (2, 3). This collection of articles facilitates reporting of some of the key issues pertaining to HIV, sexually transmitted infections, maternal health, and health systems, with a particular focus on emerging technologies and strategies to expedite the provision of appropriate health solutions.

Whether accessing HIV care and viral suppression can be achieved by offering financial incentives to patients with HIV is elucidated upon by Majam et al. Describing original pilot research that they conducted in Johannesburg, South Africa, the authors explain the extent to which participants used smartphone applications to share their HIV related results, and the usefulness of financial incentivisation as a mechanism for engagement in care (Majam et al.). A similar pilot study, this time exploring the sole use of mHealth in HIV intervention, tested how amenable participants were to responding to short message service reminders and interactive voice response system communication to report their HIV status after self-testing (Gaven et al.). Another strategy that is gaining momentum, is the use of differentiated service delivery to expand access to health services and required medication. The role of community pharmacists and community pharmacies as a potential platform for HIV products and services is considered in *The South African community pharmacy sector—an untapped reservoir for delivering HIV services* (Nyamuzihwa et al.). The authors describe the proliferation and distribution of community pharmacies, how the role of the community pharmacist can be expanded and why this presents a viable opportunity to contribute to HIV mitigation and attainment of UNAIDS targets.

The path of HIV self-testing from its conception over 25 years ago to its current iterations, is traced by Fischer et al. They highlight the salient steps and features in HIV self-testing and discuss the issues that arise from packaging digital interventions with HIV self-testing. Given the momentum that such interventions are gaining, data management is a growing concern, impeding data harmonization and scalability. The authors therefore raise the question of whether there is a need for regulatory approval or prequalification of digital interventions used with HIV self-tests (Fischer et al.). The role that technology can play in HIV screening and sexual health matters among men who have sex with men and gender diverse communities, is reported on in two other articles. Abraham et al. investigated the disposition of members of the aforementioned marginalised communities in Australia when presented with the option of accessing sexual health services on digital applications and web based channels (Abraham et al.), while Zhao et al. in their Chinese study probed the potential of establishing online HIV testing platforms on a dating site. They identified drivers and obstacles to app-based HIV testing services at various levels (Zhao et al.). Both these studies aimed at mitigating common barriers to HIV testing, like fear of stigmatisation and accessibility of services. A different technological advancement which enters the fray, is *The role of machine learning in HIV risk prediction* (Fieggen et al.). This perspective article clarifies what machine models are, and how they are developed and evaluated. The authors make a case for including machine learning as an HIV prevention tool of the future, and discuss the benefits of the predictive quality of machine learning in identifying at risk individuals, amongst its various other uses. Keeping with risk, Adedokun et al. recommend routine risk screening for cardiovascular diseases since their Nigerian study found that sub-clinical atherosclerosis was higher in HIV treatment experienced patients, and this was irrespective of the presence of traditional risk factors (Adedokun et al.).

The need to address social and systemic factors that impact sexual and reproductive health initiatives is examined in the remainder of the articles. The Maharaj opinion piece that adolescent pregnancy in sub-Saharan Africa is concerning, draws attention to the reasons for this as well as highlights some interventions which have been successful in curbing the adolescent pregnancy rate in other countries. The authors advocate for greater involvement from all sectors of society in minimising the adolescent birth rate (Maharaj). Another at risk sector is identified in *Enrollment and retention of female sex workers in HIV care and health facilities in Mabara city*. Readers are reminded that the sexual health needs of sex-workers often go unattended despite them being very much in need of such. In this original study, among various themes, the impact of healthcare workers' attitudes and the quality of services at health facilities on female sex workers' motivation to enter into HIV treatment is discussed (Arinaitwe et al.).

South Africa finds itself in the spotlight in another two articles, where attention is drawn to the country's shortfalls but accompanied by suggestions for improving the health systems. Using South Africa as an example of low- and middle- income countries in general in their assessment, Ordonez et al. explain the link between colonialism and a sub-standard healthcare system. They illuminate the need for innovation and a pragmatic integrated approach to addressing the HIV healthcare services in neo-colonial South Africa (Ordonez et al.). While the final perspective article by Nyatela et al. also provides advice to various stakeholders, they focus on how the identified stakeholders can support patients as they engage in self-care. The authors reflect on the lessons learned from the COVID-19 pandemic, and use them as a foundation on which to improve HIV mitigation generally and especially as they pertain to patients with co-morbidities (Nyatela et al.).

This collection of original research, perspectives and opinion articles provides a holistic overview of the different approaches to research into HIV and sexual reproductive healthcare. What becomes clear is that the commitment to delivering effective healthcare remains, and that innovative approaches to the provision of such continue to evolve.

Author contributions

VE: Writing—original draft, Writing—review & editing. **AC:** Writing—review & editing. **SL:** Writing—review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Sundewall J, Kaiser AH. *Sexual and reproductive health and rights: an essential element of universal health coverage*. United States of America: United Nations Population Fund (2019).

2. Mutea L, Ontiri S, Kadiri F, Michielesen K, Gichangi P. Access to information and use of adolescent sexual reproductive health services: qualitative exploration of barriers and facilitators in Kisumu and Kakamega, Kenya. *PloS One*. (2020) 15(11):e0241985. doi: 10.1371/journal.pone.0241985

3. Mengesha Z, Hawkey AJ, Baroudi M, Ussher JM, Perz J. Men of refugee and migrant backgrounds in Australia: a scoping review of sexual and reproductive health research. *Sex Health*. (2023) 20(1):20–34. doi: 10.1071/SH22073

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Incentives to promote accessing HIV care and viral suppression among HIV self-screening test users who obtain a reactive result

Mohammad Majam[1], Mothepane Phatsoane[1], Theodore Wonderlik[1], Naleni Rhagnath[1], Laura K. Schmucker[2], Leanne Singh[1], Michael Rademeyer[3], Harsha Thirumurthy[2], Noora Marcus[2] and Samanta Lalla-Edward[1]*

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Introduction: Achieving viral suppression in people with HIV is crucial in ending the AIDS epidemic. Among users of HIV self-screening tests, low rates of linkage to care and early retention in care are key obstacles to achieving viral suppression. This study sought to evaluate the efficacy of financial incentives in supporting HIV case management.
Methods: Young adults within the inner city of Johannesburg, South Africa and surrounding areas who used HIV self-tests, were able to use WhatsApp to communicate with study personnel, reported a reactive or invalid result, and were confirmed to by HIV-positive were enrolled in the study. Participants were randomised to an intervention arm that received reminders and financial rewards for engaging in care, or to a control arm that received the standard of care. The primary outcome was HIV viral load at six months.
Results: Among 2,388 HIV self-test kits that were distributed, 1757/2,388 (73,58%) recipients were able to use their phones to send photos to study personnel. 142/1,757 (8,08%) of these recipients reported reactive or invalid results. Upon confirmatory testing, 99/142 (69,71%) participants were identified as being HIV-positive and were enrolled in the study. 2 (1,41%) participants received an HIV negative result, and 41(28,87%) participants were either lost to follow-up or did not complete the confirmatory testing step. 20/99 (20,2%) from the intervention arm and 18/99 (18,18%) from the control arm completed the study (i.e., attended a 6 month follow up and participated in the exit interview). 29/99 (29,29%) were virally suppressed by at 6 months. Of those achieving viral suppression 15 (51,72%) were from the intervention arm.
Conclusion: Financial incentives and reminders were not effective in promoting engagement with HIV care and viral suppression in this setting.

KEYWORDS

HIV care cascade, financial rewards, HIV management, HIV linkage to care, HIV self-test, South Africa

Introduction

The sustained use of antiretroviral therapy (ART) is crucial for achieving viral suppression among people living with HIV and preventing onward HIV transmission (1). Achieving viral suppression hinges on the prompt identification of individuals living with HIV, and subsequent access to, and sustained retention in HIV care. Thus far, while there has been significant advancement globally in the realisation of the first two "90s" of the WHO's 90-90-90 targets (90% of people living with HIV knowing their status and 90% of HIV patients on ART respectively), achieving the final "90" (viral suppression in all who receive ART) has not been reached (2–4). It has been proposed that to be able to maintain a successful HIV continuum of care and move closer to reaching the final "90" target, timeous testing for HIV is imperative, since no or delayed testing exacerbates infection transmission (5). Ghamie G, et al. emphasise that innovative and periodic HIV testing procedures need to be adopted to reach parts of the population who are unaware of their HIV status (6).

Various studies have been conducted to identify the problems associated with HIV testing and linking into HIV care and to make recommendations on how to bridge the current gaps in the HIV treatment continuum. This is critical particularly in the low and middle income region of Sub-Saharan Africa, as this region significantly lags behind western countries when it comes to patients initiating and sustaining the use of ART (7).

One recommendation is that HIV testing take the form of HIV rapid diagnostic tests (RDT), conducted by patients themselves in the form of HIV self-screening (HIVSS), to facilitate the uptake of HIV infection identification and consequent treatment, as HIVSS has shown to have high acceptability across a wide range of populations. For low- and middle-income settings this is particularly significant, as these settings bear a high burden of HIV infections and previous studies have reported a growth in testing when HIVSS has been used. This is largely because HIVSS alleviates the tester's confidentiality, cost, and convenience concerns (8–10).

However, it has become apparent that the uptake of HIV testing does not necessarily translate into boosting accessing of care, and that further mediation strategies are essential (11). Choko, et al, reiterate this notion and suggest that while there is no one-size-fits-all solution, bespoke mediation strategies can be formulated to address the HIV testing and continued access to care needs of different population groups, from available and emerging care linkage data. For example, in South Africa text messages to confirmed HIV positive patients increased the likelihood of them linking to care (12).

One popular mediatory mechanism that has been proposed is the use of incentives. Stoner, et al, in their 20-year exploration of the impact of disbursing various forms of financial incentives to at risk groups, found that there was an inconsistent link between the disbursement of financial incentives and the prevention of HIV infection (13). Krishnamoorthy, et al, in their examination into whether financial incentives positively impacted the uptake of HIV care, concluded that it does have the potential to improve patient retention in the HIV cascade of care (14). A year-long review of household economic strengthening (HES) strategies as an approach to stimulating uptake in HIV testing and care, drew two significant conclusions. The first is that financial rewards stimulate the uptake of HIV testing and linkage to care in adults generally and in specific contexts like when financial rewards can help people to pay for transportation expenses. The second is that it is difficult to pinpoint trends amongst the various HES schemes given that there are many variables to consider (15).

Another disconcerting reality is that there is also a need for HIVSS and HIV care interventions that target men in particular because they have lower levels of engagement in testing and treatment (16, 17). Whereas women often access testing around childbirth, men access healthcare (including HIV testing) more rarely and as a consequence are diagnosed later in the HIV disease progression (18, 19) and are in addition less likely to link to care than women (20). Identifying interventions to increase HIV testing and linkage to care among men – particularly those engaged in high-risk behaviours remains an HIV prevention priority.

Drawing on health and behavioural economics, this pilot study developed and tested a financial incentive intervention programme to measure the effect of a modest financial incentive offered in: (1) completing a confirmatory HIV test following a positive HIVSS test result, and (2) demonstrating viral suppression by approximately 6-months after a positive HIVSS test result. By testing whether targeted, low-cost incentives for facilitating HIV care access and viral suppression are effective in the context of HIVSS, the results from this study, reported on here, can inform larger-scale efforts, in South Africa and in other countries in the region, in achieving strengthened HIV care cascades.

Materials and methods

Study design

This study took place from July to December 2020 and enrolled 142 participants. Upon meeting the inclusion criteria, participants were randomly assigned to intervention or control: the intervention group receiving financial incentives for confirmatory testing, linking to care and viral suppression – or the control group receiving standard of care (SOC) for linking to care.

All participants who completed key study procedures received standard financial compensation for time and transportation.

Study site

Locations which yielded high numbers of men and young adults within the inner city of Johannesburg, South Africa as well as its surrounding areas of Alexandra, Soweto and Yeoville, were deliberately selected for the distribution of HIV self-test (HIVST) kits. In 2020, the HIV prevalence of the City of Johannesburg was 13% (21). Confirmatory testing of HIV positive results was undertaken at the Ezintsha Research Centre in Hillbrow, Johannesburg, South Africa.

Study population

Convenience sampling was used to recruit candidates already participating in the following initiatives: STAR HIVSS distribution programme, Sedia, and Hepatitis C virus (HCV) product evaluation studies in operation at the Ezintsha research clinic and ANOVA's harm reduction initiative at the Yeoville clinic. Both males and females were recruited on condition that they were willing to not only test for HIV, but also share their results digitally *via* short messaging service (SMS) or WhatsApp. Race, gender, ethnicity, and sexual orientation were disregarded.

After distributing 2,388 HIVST kits to potential study participants, from the 402 candidates who responded, 142 were eventually deemed eligible for confirmatory testing and possible inclusion in the study. Eventually, 99 participants who had fulfilled all the study criteria comprised the study sample, 49 of whom were assigned to the intervention arm and 50 to the control arm.

Inclusion and exclusion

Eligible participants were 18 years or older at the time of the study and had reported an HIV positive status after being tested. They also had access to a phone with a personal or valid phone number that was going to be active for at least six-months post HIV self-screening and which had a WhatsApp or text messaging feature. Each participant also needed to have understood and signed the informed consent form.

Ineligible participants were those who did not meet the eligibility criteria, were not willing to undergo a confirmatory test after testing positive for HIV and were unwilling to provide informed consent.

Recruitment process

Field workers from the STAR HIVSS distribution programme, using either the fixed HIVSS distribution or the door-to-door distribution channel, disseminated an HIVSS kit, IFU pamphlet and a uniquely barcoded result card, to passers-by and residents. Recipients who tested positive for HIV were requested to share their result with the study staff to a designated phone number *via* their mobile phones. This could be done by sending either a picture of their positive results on the results-card (**Supplementary Figure S1**) *via* WhatsApp or *via* SMS reporting the positive result and quoting the unique barcode from the test kit. These candidates as well as those with confirmed HIV positive results from the Sedia and HCV studies as well as the ANOVA-Drug users harm reduction initiative, who presented themselves for routine testing at the Yeoville site, were provided with the opportunity to participate in the study. They too were required to submit text messages or photographic evidence of their HIV positive results.

Study procedure

Confirmatory testing

After the validation of HIV positive results by study staff, participants were contacted by a linkage officer within three days to conduct an informed consent telephonically before proceeding with randomly grouping participants into the intervention and control. At this stage, only STAR candidates received ZAR50 (approximately USD 3,00) for the photographic evidence of positive results sent *via* WhatsApp. All participants with an HIV positive result were required to undergo confirmatory testing at the Ezintsha research clinic before they could be manually randomized into a particular study arm. All participants who presented themselves for confirmatory testing were reimbursed ZAR150 (approximately USD 9,00) for time and transport costs, with those from the STAR programme who randomised in the intervention arm receiving a further R75 (approximately UDS 4,90) for completing confirmatory testing. The research nurse performed a blood draw for the baseline viral load (VL). All participants were advised to attend an ART clinic of their choice.

Randomisation

Participants were randomised into one of two study arms after their HIV positive test results were confirmed, as described above. Random number generation was used for randomisation and Stata for assignment. To facilitate randomisation for Sedia, ANOVA and HCV participants, they were also required to submit images of their self-test RDT for verification to the same telephone number as STAR candidates. Upon randomisation into their specific arm, the letter T was attached to the end of the intervention arm candidate's patient identity number (PID) and the letter C attached to the end of the control arm candidate's PID. An additional code was added to the end of the aforementioned coding to indicate whether or not the patient had access to WhatsApp (M if no WhatsApp). A further code preceded the PID to indicate the group from which the patient was recruited: S for the Sedia group, A for ANOVA group, and H for the HCV group. While no balance tests were run during the randomisation process, participants were randomised 1:1, so that there was an even distribution among the participants from each recruitment site or programme.

Follow up visits

With regards to medication pick-up reporting, monthly reminders to collect medication from their nearest clinic were sent to all intervention arm participants *via* text messaging or WhatsApp. Participants were requested to send a picture of their collected medication to the study WhatsApp number. Participants whose WhatsApp pictures were verified by study staff received a ZAR25 (approximately USD 1,50) reward *via* e-Wallet. Incentivisation was not extended to participants without WhatsApp or who did not submit an image.

End-line VL

Approximately six months after receiving and verifying the image from the participant indicating an HIV positive reading, up to five follow-up calls (one per week unless an additional call within a particular week was warranted) were made to each candidate inviting them to complete a follow-up visit at the study clinic. Voice messages were left for unreachable participants. On presenting themselves at the clinic, informed consent was administered by the linkage officer before the completion of the exit interview questionnaire and collation of demographic data. Participants subsequently had their blood sample (4 ml EDTA) drawn by a research nurse for laboratory VL PCR testing. These returning participants were reimbursed for their time and transportation cost. Moreover, intervention arm participants with a VL < 400 copies/ml were rewarded further with ZAR300 (approximately USD 18). On completion of all procedural steps, participants were exited from the study once they completed an exit questionnaire.

Figures 1,2 show the study design workflow and work study process per recruitment group respectively, while Supplementary Table S1 contains the incentive summary.

Data management

Data management was performed by the research staff who created the standard operating procedures for maintaining the

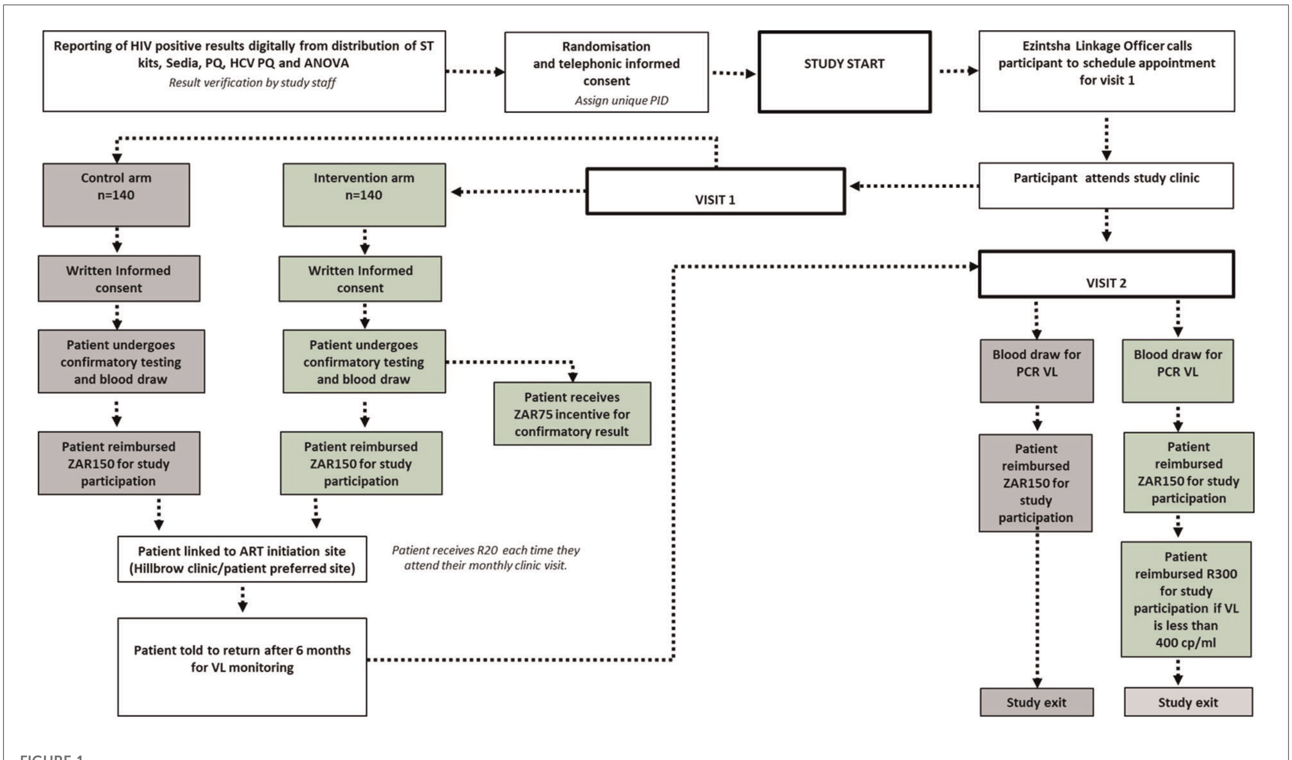
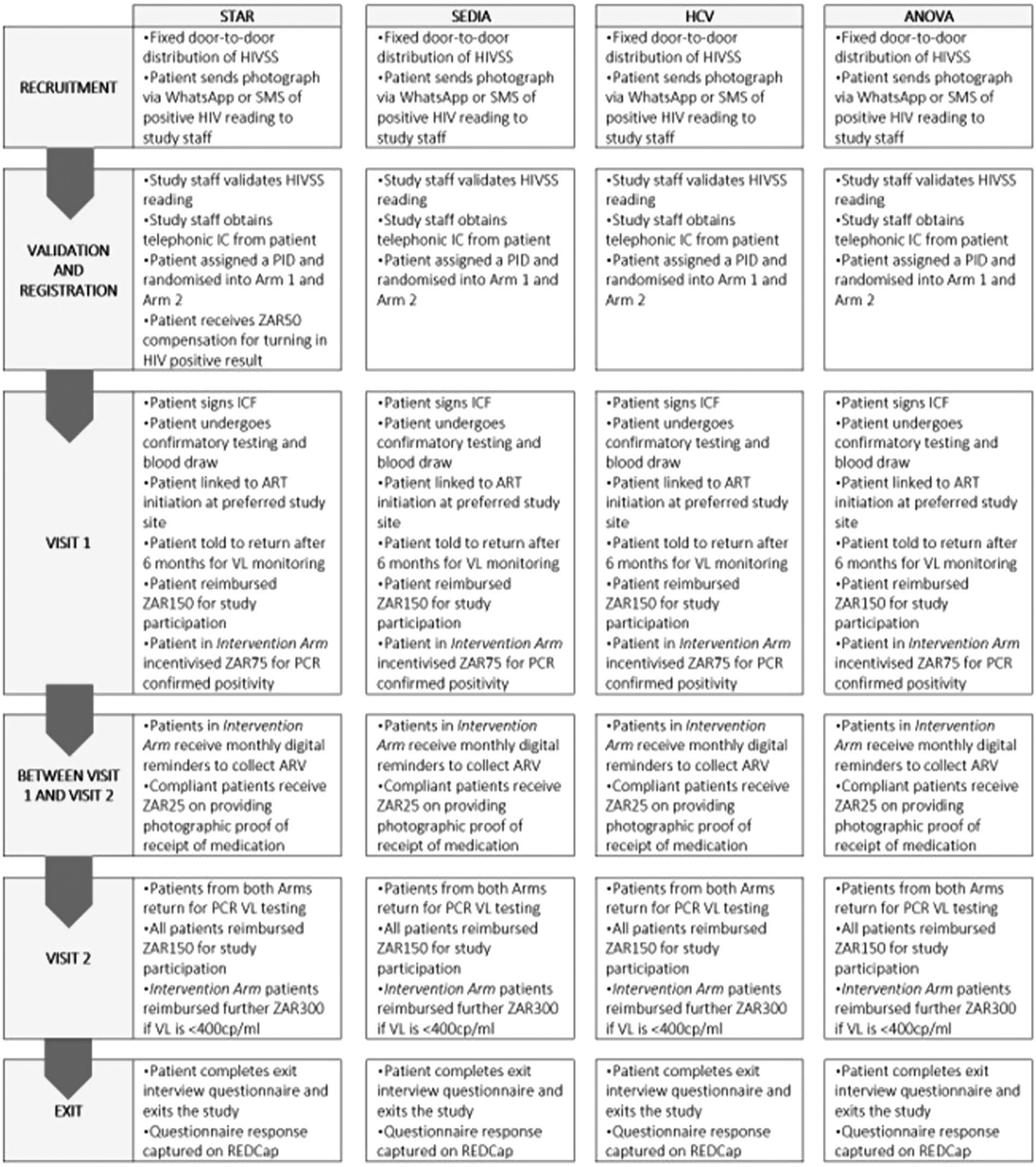


FIGURE 1
Study design workflow.



	STAR	SEDIA	HCV	ANOVA
RECRUITMENT	•Fixed door-to-door distribution of HIVSS •Patient sends photograph via WhatsApp or SMS of positive HIV reading to study staff	•Fixed door-to-door distribution of HIVSS •Patient sends photograph via WhatsApp or SMS of positive HIV reading to study staff	•Fixed door-to-door distribution of HIVSS •Patient sends photograph via WhatsApp or SMS of positive HIV reading to study staff	•Fixed door-to-door distribution of HIVSS •Patient sends photograph via WhatsApp or SMS of positive HIV reading to study staff
VALIDATION AND REGISTRATION	•Study staff validates HIVSS reading •Study staff obtains telephonic IC from patient •Patient assigned a PID and randomised into Arm 1 and Arm 2 •Patient receives ZAR50 compensation for turning in HIV positive result	•Study staff validates HIVSS reading •Study staff obtains telephonic IC from patient •Patient assigned a PID and randomised into Arm 1 and Arm 2	•Study staff validates HIVSS reading •Study staff obtains telephonic IC from patient •Patient assigned a PID and randomised into Arm 1 and Arm 2	•Study staff validates HIVSS reading •Study staff obtains telephonic IC from patient •Patient assigned a PID and randomised into Arm 1 and Arm 2
VISIT 1	•Patient signs ICF •Patient undergoes confirmatory testing and blood draw •Patient linked to ART initiation at preferred study site •Patient told to return after 6 months for VL monitoring •Patient reimbursed ZAR150 for study participation •Patient in *Intervention Arm* incentivised ZAR75 for PCR confirmed positivity	•Patient signs ICF •Patient undergoes confirmatory testing and blood draw •Patient linked to ART initiation at preferred study site •Patient told to return after 6 months for VL monitoring •Patient reimbursed ZAR150 for study participation •Patient in *Intervention Arm* incentivised ZAR75 for PCR confirmed positivity	•Patient signs ICF •Patient undergoes confirmatory testing and blood draw •Patient linked to ART initiation at preferred study site •Patient told to return after 6 months for VL monitoring •Patient reimbursed ZAR150 for study participation •Patient in *Intervention Arm* incentivised ZAR75 for PCR confirmed positivity	•Patient signs ICF •Patient undergoes confirmatory testing and blood draw •Patient linked to ART initiation at preferred study site •Patient told to return after 6 months for VL monitoring •Patient reimbursed ZAR150 for study participation •Patient in *Intervention Arm* incentivised ZAR75 for PCR confirmed positivity
BETWEEN VISIT 1 AND VISIT 2	•Patients in *Intervention Arm* receive monthly digital reminders to collect ARV •Compliant patients receive ZAR25 on providing photographic proof of receipt of medication	•Patients in *Intervention Arm* receive monthly digital reminders to collect ARV •Compliant patients receive ZAR25 on providing photographic proof of receipt of medication	•Patients in *Intervention Arm* receive monthly digital reminders to collect ARV •Compliant patients receive ZAR25 on providing photographic proof of receipt of medication	•Patients in *Intervention Arm* receive monthly digital reminders to collect ARV •Compliant patients receive ZAR25 on providing photographic proof of receipt of medication
VISIT 2	•Patients from both Arms return for PCR VL testing •All patients reimbursed ZAR150 for study participation •*Intervention Arm* patients reimbursed further ZAR300 if VL is <400cp/ml	•Patients from both Arms return for PCR VL testing •All patients reimbursed ZAR150 for study participation •*Intervention Arm* patients reimbursed further ZAR300 if VL is <400cp/ml	•Patients from both Arms return for PCR VL testing •All patients reimbursed ZAR150 for study participation •*Intervention Arm* patients reimbursed further ZAR300 if VL is <400cp/ml	•Patients from both Arms return for PCR VL testing •All patients reimbursed ZAR150 for study participation •*Intervention Arm* patients reimbursed further ZAR300 if VL is <400cp/ml
EXIT	•Patient completes exit interview questionnaire and exits the study •Questionnaire response captured on REDCap	•Patient completes exit interview questionnaire and exits the study •Questionnaire response captured on REDCap	•Patient completes exit interview questionnaire and exits the study •Questionnaire response captured on REDCap	•Patient completes exit interview questionnaire and exits the study •Questionnaire response captured on REDCap

FIGURE 2
Work study process per recruitment group. HCV, hepatitis C virus; HIVSS, HIV self-screening; SMS, short messaging services; IC, informed consent; PT, participant; PID, patient identification; ICF, informed consent; ART, antiretroviral therapy; VL, viral load; PCR, polymerase chain reaction; ZAR, South African rand; cp/ml, copies per millilitre.

confidentiality of participants as well as all the data (both paper-based and electronic) and the transfer, entry and storage levels of the data. Only protocol approved (by the ethics committee) study team members had access to the study data and sharing of any study information beyond the boundaries of the approved study team was disallowed. Data were securely stored by Ezintsha for the regulatory authority mandated storage period.

Data collection

Two methods were used to gather participant demographic and contact details data: (i) manual paper-based collection form and (ii) electronically utilising a phone on the A2D24 Open Data Kit (ODK) platform (Table 1). The word "positive" along with the test kit unique barcode was sent by participants who tested positive and who were enrolled using the manual process, to a number provided by the field-worker. Thereafter, these participants' tests results were confirmed at the Ezintsha Research Clinic before being manually randomised into a particular study arm, the summary of which is contained in Table 1, and pictorially represented in Supplementary Figures S2A–C. Exit interview question responses were captured on REDCap by the designated data-capturer.

Training

The training of study staff was informed by the study training material. On culmination of the training, competency logs were completed, signed by team members, and filed.

Ethical considerations

Ethical approval was received from the Human Research Ethics Committee Members of University of the Witwatersrand (Ethics Reference: 191121) and the Research Committee of Johannesburg Health District (DRC Reference: 2020-09-007).

Results

Demographics from kit distribution and enrolment

A total of 2,388 HIVST kits were distributed comprising 1090/2,388 (45,64%) male recipients and 1298/2,388 (54,36%) females. Altogether, 1757/2,388 (73,58%) of candidates were able to report their results in a photo of their HIVST results *via* WhatsApp and 631/2,388 (26,42%) could not. 142/2,388 (5,95%) who turned in a positive or invalid result and subsequently verified as such by study staff, comprised 56/142 (39,44%) responses from male candidates and 86/142 (60,56%) from female candidates. 83/142 (58,45%) candidates who were able to send photographs were assigned to the A2D24 workflow, while the balance, 59/142 (41,455%) were assigned to the manual workflow, all 124 being deemed eligible for the study. Eventually, 138/142 (97,18%) of eligible candidates were indeed true positives and qualified for inclusion in the entire study. The participant yields recruited from the various studies are as follows: STAR - 60/138 (43,48%), Sedia study - 64/138 (46,38%), ANOVA clinic – 8/138 (5,8%), and HCV study – 6/138 (4,35%) (Table 2).

TABLE 1 Data collection summary.

Manual (DCF)	**Electronic (A2D24 ODK platform)**
STAR Programme cell phone without WhatsApp	STAR Programme cell phone with WhatsApp
HCV mobile phone without WhatsApp	HCV mobile phone with WhatsApp
Sedia mobile phone without WhatsApp	Sedia mobile phone with WhatsApp
ANOVA without WhatsApp	ANOVA with WhatsApp

DCF, data collection form; ODK, open data kit; HCV, hepatitis C virus.

HIVST reporting and randomisation

Of the self-reported results, 138/402 (34,33%) candidates reported a positive reading and 4/402 (1,00%) of the results were invalid, legitimising these candidates for inclusion into the study.

TABLE 2 Demographics from kit distribution and enrolment.

	Frequency (*n*)	**Percentage (%)**[a]
Kits distributed	2 388	
Sex		
Male	1090	45,64%
Female	1298	54,36%
Able to send photo (ASP)		
ASP	1757	73,58%
Not ASP	631	26,42%
HIVSS result reported (positive or invalid)	142	
Sex		
Male	56	39,44%
Female	86	60,56%
Able to send photo (ASP)		
ASP	83	58,45%
Not ASP	59	41,55%
Recruitment/enrolment method (positive)	138	
STAR distribution	60	43,48%
Sedia study	64	46,38%
ANOVA clinic	8	5,80%
HCV study	6	4,35%

[a]Due to rounding percentages may not always total to 100.
n, number; HIVSS, HIV self-screening; ASP, able to send photo; HCV, hepatitis C virus.

73/142 (51,41%) candidates were randomised into the intervention arm and 69/142 (48,59%) into the control arm. 2/142 (1,41%) participants were confirmed HIV negative, and 41/142 (28,87%) participants had pending HIV results by the time recruitment had closed or had been lost to follow (unreachable after five attempts to contact them). Amongst all the confirmed positives, there were 21 more females (60/99, 60,61%) than males (39/99, 39,39%). Baseline VL results were available for 95/99 (95,96%) participants, and 55/95 (57,89%) had a VL < 400 copies/ml. Most of the participants (60/95, 63,16%) were enrolled from the Sedia study, within the confirmed positive patients group (Tables 3A,B).

Incentives and follow up

Within the intervention arm, 20 confirmed positive participants with a baseline VL were part of the A2D24 workflow, rendering them eligible for the medication pick-up incentive. Three quarters (15/20) of this had a baseline VL < 400 copies/ml, and 5/15 (23,81%) showed a baseline VL > 400 copies/ml. In this group, 13/20 (65,00%) of participants shared at least one example of photographic evidence of having collected their medication. Among these 13 11/13 (84,62%) of whom had a baseline VL < 400 copies/ml and 2/13 (15,38%) displaying a baseline VL > 400 copies/ml (Table 4A).

TABLE 3(A) HIVST reporting and randomisation.

	Frequency (*n*)	Percentage of subcategory (%)[a]	Percentage of total distribution (%)[a]
Kits distributed	2 388		
HIVSS results reported	402		16,83%
HIVSS positive	138	34,33%	5,78%
HIVSS negative	260	64,68%	10,89%
HIVSS invalid	4	1,00%	0,17%
Randomisation eligibility and confirmatory testing (HIVSS reported positive or invalid)	142	35,32%	5,95%
Study arms			
Intervention arm	73	51,41%	
Control arm	69	48,59%	
Result confirmation			
Confirmed positive	99	69,72%	4,15%
Confirmed negative	2	1,41%	
Confirmation pending at time recruitment closed or lost to follow-up (not reached after 5 attempts)	41	28,87%	

[a]Due to rounding percentages may not always total to 100.
HIVST, HIV self-test; *N*, number; HIVSS, HIV self-screening.

TABLE 3(B) Confirmed positive distribution.

	Frequency (*n*)	Percentage (%)[a]
Confirmed positive	99	
Baseline VL for those confirmed positive	95	95,95%
VL < 400	55	57,89%
VL > 400	40	42,11%
Randomization for those with a baseline VL		
Intervention arm	47	49,47%
Control arm	48	50,53%
Sex		
Male	36	37,89%
Female	59	62,11%
Able to send photo (ASP)		
ASP	44	46,32%
Not ASP	51	53,68%
Recruitment/enrolment method		
STAR distribution	23	24,21%
Sedia study	60	63,16%
ANOVA Clinic	7	7,37%
HCV study	5	5,26%

[a]Due to rounding percentages may not always total to 100.
n, number; VL, viral load; ASP, able to send photo; HCV, hepatitis C virus.

All 99 participants who tested HIV positive during the confirmatory testing procedure were entitled to a follow-up visit six months after the commencement of their participation in the study. Less than half of these patients (38/99; 38,38%) attended the follow-up visit, 20/38 (52,63%) of who were from the intervention arm and 18/38 (47,37%) from the control arm. Furthermore, 29/38 (76,32%) participants exhibited an end line VL < 400 copies/ml whereas 9/38 (23,68%) patients had an end line VL > 400copies/ml. Most of this group, (61/99; 61,62%) were either pending or lost to follow-up by the close of study. Although the study team did not believe that the recruited sample size was sufficient to adequately measure a statistically significant effect, we did run a Fischer's exact test for which the *p*-values are presented in the Table 4B.

Exit interview

34 participants completed the exit interview questionnaire. The majority (26/34, 76,47%) were in the 26–45-year age

range. 24/34 with an HIV diagnosis were also in the 26–45 year age range. While 24/34 (70,58%) were newly diagnosed, by the close of the study, majority self-reported that they had already commenced HIV treatment (33/34 (97,05%) and achieved viral suppression (31/34 (91,17%). 32/34 (94,11%) participants reported collecting their medication regularly. 33/34 (97,05%) participants enrolled in the study to gain knowledge of their HIV status, while 13/34 (38,23%) were motivated by the financial incentive (**Table 5**).

Discussion

Meeting all the World Health Organization's 90-90-90 goals remains elusive in sub-Saharan Africa. Irrespective of whether HIV testing is home based or community location based, a recent study asserts that the location of the testing has no significant impact on the extent to which HIV positive patients access HIV care, although patients most likely to seek care further are previously diagnosed as opposed to newly diagnosed ones (22). Furthermore, attracting males not just for HIV testing but for continuous ART remains unsatisfactory, and even incentives cannot guarantee male engagement (23). Even newer innovative approaches like mobile health (mHealth) technology while effective in communicating reminders to HIV positive patients, still experienced efficacy impediments due to illiteracy, for example (24).

The assertions are significant in the light of our study. At the outset, despite a deliberate attempt to recruit at least an equal number of males and females for participation in the investigation, fewer males were reached and a significantly lower number of them formed part of the study sample. Whether this is because the number of males who tested positive was much lower than their female counterparts, or whether the male respondents number is lower because of apathy on their part is unclear. If the reason is the latter, it supports the trend that was expounded on in a previous South African study where across the HIV treatment continuum, females have proved to be more responsive (25). Sileo et. al. concluded in their study, that "masculine norms" like stigma concerns and inaccurate assumptions of the effect of HIV treatment negatively affected male engagement (26). Consequently, it is also plausible that this could have been a driving factor for the lower male responsiveness.

Using financial incentives in the identification and management of HIV in sub Saharan Africa appears to have the potential to positively impact adolescents, a recent study shows (27). Other studies undertaken in rural Uganda showed that while male engagement is directly proportional to the value of the "prize" or incentive, incentives do have the potential to increase male participation generally (28) and a separate randomised trial indicated that financial incentives had no impact on the commitment to viral suppression in HIV positive individuals (29). The idea of rewarding individuals financially was not met with enthusiasm in a recent investigation in Cape Town, South Africa either. It emerged that incentivisation received a lukewarm reception from some patients as well as healthcare workers, on the grounds of morality (30). That financial incentivisation, irrespective of the form or monetary value cannot be relied

TABLE 4(A) monthly medication collection incentive.

	Frequency (n)	Percentage of subcategory (%)[a]	Percentage of total (%)[a]
Eligible for pick-up incentive	20		
Baseline VL < 400	15	71,43%	
Baseline VL > 400	5	23,81%	
Medication pick-up shared	13		65,00%
Baseline VL < 400	11	84,62%	
Baseline VL > 400	2	15,38%	

[a] Due to rounding percentages may not always total to 100.
n, number; VL, viral load.

TABLE 4(B) 6-month follow up.

	Intervention ($n = 49$)		Control ($n = 50$)		
	Frequency	Percentage	Frequency	Percentage	p-value
Eligible for 6 month follow-updd					
Completed	20	40.82	18	36.00	0.682
Pending/Lost to care	29	59.18	32	64.00	
Viral load completed at 6 months					
VL < 400	15	75.00	14	77.78	1.000
VL > 400	5	25.00	4	22.22	

n, number; VL, viral load.

TABLE 5 Exit interview data collection summary.

Criteria	$N = 34$	Percentage (%)[a]
Demographics		
Age		
18–25	2	5,88%
26–35d	12	35,29%
36–45	14	41,18%
46–55	6	17,65%
Education		
Less than high school	1	2,94%
Some high school	22	64,71%
High school graduate	4	11,76%
College or specialised training	3	8,83%
College or university graduate	4	11,76%
Employment		
Yes	8	23,53%
No	26	76,47%
HIV diagnosis		
Date of diagnosis		
New < 2yrs ago	24	70,59%
2 – 10yrs ago	7	20,59%
10 + yrs ago	3	8,82%
HIV diagnosis age		
18–25	5	14,71%
26–35	13	38,24%
36–45	11	32,35%
46–55	5	14,70%
ART		
ARV – current		
Yes	33	97,06%
No	1	2,94%
ARV – initiation		
New < 2 yrs ago	27	79,41%
2–10 yrs ago	3	8,82%
10 + yrs ago	3	8,82%
Blank	1	2,94%
Pick-up meds frequency		
Monthly	8	23,53%
Every 2 months	12	35,29%
Every 3 months	11	32,35%
Every 4 months	1	2,94%
Other (incl. blank)	2	5,88%
Viral suppression goal		
Yes	32	94,11%
No	2	5,88%
Achievement of suppression goal		
Yes	31	91,18%
No	1	2,94%
Not answered	2	5,88
Motivators for study participation		
Knowledge of HIV status		
Strongly agree	18	52,94%
Agree	15	44,12%
Strongly disagree	1	2,94%
Money		
Strongly agree	6	17,65%
Agree	7	20,58%
Neither agree not disagree	2	5,88%
Disagree	8	23,53%
Strongly disagree	11	32,35%
Study feedback		
Satisfaction with study experience		
Very much	29	85,29%
Neutral	3	8,82%
Fairly	2	5,88%

[a] Due to rounding percentages may not always total to 100.
n, number; yrs, years; incl, including.

upon to increase engagement with the HIV management continuum amongst adults and particularly male ones has been reinforced in our study too, as the poor responsiveness despite the promise of incentivisation, pointed to it being ineffectual.

It appears then that the action of incentivising HIV testing and adherence to treatment needs to be administered as a complement to additional strategies, like HIV and social responsibility educational programmes, for it to be taken seriously as a factor in promoting responsible treatment behaviour in HIV patients and the public at large.

Limitations

COVID-19 lockdowns adversely affected recruitment, participant follow-up, and measurement of viral loads at 6 months. The study workflow required participants to have WhatsApp for results and medication picture sharing. This was challenging as many potential participants did not have smartphones, necessitating the introduction of a parallel workflow for them. Subsequently contact number verification became a challenge resulting in participants providing incorrect phone numbers which led in part to the high rate of participants who did not complete follow-up. Whether incorrect numbers were offered deliberately (and if so, why) or in error is unclear. Social status was not used to determine study eligibility which could have altered the study outcome (e.g. with respect to types of phones, and study completion rates). Using convenience sampling may have introduced a bias in that participants joining from other research studies may have been more inclined to have health seeking behaviour. Lastly, as no other modes of communication (e.g., email) were explored this could have also affected the completion rates.

Conclusion

In this pilot trial, we did not find evidence that financial incentives over and above the reimbursement provided for time and travel are effective in increasing engagement with the HIV care continuum among people living with HIV. This can be seen in the relatively even number of participants who completed follow-up between study arms (20 intervention vs. 18 control). Several of these participants mentioned being motivated by a desire to take control of their health rather than the financial incentives.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Human Research Ethics Committee of the University of the Witwatersrand (Ethics Reference: 191121) and the Research Committee of Johannesburg Health District (DRC Reference: 2020-09-007). The patients/participants provided their written informed consent to participate in this study.

Author contributions

MM, LS, HT, NR, SL-E contributed to the conception and design of the study. MP, TW, LKS, NM contributed to data collection and data analysis. MR led the mHealth development and data reporting. LS, SL-E wrote the first draft of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

MR was employed by A2D24. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frph.2022.976021/full#supplementary-material.

References

1. World Health Organisation. HIV/AIDS. (2021).

2. UNAIDS. *90–90–90: good progress, but the world is off-track for hitting the 2020 targets*. Geneva: UNAIDS (2020).

3. UNAIDS. *Global HIV & AIDS statistics — fact sheet*. Geneva: UNAIDS (2021).

4. xx. https://www.unaids.org/en/resources/909090

5. Campbell CK, Lippman SA, Moss N, Lightfoot M. Strategies to increase HIV testing among MSM: a synthesis of the literature. *AIDS Behav*. (2018) 22:2387–412. doi: https://doi.org/10.1007/s10461-018-2083-8

6. Chamie G, Napierala S, Agot K, Thirumurthy H. HIV Testing approaches to reach the first UNAIDS 95% target in sub-saharan Africa. *Lancet HIV*. (2021) 8(4):e225–36. ISSN 2352-3018, doi: https://doi.org/10.1016/S2352-3018(21)00023-0

7. Koduah Owusu K, Adu-Gyamfi R, Ahmed Z. Strategies to improve linkage to HIV care in urban areas of sub-saharan Africa: a systematic review. *HIV AIDS*. (2019) 11:321–32. doi: 10.2147/HIV.S216093

8. Johnson CC, Kennedy C, Fonner V, Siegfried N, Figueroa C, Dalal S, et al. Examining the effects of HIV self-testing compared to standard HIV testing

services: a systematic review and meta-analysis. *J Int AIDS Soc*. (2017) 20 (1):21594. doi: 10.7448/IAS.20.1.21594

9. Majam M, Rhagnath N, Msolomba V, Singh L, Urdea MS, Lalla-Edward ST. Assessment of the sedia HIV self-test device: usability and performance in the hands of untrained users in johannesburg, South Africa. *Diagnostics*. (2021) 11 (10):1816. doi: 10.3390/diagnostics11101816

10. Hamilton A, Thompson N, Choko AT, Hlongwa M, Jolly P, Korte JE, et al. HIV Self-Testing uptake and intervention strategies among men in sub-saharan Africa: a systematic review. *Front Public Health*. (2021) 9:1–16. doi: 10.3389/fpubh.2021.594298

11. Njau B, Damian DJ, Abdullahi L, Boulle A, Mathews C. The effects of HIV self-testing on the uptake of HIV testing, linkage to antiretroviral treatment and social harms among adults in Africa: a systematic review and meta-analysis. *PLoS One*. (2021) 16(1):e0245498. doi: 10.1371/journal.pone.0245498

12. Choko AT, Jamil MS, MacPherson P, Corbett E, Chitembo L, Ingold H, et al. Measuring linkage to HIV treatment services following HIV self-testing in low-income settings. *J Int AIDS Soc*. (2020) 23(6):e25548. doi: 10.1002/jia2.25548

13. Stoner MCD, Kilburn K, Godfrey-Faussett P, Ghys P, Pettifor AE. Cash transfers for HIV prevention: a systematic review. *PLoS Med*. (2021) 18(11): e1003866. doi: 10.1371/journal.pmed.1003866

14. Krishnamoorthy Y, Rehman T, Sakthivel M. Effectiveness of financial incentives in achieving UNAID fast-track 90-90-90 and 95-95-95 target of HIV care continuum: a systematic review and meta-analysis of randomized controlled trials. *AIDS Behav*. (2021) 25(3):814–25. doi: 10.1007/s10461-020-03038-2

15. Swann M. Economic strengthening for HIV testing and linkage to care: a review of the evidence. *AIDS Care*. (2018) 30(sup3):85–98. doi: 10.1080/09540121.2018.1476665

16. Jobson G, Khoza S, Mbeng R, Befula N, Struthers HE, Kerongo G, et al. Bridging the gap: reaching men for HIV testing through religious congregations in South Africa. *JAIDS J Acquir Immune Defic Syndr*. (2019) 81(5):e160–e2. doi: 10.1097/QAI.0000000000002078

17. Staveteig SWS, Head S, Bradley S, Nybro E. Demographic patterns of HIV testing uptake in sub-Saharan Africa. DHS Comparative Reports No. 30. Calverton, Maryland, USA: ICF International, 2013.

18. Hlongwa M, Mashamba-Thompson T, Makhunga S, Hlongwana K. Barriers to HIV testing uptake among men in sub-saharan Africa: a scoping review. *Afr J AIDS Res*. (2020) 19(1):13–23. doi: 10.2989/16085906.2020.1725071

19. Hamilton A, Shin S, Taggart T, Whembolua G-L, Martin I, Budhwani H, et al. HIV Testing barriers and intervention strategies among men, transgender women, female sex workers and incarcerated persons in the Caribbean: a systematic review. *Sex Transm Infect*. (2020) 96(3):189–96. doi: 10.1136/sextrans-2018-053932

20. Maughan-Brown B, Beckett S, Kharsany ABM, Cawood C, Khanyile D, Lewis L, et al. Poor rates of linkage to HIV care and uptake of treatment after home-based HIV testing among newly diagnosed 15-to-49 year-old men and women in a high HIV prevalence setting in South Africa. *AIDS Care*. (2021) 33 (1):70–9. doi: 10.1080/09540121.2020.1719025

21. van Schalkwyk C, Dorrington RE, Seatlhodi T, Velasquez C, Feizzadeh A, Johnson LF. Modelling of HIV prevention and treatment progress in five South African metropolitan districts. *Sci Rep*. (2021) 11(1):5652. doi: 10.1038/s41598-021-85154-0

22. Sabapathy K, Hensen B, Varsaneux O, Floyd S, Fidler S, Hayes R. The cascade of care following community-based detection of HIV in sub-Saharan Africa – A systematic review with 90-90-90 targets in sight. *PLoS One*. (2018) 13(7):e0200737. doi: 10.1371/journal.pone.0200737

23. Hlongwa M, Mashamba-Thompson T, Makhunga S, Hlongwana K. Mapping evidence of intervention strategies to improving men's Uptake to HIV testing services in sub-saharan Africa: a systematic scoping review. *BMC Infect Dis*. (2019) 19(1):496. doi: 10.1186/s12879-019-4124-y

24. Bervell B, Al-Samarraie H. A comparative review of mobile health and electronic health utilization in sub-Saharan African countries. *Soc Sci Med*. (2019) 232:1–16. doi: 10.1016/j.socscimed.2019.04.024

25. Huerga H, Van Cutsem G, Ben Farhat J, Puren A, Bouhenia M, Wiesner L, et al. Progress towards the UNAIDS 90–90-90 goals by age and gender in a rural area of KwaZulu-Natal, South Africa: a household-based community cross-sectional survey. *BMC Public Health*. (2018) 18(1):303. doi: 10.1186/s12889-018-5208-0

26. Sileo KM, Fielding-Miller R, Dworkin SL, Fleming PJ. A scoping review on the role of masculine norms in men's Engagement in the HIV care continuum in sub-saharan Africa. *AIDS Care*. (2019) 31(11):1435–46. doi: 10.1080/09540121.2019.1595509

27. Chikwari CD, Dringus S, Ferrand RA. Barriers to, and emerging strategies for, HIV testing among adolescents in sub-Saharan Africa. *Curr Opin HIV AIDS*. (2018) 13(3):257–64. doi: 10.1097/COH.0000000000000452

28. Ndyabakira A, Getahun M, Byamukama A, Emperador D, Kabageni S, Marson K, et al. Leveraging incentives to increase HIV testing uptake among men: qualitative insights from rural Uganda. *BMC Public Health*. (2019) 19 (1):1763. doi: 10.1186/s12889-019-8073-6

29. Thirumurthy H, Ndyabakira A, Marson K, Emperador D, Kamya M, Havlir D, et al. Financial incentives for achieving and maintaining viral suppression among HIV-positive adults in Uganda: a randomised controlled trial. *Lancet HIV*. (2019) 6(3):e155–e63. doi: 10.1016/S2352-3018(18)30330-8

30. Swartz A, Maughan-Brown B, Perera S, Harrison A, Kuo C, Lurie MN, et al. "The money, it'S OK but it'S not OK": patients' and Providers' perceptions of the acceptability of cash incentives for HIV treatment initiation in Cape Town, South Africa. *AIDS Behav*. (2022) 26(1):116–22. doi: 10.1007/s10461-021-03355-0

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Providing HIV testing in men who have sex with men through a gay social networking app in China: A qualitative interview study with multisectoral service providers

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Objective: We explored the feasibility of app-based HIV testing services (AHTS) among men who have sex with men (MSM) according to the perspectives of testing service providers.

Methods: Twenty-one current or previous AHTS providers participated in a semi-structured interview which explored the facilitators and barriers to AHTS. Ten participants originating from the Center for Disease Control and Prevention (CDC) and 11 from the non-governmental organization (NGO) in Shijiazhuang, China took part in this study. Interviews was transcribed verbatim, and the socioecological model (SEM) was applied to thematic analysis.

Results: Twenty-one participants from AHTS services commented on the integration of online appointment schedules into HIV testing services. AHTS was deemed a convenient and efficient method for MSM and service providers to choose their preferred location and times. Moreover, it allowed for important HIV-related information to be accessed online and targeted toward at-risk individuals. Participants thought MSM may feel unsure about personal information security being stored within a privatized app and was considered a barrier to AHTS's usability. As such, they believed establishing a government-led national online platform for AHTS would allow for greater trust from MSM, rather than a social media app.

Conclusion: By linking booking services to an online platform, AHTS was deemed a convenient and efficient method for HIV testing services, especially for young MSM who are familiar with smartphone applications. To improve the use of these services, AHTS apps should focus on ensuring the confidentiality of personal information and internet security to build trust between MSM and service providers.

KEYWORDS

AHTS, MSM, facilitators, barriers, qualitative interviews

Introduction

In China, HIV (human immunodeficiency virus) has become an epidemic among men who have sex with men (MSM) and poses a serious public health challenge (1, 2). Although China has improved the prevention of HIV through prophylaxis treatments and prevention strategies, its prevalence was estimated to be 6% in 2020 (3, 4). A general lack of awareness about HIV and strategies to prevent transmission indicate better strategies are needed to contain outbreaks and lower prevalence further (3).

HIV testing is key for prevention of HIV infections and progression to AIDS, as it allows HIV positive individuals to be identified and treated such that the infection remains inactive and non-transmissible, and provides the opportunity for health providers to encourage protective sexual practices (3, 5). It is estimated only 62.2% of MSM in China have tested for HIV and know their infection status in 2020 (4), indicating HIV testing rates are suboptimal. Disturbingly, a survey conducted in Ningbo, China showed just 57.1% of MSM underwent HIV testing in the past year (6), and in Guangzhou only 44.3% of MSM were tested frequently (testing at least two times per year) over 2 years (7). Moreover, young MSM have a higher sex drive and are more likely to engage in risky sexual intercourse following online activity (5, 8). Concerningly, a previous study on university students found amongst 375 MSM, just 50.4% had ever taken an HIV test (9). Therefore, HIV testing among young MSM should be promoted by public health campaigns to establish a social norm that healthy testing habit is important to lowering HIV rates and risk in China (10–12).

With the advent of social media, its widespread use has also changed dating and sex dynamics among MSM. Settings where MSM date have shifted from traditional locations (bars, saunas, parks, etc.,) to online interactions hence, gay social media apps have been targeted for the promotion and services of HIV testing as a novel way to increase awareness and social normalcy of testing (13–15). Several studies suggest this approach could improve health outcomes by broadening HIV testing coverage and is considered a promising approach (16–22). For example, a Beijing study has found providing online booking systems for HIV testing at a nearby clinics *via* social media platforms significantly increased testing uptake (22). Despite the promise, perspectives of service providers from the CDC and MSM non-government organizations are unknown. Understanding the perspectives of services providers could fine tune this approach and facilitate its implementation in other areas of China. From February 2019 onwards, app-based HIV testing services (AHTS) has been trialed for use in Shijiazhuang, China. This study aimed to explore the experiences of providers and understand facilitators and barriers for providing AHTS to MSM in China.

Materials and methods

The process of app-based HIV testing

In 2019, with support of the National Key Science and Technology fund, the Chinese CDC cooperated with Blued, a Chinese gay dating app used in China (1), to set up a HIV booking platform called "Happy Testing". Here, MSM could choose AHTS sites nearby (CDCs or NGOs) for HIV services. To make the appointment, individuals signed an informed consent form and structured questionnaire that asked about their demographics and assessed risky behaviors. After submitting the questionnaire, individuals could make an appointment for a testing site location and time. After they received a booking code, which would be used to attend their allocated service.

Study participants

From December 2021 to January 2022, AHTS provider staff were enrolled through two senior staff members from Shijiazhuang CDC and the head of NGO institutions. Participants included in our study from CDC and NGO were recruited by leaders in the institutions independently based on the following criteria: (1) currently or formerly engaged in AHTS (work on publicity, counseling or testing of AHTS) for MSM and (2) willing to participate in our interview.

Data collection

Data was collected through the means of individual semi-structured interviews. Each interview was 30–60-min long and done *via* an online meeting or phone call. The goal of the meeting was to explore the experiences and perspectives of delivering AHTS to MSM. Questions were open-ended and examples are as follows: Can you describe the process of providing AHTS services to MSM? Describe what issues you encountered when providing AHTS services? Describe the strengths of this service based on your own experience. After acquiring verbal consent, all interviews were audio-recorded by a recording pen and transcribed verbatim using the transcription application iFLYREC (https://www.iflyrec.com/software). All interviews were conducted by TZ and ZC. Then, audio recordings and transcriptions were reviewed by TZ and ZC to check the accuracy and completeness of data. Data about the participants were translated to a unique ID code which allowed for the institution type and location to be referenced to throughout analysis.

Data analysis

Qualitative analyses of interviews were conducted by means of a thematic analysis approach which was guided by the socioecological model (SEM) (23–25). Transcriptions, coding, and analyses in this study were completed in Mandarin, and results were translated to English for manuscript preparation (26). Thematic analysis identified themes within the transcription data through a set of standardized steps: (1) the researcher familiarized themselves with the data by reading transcripts multiple times and listening to audiotapes; (2) using deductive and inductive methods, codes were generated according to things that appeared meaningful and identified any possible themes. These themes were reviewed, named, and identified as facilitators or barriers of AHTS service. Specific quotes were also taken from the transcribed interviews as representative examples during analysis. (3) using SEM, themes were categorized into individual, interpersonal, organizational, community, and public policy levels according to how they would influence the future of AHTS (23–26). All analyses were conducted by TZ and ZC through NVivo qualitative data analysis software.

Results

General characteristics of participants

A total of 21 AHTS providers were recruited and completed the interview (from NGO and CDC in Shijiazhuang), which consisted of 10 individuals from CDC and 11 individuals from NGO. The average age of all participants was 39.43 years (range, 19.99–70.35 years). Participants from CDCs had an average age of 48.71 years (34.52–70.35 years), and this was 31.69 years in NGOs (19.99–45.14 years). From the analysis of interviews, 18 main themes emerged which was categorized into five dimensions based on SEM analysis (individual, interpersonal, organizational, community and public policy, Table 1).

Individual facilitators of providing AHTS

Participants in our study mentioned filling out online information for HIV risk assessment was more consumer friendly than face-to-face questioning, as MSM would feel less embarrassed and reserved about their answers. It was agreed that online HIV risk assessment made MSM feel less judged by their responses and allowed them to answer questions at their own pace. This also improved information accuracy most of the time. *"When filling out information online, they (MSM) may not feel pressured about their response because no one else is present and there can be no judgement. This makes the user more relaxed about completing the questionnaire." "If they feel insecure about their response to a question, there is no one online to judge their answers- they likely don't feel worried about giving this information."* Furthermore, AHTS services was convenient for MSM, with uploads of past testing appointments on the app allowing users to determine whether they need testing and when they last had a test. Additionally, AHTS services also allowed them to select suitable times and see nearby locations in the one app, rather than having to check nearby locations individually online and calling to find their individual clinic availabilities. This was also deemed convenient and flexible. *"If they (MSM) forgot the last time they were tested, they can log in and see the date of their last appointment. This information can confirm whether they need to be tested again." "Some (MSM) may have work, school or something like that- they can arrange the testing time according to their own situation".*

Barriers for individuals using AHTS included the operation of platform login and information filling, which may hinder use by older MSM, those who were vision impaired, or people unfamiliar with using online services. Several members expressed concerns about whether some MSM could complete the online booking process and questionnaires needed for AHTS and expressed this may impact the accuracy of online information collection if the user is unsupervised or not helped. *"Some middle-aged and elderly people use the social media app and know about AHTS through the platform, but they don't understand its functions and online questionnaires. Some people have told me they (MSM) want to make an appointment online, but don't know how to do it." "Some elderly MSM don't know how to use smartphones, or can only use cellphones which cannot make an online appointment." "MSM may finish the online questions, but the reliability of content is uncertain. After all, it is not face-to-face, we cannot tell whether or not he was able to understand the question and answer correctly." "There is also a problem with the authenticity of the information filled online. They won't necessarily give you real information."* Some staff

TABLE 1 Multilevel influencing factors of providing AHTS in MSM.

Individual	Interpersonal	Organizational	Community	Public policy
Facilitators				
Acceptability of online information system	Facilitating peer mobilization	Digital management	The dissemination of AHTS-related information	Stimulating the evaluation of HIV testing policy
Convenience in services		Enhancing testing efficiency		
		Covering high-risk MSM		
Barriers				
Operations of online services	Difficulties in effective communication	Heavy workload	Distribution of AHTS sites	The authority of online platform
The usage of online platform			Effect of other testing services	Effect of COVID-19 related policies on AHTS
Personal characteristics of MSM				
Trust of testing facilities				

stated the awareness of the social media app among MSM was limited and affected the accessibility of AHTS. *"If MSM use the social media app, they can make an appointment but for MSM who don't know or don't use it, they lose access." "Some people also may have used the social media app for a while but might delete it."* Personal characteristics of MSM including psychological factors and personal mobility also impacted the uptake of AHTS. Online services also do not change people's mindset toward HIV testing and fear of a positive result which are at the crux of the testing issues. *"I think that some MSM are in denial. They feel they will be fine and do not need testing." "Some MSM are just afraid of being diagnosed with HIV, and to avoid problems and reality, they do not test."* In addition, personal information privacy was a concern. *"Some MSM may think information on the Internet is not secure and are afraid of privacy leaks." "Some MSM may worry about whether their information may be leaked and whether personal privacy is respected online."* Mobility of MSM also affects the continual uptake of AHTS services due to geographic breadth of the service which could complicate reliable testing data *"There may be relatively large individual turnover. He is staying here now, and he will come here to test, and when he goes to other places next year, he will go to other places to test."* MSM's trust in testing facilities also exerted a significant influence on AHTS seeking. Some participants expressed the varied trust in CDCs and NGOs among MSM. *"I feel that this is an inherent thought that health institutions affiliated by provincial governments (higher institutional level) were better than their counterparts affiliated by municipal governments (lower institutional level)." "For district-level CDC which are close to municipal CDC, most of MSM are less likely to go to the district CDC." "Many MSM tended to choose their familiar NGOs." "Some MSM remain skeptical of the authority of the NGO"*.

Interpersonal-level facilitators and barriers of providing AHTS

Several participants mentioned MSM who used AHTS services could facilitate other MSM through word of mouth, which may promote the uptake and awareness of HIV testing through AHTS. *"Information spreads quickly online, and many people receiving AHTS may introduce it to their friends." "Some MSM may introduce the app to their friends if they have a positive experience with AHTS services. It is very convenient"*.

Besides, several members from CDCs reported non–MSM service providers found interpersonal communication difficult. *"It is not easy to intervene for certain groups (of MSM). I think it is difficult for a heterosexual worker to intervene in this group of people. It is not easy to be trusted by his small circle"*.

Organizational-level facilitators and barriers of providing AHTS

Staff included in our study also commented that online booking made HIV services more sustainable, standardized, and accessible. *"Data collection from online platforms are very good because we can see how many tests are done per year and can better understand individual testing and risk status." "I think in the information age, the storage of information online is more convenient than by paper."* Online scheduled services also help HIV testing staff individuals and service agencies optimize their schedules and provision of services, which improves the service efficiency for testing facilities. *"For ourselves, we can arrange work schedules in advance according to appointment times." "I can arrange my own time reasonably according to the service* *schedule of the testing point."* Some participants in our study indicated users of social media apps tend to have more high-risk sexual behaviors including multiple sexual partners and low condom use. This implies promotion of AHTS is sensitive to vulnerable populations with better public health impacts. *"Many young people use social media apps, and their sexual activity and desire to make friends is also high. They are also more likely to have casual sexual partners. If they are more sexually active, the risk of their sexual behaviors may also be high".*

Many participants reported organizational challenges for providing AHTS. Specifically, staff from the CDCs commented that AHTS increased the demand for testing and counseling. The added workload was not met with adequate staff, which caused service shortfalls. During the COVID-19 pandemic, many CDC staff participated in epidemic prevention and control, which restricted time and effort devoted to AHTS. Moreover, the fixed working time restricted the number of AHTS services provided by CDCs. *"During the COVID-19 pandemic, most of our energy was redirected. I was responsible for other tasks. With HIV test bookings online, sometimes there was no time or energy for the service. Some people came for their appointed time and staff wasn't there- this causes trouble." "The service quality of AHTS is restricted by number of personnel. We may have other jobs after an online appointment was made. If that happens, we cannot provide services for them." "If someone wanted to go on a weekend or at night, NGOs or hospital were the only other option".*

Community-level facilitators and barriers of providing AHTS

Some participants commented online platforms could facilitate the dissemination of AHTS-related information in the social network of MSM, which could help cultivate the online HIV testing culture in local MSM community. *"I think the online platform has also promoted HIV testing. To be specific, more people know about AHTS. Because not all people could see our offline campaigns. Through the Internet, more people know about it." "AHTS helps cover a wider range of MSM, and the volume of HIV testing will increase".*

However, the unbalanced regional distribution of testing sites in communities is an important factor affecting the accessibility of services. Since the AHTS sites were mainly located in urban areas, this limited the availability of services in rural areas. *"Our AHTS sites are mainly in urban areas, but MSM are also in rural areas, and it is not convenient for them to seek AHTS through NGO or CDC."* The staff also stated the existence of other service resources makes AHTS less needed in city centers. *"We have many testing sites here, and the HIV testing can be done in many other places. It is not necessary for him to seek for AHTS." "If they don't want to seek AHTS, they could also get HIV self-test kits".*

Policy-level facilitators and barriers of providing AHTS

Participants conveyed AHTS's online nature provides the potential to improve HIV testing services, and shared opinions on how to best optimize AHTS as a public health strategy in the future. In particular, enhancing accessibility to rural areas and strengthening NGO service quality was a priority. *"AHTS has shown potential to promote HIV testing in MSM and expanding the geographical coverage of AHTS sites is being considered." "Enhancing the supervision and guidance for NGO is needed to improve their service quality".*

Providers also suggested several times the construction of a nationally led online HIV service information and booking platform would improve the reliability and trustworthiness of AHTS. Providers thought if the platform was supported by the government, it could facilitate the enthusiasm of health facilities in other geographical regions to join in and increase the legitimacy of the service. *"I reckon it is better to choose a platform which is more authoritative. If the platform was built by the government, I believe that the MSM will feel it more trustworthy, and CDCs in various areas will be willing to join this platform."* Furthermore, COVID-19 lockdown policies reduced the availability of HIV testing, which reduced the feasibility of MSM to consider AHTS. *"Due to COVID-19, the CDC has restricted access to testing, and they (MSM) cannot be tested." "For some college students, school is closed, and they cannot come out because of COVID-19." "Because of the impact of the COVID-19, students cannot leave school. Even if they want to test, they just can't get out".*

Discussion

This study provides detailed accounts about the facilitators and barriers to AHTS and their impact on HIV testing in China. The app was considered a consumer-friendly and convenient method for HIV testing, however user information security and concerns about legitimacy require improving for improving AHTS uptake. The suggested changes proposed by service providers are important to the future of HIV booking services and may be important information for other countries and software engineers to consider when creating a user-friendly platform.

Across service providers, participants in this study believed AHTS improved positive testing and normalized HIV testing culture in MSM communities by increasing its exposure on a gay dating app and making testing services publicly available. Providers thought the nature of AHTS allowed for a people-centered approach as the individual had the power of choosing which HIV testing service or time worked for them. In addition, self-risk assessment and remote questionnaires allowed the individual to feel control over the HIV testing process. This was a positive take-away point to note, as person-centered frameworks have been touted by the World Health Organization as facilitators to care, improve health and clinical outcomes, health literacy and satisfaction (27, 28). Qualitative studies also suggest the use of online booking services creates a positive individual user-experience because the person is not required to hold or wait while on a call, answer questions verbally in public, and allows for in-advance scheduling which may not be available otherwise (29).

Despite this, health providers reported the quality of online information, especially risky behaviors, could be impacted if active supervision wasn't provided. This is worrying, considering the reliability and validity of information in HIV risk assessment is important to ensuring risk-stratification tools are properly incentivized and tailored for the individual, for example the recommendation of pre-exposure prophylaxis or increased frequency of testing (30). Although self-administrated risk assessments were expressed by some providers and previous qualitative studies (29) to reduce judgement and provide more convenient risk assessment of HIV infection, self-reported information is subject to recall and social desirability biases, which may not reflect one's reality (31, 32). This could be made worse without effective face-to-face communication, which reduces the service quality and authenticity of information. Although this was a concern by service providers, a qualitative analysis of HIV testing app users in South Africa and Canada expressed app-based risk assessment resulted in less fear of answering questions, which was attributed to the less personable nature of answering a phone-based questionnaire (29). In addition, fear of judgement from in-person assessors led some users to forgo testing because they weren't mentally ready for face-to-face assessment. To reduce this problem, information re-checking on a printed version of the user's responses once arriving at the clinic would assist the quality of data, but some degree of self-reporting bias will always exist whether face-to-face or online questionnaires are used.

While on one hand AHTS allows for convenient and people-centered approaches to HIV testing, the stigma and discrimination associated with HIV testing is a barrier that prevents some MSM from seeking care. Being on a social media app, the knowledge and awareness about AHTS and HIV testing is disseminated easier and faster, which for some, could exacerbate insecurities about a possible or diagnosed positive status. Furthermore, worries about personal information security have been associated with fears of discrimination and stigma, and likely influence negative views on AHTS services (33). Therefore, while AHTS is a vehicle to improve testing, the underlying social stigma, confidentiality, and privacy concerns require specific addressing from a public health perspective (34–36). Health promotion advocacy should seek to decrease fears associated with HIV and increase the effectiveness of HIV treatments which strop progression and reduce transmission (37). Additionally, training programs which develop non-judgmental and empathetic communication skills for providers will help eliminate feelings of estrangement and build trust between MSM and testing facilities.

The theme of barriers to access was prevalent across interviews, and several members expressed a lack of AHTS sites in rural areas limited the volume of AHTS uptake. Considering geographic distance is associated with HIV testing services rates (38), expanding AHTS to rural areas would facilitate utilization of HIV testing in the future. Access to AHTS for MSM without access to the app, who were elderly, or traveled regularly (for work, truck drivers, etc.,) was an additional concern as AHTS was only available locally (39, 40). Clearly, while AHTS has the potential to increase HIV testing among MSM, this strategy has inherent restrictions which currently cannot replace other means of booking. Considering AHTS also limited services to HIV testing, the addition of other HIV-related appointments like voluntary counseling and testing, provider-initiated testing and counseling and HIV self-testing was suggested to allow MSM access to other services from one provider. This would allow for continuity of care and a sense of support from their provider.

Information security was a prevalent theme that provider representatives thought would limit the uptake of AHTS. Considering AHTS services are only available through a social media app, worries about the perceived authority of the app and guaranteed confidentiality are reasonable. These concerns are not unique to AHTS providers, with a recent BMJ report finding serious problems with privacy in mobile health apps where lack of information safety could permit third parties from accessing user emails, and 88% could access and potentially share personal data (41). In view of this, AHTS providers suggested a government-led platform would assure both MSM and providers about the authenticity of HIV testing considering the government is a highly regarded institution amongst Chinese citizens (42, 43). This would also likely allow for better security and privacy technology to be integrated within the platform, thereby relieving fears about information leaks or third-party usership (41).

During the COVID-19 pandemic, some CDC staff responsible for HIV prevention were transferred to different roles to control the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This impacted the capacity of CDC for providing AHTS, while the COVID-19 lockdown policy also restricted MSM from accessing HIV testing services. This effected the accessibility to HIV testing services and communication of availability within the app. In future, providers and facilities should work together to further improve communication and streamline the experience for HIV testing services (44, 45). The addition of HIV self-testing to AHTS is an alternative which could improve the accessibility of HIV testing services and meet the testing needs of MSM during lockdowns (46). Testing agencies should consider recruiting more professionals to improve their management and ensure the continuity of HIV testing services.

This study provides useful feedback which indicates integrating online services into HIV testing strategies could expand HIV testing by providing convenience to a service that is otherwise stressful and difficult to coordinate in China. While having AHTS present on a gay dating app does promote awareness about HIV testing, the information gained by this thematic analysis suggests a government-led platform would improve perceived trustworthiness and legitimacy about AHTS. It would therefore be in the best interests of public health to facilitate this coordination, and meanwhile also consider expanding services to neighboring rural areas where HIV testing services are not as plentiful. It would be useful if future interventions investigated the perceived legitimacy of a government-led platform for information security and public credibility to investigate whether these interventions were successful, should they be implemented.

Strengths and limitations

Some limitations of this study should be acknowledged. First, this study focused on AHTS services among providers in Shijiazhuang which limits the generalizability of these findings to wider China and other continents. Second, the small sample size in our study ($n = 21$) prevents this thematic assessment from providing a robust initial assessment. Despite this, the heterogeneity of themes presented by the participants suggests this study achieved thematic saturation, hence no further participants were sought after interviews were completed. Thirdly, interviews were conducted on past service providers and not MSM users of AHTS. This likely influences the depth of data analyzed in this study and could limit the validity of statements pertaining to MSM experiences. As such, providers can only comment on their own opinions or what MSM have stated in the past, which may not be representative of MSM. It would be beneficial to have both opinions available for comparison, and these may allow for changes to AHTS which could be tailored to MSM.

Conclusion

Although AHTS has several advantages, a series of challenges remains to be addressed. Future interventions should emphasize confidentiality and establish a government-led approach to AHTS to address MSM concerns. Future studies should interview MSM to gauge their own experiences and concerns to provide a more tailored approach to AHTS that facilitates greater support and uptake of HIV testing.

Data availability statement

The datasets presented in this article are not readily available because the datasets generated and/or analyzed during the current study are not publicly available due to privacy and confidentiality agreements as well as other restrictions but are available from the corresponding author (ZW) on reasonable request. Requests to access the datasets should be directed to ZW, wuzy@263.net.

Ethics statement

This study was approved by Institutional Review Board of National Center for AIDS/STD Control and Prevention, China CDC (NCAIDS/STD, Project No.: X180629516).

Author contributions

TZ, ZJ, YQ, LL, LW, YL, CJ, and LG contributed to the conception and design of the study. TZ and ZC contributed to the collection and analysis of data. TZ wrote the first draft of the manuscript. ZW and GB critically reviewed and revised the manuscript. All authors read and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. Ren C, Tucker JD, Tang W, Tao X, Liao M, Wang G, et al. Digital crowdsourced intervention to promote HIV testing among MSM in China: study protocol for a cluster randomized controlled trial. *Trials.* (2020) 21:931. doi: 10.1186/s13063-020-04860-8

2. Dong MJ, Peng B, Liu ZF, Ye QN, Liu H, Lu XL, et al. The prevalence of HIV among MSM in China: a large-scale systematic analysis. *BMC Infect Dis.* (2019) 19:1000. doi: 10.1186/s12879-019-4559-1

3. Wu Z, Wang Y, Detels R, Bulterys M, McGoogan JM. (Editors). *HIV/AIDS in China: Epidemiology, Prevention and Treatment.* Singapore: Springer (2020).

4. UNAIDS: Key Population Atlas (2021). Available online on: https://kpatlas.unaids.org/dashboard (accessed September 24, 2022).

5. Liu Z, Chen Y, Yao T, Zhang T, Song D, Liu Y, et al. Factors related to HIV testing frequency in MSM based on the 2011-2018 survey in Tianjin, China: a hint for risk reduction strategy. *BMC Public Health.* (2021) 21:1900. doi: 10.1186/s12889-021-11948-6

6. Jiang H, Hong H, Dong H, Jiang J, He L. HIV testing and risks of sexual behavior among HIV-negative men who have sex with men in Ningbo, China. *Int J Environ Res Public Health.* (2020) 17:1322. doi: 10.3390/ijerph17041322

7. Cheng W, Egan JE, Liu Q, Xu H, Stall R, Friedman MR. Psychosocial correlates of HIV testing frequency among men who have sex with men in Guangzhou, China. *AIDS Behav.* (2020) 24:363–72. doi: 10.1007/s10461-019-02431-w

8. Zhang L, Ding X, Lu R, Feng L, Li X, Xiao Y, et al. Predictors of HIV and syphilis among men who have sex with men in a Chinese metropolitan city: comparison of risks among students and non-students. *PLoS ONE.* (2012) 7:e37211. doi: 10.1371/journal.pone.0037211

9. Ye R, Liu C, Tan S, Li J, Simoni JM, Turner D, et al. Factors associated with past HIV testing among men who have sex with men attending university in China: a cross-sectional study. *Sex Health.* (2021) 18:58–63. doi: 10.1071/SH20088

10. Liu S, Wang K, Yao S, Guo X, Liu Y, Wang B. Knowledge and risk behaviors related to HIV/AIDS, and their association with information resource among men who have sex with men in Heilongjiang province, China. *BMC Public Health.* (2010) 10:250. doi: 10.1186/1471-2458-10-250

11. Zhao Y, Bromberg DJ, Khoshnood K, Sheng Y. Factors associated with regular HIV testing behavior of MSM in China: a cross-sectional survey informed by theory of triadic influence. *Int J STD AIDS.* (2020) 31:1340–51. doi: 10.1177/0956462420953012

12. UNAIDS 2016–2021 strategy: on the fast-track to end AIDS (2015). Available online on: https://www.unaids.org/sites/default/files/media_asset/20151027_UNAIDS_PCB37_15_18_EN_rev1.pdf (accessed September 24, 2022).

13. Abara W, Annang L, Spencer SM, Fairchild AJ, Billings D. Understanding internet sex-seeking behaviour and sexual risk among young men who have sex with men: evidences from a cross-sectional study. *Sex Transm Infect.* (2014) 90:596–601. doi: 10.1136/sextrans-2014-051545

14. Zhang D, Bi P, Lv F, Tang H, Zhang J, Hiller JE. Internet use and risk behaviours: an online survey of visitors to three gay websites in China. *Sex Transm Infect.* (2007) 83:571–6. doi: 10.1136/sti.2007.026138

15. Zhou Y, Wu D, Tang W, Li X, Huang S, Liu Y, et al. The roles of two HIV self-testing models in promoting HIV-testing among men who have sex with men (in Chinese). *Chin J Epidemiol.* (2021) 42:263–8. doi: 10.3760/cma.j.cn112338-20200629-00893

16. Cao B, Saha PT, Leuba SI, Lu H, Tang W, Wu D, et al. Recalling, sharing and participating in a social media intervention promoting HIV testing: a longitudinal analysis of HIV testing among MSM in China. *AIDS Behav.* (2019) 23:1240–9. doi: 10.1007/s10461-019-02392-0

17. Cao B, Gupta S, Wang J, Hightow-Weidman LB, Muessig KE, Tang W, et al. Social media interventions to promote HIV testing, linkage, adherence, and retention: systematic review and meta-analysis. *J Med Internet Res.* (2017) 19:e394. doi: 10.2196/jmir.7997

18. Cao B, Liu C, Durvasula M, Tang W, Pan S, Saffer AJ, et al. Social media engagement and HIV testing among men who have sex with men in China: a nationwide cross-sectional survey. *J Med Internet Res.* (2017) 19:e251. doi: 10.2196/jmir.7251

19. Anand T, Nitpolprasert C, Ananworanich J, Pakam C, Nonenoy S, Jantarapakde J, et al. Innovative strategies using communications technologies to engage gay men and other men who have sex with men into early HIV testing and treatment in Thailand. *J Virus Erad.* (2015) 1:111–5. doi: 10.1016/S2055-6640(20)30483-0

20. Rhodes SD, McCoy TP, Tanner AE, Stowers J, Bachmann LH, Nguyen AL, et al. Using social media to increase HIV testing among gay and bisexual men, other men who have sex with men, and transgender persons: outcomes from a randomized community trial. *Clin Infect Dis.* (2016) 62:1450–3. doi: 10.1093/cid/ciw127

21. Young SD, Cumberland WG, Nianogo R, Menacho LA, Galea JT, Coates T. The HOPE social media intervention for global HIV prevention in Peru: a cluster randomised controlled trial. *Lancet HIV.* (2015) 2:e27–32. doi: 10.1016/S2352-3018(14)00006-X

22. Wang L, Podson D, Chen Z, Lu H, Wang V, Shepard C, et al. Using social media to increase HIV testing among men who have sex with men - Beijing, China, 2013-2017. *MMWR Morb Mortal Wkly Rep.* (2019) 68:478–82. doi: 10.15585/mmwr.mm6821a3

23. McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. *Health Educ Q.* (1988) 15:351–77. doi: 10.1177/109019818801500401

24. MacNeill JJ, Linnes JC, Hubach RD, Rodriguez NM. From crisis to crisis: impacts of the COVID-19 pandemic on people living with HIV and HIV/AIDS service organizations in Indiana. *BMC Health Serv Res.* (2022) 22:622. doi: 10.1186/s12913-022-07998-0

25. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol.* (2006) 3:77–101. doi: 10.1191/1478088706qp063oa

26. Pan C, Wang H, Chen M, Cai Y, Li P, Xiao C, et al. Stress and coping in nurses taking care of people living with HIV in Hunan, China: a descriptive qualitative study. *Neuropsychiatr Dis Treat.* (2022) 18:303–15. doi: 10.2147/NDT.S341151

27. Framework on integrated, people-centred health services: report by the Secretariat (2016). Available online at: https://apps.who.int/iris/handle/10665/252698 (accessed September 24, 2022).

28. Global health sector strategies on, respectively, HIV, viral hepatitis and sexually transmitted infections for the period 2022-2030 (2022). Available online on: https://www.who.int/teams/global-hiv-hepatitis-and-stis-programmes/strategies/global-health-sector-strategies/developing-ghss-2022-2030 (accessed September 24, 2022).

29. Janssen R, Engel N, Pant Pai N, Esmail A, Dheda K, Thomas R, et al. 'You're only there on the phone'? A qualitative exploration of community, affect and agential capacity in HIV self-testing using a smartphone app. *Sociol Health Illn.* (2021) 43:591–606. doi: 10.1111/1467-9566.13242

30. Weinhardt LS, Forsyth AD, Carey MP, Jaworski BC, Durant LE. Reliability and validity of self-report measures of HIV-related sexual behavior: progress since 1990 and recommendations for research and practice. *Arch Sex Behav.* (1998) 27:155–80. doi: 10.1023/A:1018682530519

31. Al-Dahshan A, Chehab M, Al-Kubaisi N, Selim N. Reliability of online pregnancy-related information and associated feelings of worry among expectant women in Qatar. *BMC Preg Childbirth.* (2022) 22:117. doi: 10.1186/s12884-022-04457-w

32. Bergen N, Labonté R. "Everything is perfect, and we have no problems": detecting and limiting social desirability bias in qualitative research. *Qual Health Res.* (2020) 30:783–92. doi: 10.1177/1049732319889354

33. Veronese V, Clouse E, Wirtz AL, Thu KH, Naing S, Baral SD, et al. "We are not gays… don't tell me those things": engaging 'hidden' men who have sex with men and transgender women in HIV prevention in Myanmar. *BMC Public Health.* (2019) 19:63. doi: 10.1186/s12889-018-6351-3

34. Ritchwood TD, He J, Smith MK, Tang W, Ong JJ, Oduro A, et al. "Getting to zero" among men who have sex with men in China: a review of the HIV care continuum. *Curr HIV/AIDS Rep.* (2019) 16:431–8. doi: 10.1007/s11904-019-00472-3

35. Adeagbo O, Herbst C, Blandford A, McKendry R, Estcourt C, Seeley J, et al. Exploring people's candidacy for mobile health-supported HIV testing and care services in rural KwaZulu-Natal, South Africa: qualitative study. *J Med Internet Res.* (2019) 21:e15681. doi: 10.2196/15681

36. Logie CH, Lacombe-Duncan A, Brien N, Jones N, Lee-Foon N, Levermore K, et al. Barriers and facilitators to HIV testing among young men who have sex with men and transgender women in Kingston, Jamaica: a qualitative study. *J Int AIDS Soc.* (2017) 20:21385. doi: 10.7448/IAS.20.1.21385

37. Nannozi V, Wobudeya E, Gahagan J. Fear of an HIV positive test result: an exploration of the low uptake of couples HIV counselling and testing (CHCT) in a rural setting in Mukono district, Uganda. *Glob Health Promot.* (2017) 24:33–42. doi: 10.1177/1757975916635079

38. Chen W, Zhou F, Hall BJ, Tucker JD, Latkin C, Renzaho AMN, et al. Is there a relationship between geographic distance and uptake of HIV testing services? A representative population-based study of Chinese adults in Guangzhou, China. *PLoS ONE.* (2017) 12:e0180801. doi: 10.1371/journal.pone.0180801

39. Guo C, Yu M, Deng X, Gong H, Li Y, Li C, et al. The characteristics of internet-based venue sex-seeking and mobility among money boys in Tianjin, China. *HIV Med.* (2019) 20:473–84. doi: 10.1111/hiv.12746

40. Snyder H, Yeldandi VV, Prem Kumar G, Liao C, Lakshmi V, Gandham SR, et al. Field-based video pre-test counseling, oral testing, and telephonic post-test counseling: implementation of an HIV field testing package among high-risk Indian men. *AIDS Educ Prev.* (2012) 24:309–26. doi: 10.1521/aeap.2012.24.4.309

41. Tangari G, Ikram M, Ijaz K, Kaafar MA, Berkovsky S. Mobile health and privacy: cross sectional study. *BMJ.* (2021) 373:n1248. doi: 10.1136/bmj.n1248

42. Chen Q, Zhang Y, Evans R, Min C. Why do citizens share COVID-19 fact-checks posted by Chinese government social media accounts? The elaboration likelihood model. *Int J Environ Res Public Health.* (2021) 18:10058. doi: 10.3390/ijerph181910058

43. Lu L, Liu J, Yuan YC, Burns KS, Lu E, Li D. Source trust and COVID-19 information sharing: the mediating roles of emotions and beliefs about sharing. *Health Educ Behav.* (2021) 48:132–9. doi: 10.1177/1090198120984760

44. Carnevale C, Richards P, Cohall R, Choe J, Zitaner J, Hall N, et al. At home testing for sexually transmitted infections during the COVID-19 pandemic. *Sex Transm Dis.* (2021) 48:e11–4. doi: 10.1097/OLQ.0000000000001313

45. Rick F, Odoke W, van den Hombergh J, Benzaken AS, Avelino-Silva VI. Impact of coronavirus disease (COVID-19) on HIV testing and care provision across four continents. *HIV Med.* (2022) 23:169–77. doi: 10.1111/hiv.13180

46. Jiang H, Xie Y, Xiong Y, Zhou Y, Lin K, Yan Y, et al. HIV self-testing partially filled the HIV testing gap among men who have sex with men in China during the COVID-19 pandemic: results from an online survey. *J Int AIDS Soc.* (2021) 24:e25737. doi: 10.1002/jia2.25737

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Adolescent pregnancy in sub-Saharan Africa – a cause for concern

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Introduction

It is estimated that adolescent girls in low- and middle-income countries (LMICs) have approximately 21 million pregnancies each year (1). Adolescent pregnancy, which occurs amongst adolescent girls aged between 10 and 19 years, is associated with various public health concerns and increased risks of maternal mortality, low birthweight, and other severe neonatal complications (2). They also have an unfavourable impact on the mental, physical, and social wellbeing of adolescents, and remain a leading cause of death among adolescent girls globally (2).

Although a decline in adolescent birth rates (ABR) has been observed globally, sub-Saharan Africa (SSA) continues to have twice the global average, with over 100 births per 1,000 women, in 2021 (3). The estimated actual number of births among 15–19-year-olds was 6 114 000 and 332 000 among younger adolescents aged 10–14 years in SSA in 2021 (3). Africa has a higher proportion of youth compared to any other continent; and adolescent pregnancy rates are therefore likely to increase further in countries in SSA (4). Adolescent pregnancies are therefore a significant health concern and have been recognised as a key objective in the United Nations Sustainable Development Goals (SDGs) (5). The contributing factors for high ABR in SSA are heterogenous and differ amongst countries in SSA. Existing data on the contributing factors for adolescent pregnancies in SSA emanate from country specific studies and collective data is limited. However, a few studies that combined data from single country studies on the determinants of adolescent pregnancy have been conducted (6–8). Collectively, these studies suggest that inter alia, socio economic status, lack of parental communication and support, early marriage, religion, and low educational status of adolescents are contributing factors.

Economic, sociocultural, and environmental factors

Poverty is generally considered as an indicator of the economic status of a country. Studies from Ghana (9), South Africa (10) and Tanzania (11) demonstrate the relationship between poverty and coerced sexual relations with older men, as a means for adolescents to meet their basic financial needs. Adolescent girls may also become pregnant intentionally to receive government support grants intended for teenage mothers, without considering the consequences of their actions (12). Nigeria, the country with the largest economy in Africa had an adolescent pregnancy rate of 106 adolescent births per 1,000 population in 2021 and shows an increasing trend (13). In South Africa (SA), which has the second largest economy in Africa, the ABR is also high (14). In SA, the lack of adequate reproductive health services and appropriate sexuality education are part of the composite etiology that contributes to increasing ABR's (15). Between 2017 and 2021, births among girls aged 10–14 years and 15–19 years increased in SA by 48.7% and 17.9% respectively, and are likely to increase (16). In contrast, in Burundi, which has the lowest gross domestic product per capita in Africa (17), the adolescent fertility rate (births per 1,000 women ages 15–19) was 58/1,000 compared with the total fertility rate of 5.5/1,000 women in that country (18). These comparisons suggest that the economic status of countries in Africa remains part of a composite etiology, which may also include power imbalances, gender-based violence, substance abuse, lack of access to termination of pregnancy services, negative attitudes of caregivers and inadequate reproductive health education.

It has also been suggested that lower levels of education may be associated with adolescent pregnancies. In Niger, Mali, and Chad, where the adolescent fertility rates are amongst the highest in the world, the expected years of schooling attained by girls between the ages of 4 and 17 is fewer than seven years (2). On the contrary, other studies suggest that higher levels of education are likely to be associated with a lower likelihood of having a first adolescent pregnancy, particularly in SSA (4, 7). Adolescents with higher levels of education are more likely to delay the onset of sexual relations and marriage; and are more informed about their rights, reproductive health, timing of marriage and pregnancy (19).

Child marriages are also implicated as a contributing cause for high ABR's in SSA, particularly in the Congo and Central Africa (20). The Congo has one of highest rates of child marriage globally, with one in three girls married before age 18, and 7% married before the age of 15 (20). Similarly, other studies have also shown an association between child marriage and adolescent pregnancy in African countries (21, 22). Most girls who experience child marriage have low levels of education, live in poor households and often in rural areas, increasing their odds of engaging in behaviours that put them at risk of pregnancy (23). Data also suggests the association of child marriages with first pregnancy among adolescent girls in SSA (6). Pregnancies in these marriages may occur because of pressure from partners or family members to start families earlier or to prove reproductive potential. In most sub-Saharan African countries, adolescent girls may face social pressure to marry and, once married, to have children (4). In parts of South Africa, cultural practices like "ukuthwala" also lead to adolescent pregnancies. This practice involves the arranged marriage of girls below the age 18 mostly to older men, without the bride's consent (24). This type of marriage is in violation of the country's national law, as well as regional and international instruments to which this country is a party (24).

Individual factors

Individual perceptions about abstinence from sexual intercourse, early sexual debut, and negative perceptions about contraceptive usage among adolescents may contribute to adolescent pregnancies. Sexual coercion, low or incorrect use of contraceptives, and low self-esteem have also been suggested as contributing factors (6–8). Other personal factors may include stigma, fear of negative attitudes from parents and elders in the community and discrimination by healthcare providers. It has been suggested that healthcare providers may not appreciate the fears of adolescents regarding contraception or reproductive health issues, and adolescents themselves may not appreciate comprehensive sexuality education (10). Adolescents may also perceive contraceptive usage as a reserve for married couples, thereby contributing to low contraceptive uptake and resultant pregnancies (10). Additionally, a lack of awareness, misconceptions and poor knowledge about the range and use of contraceptive methods exists amongst some adolescents (25). Alternatively, some adolescents may desire pregnancy despite a suitable knowledge and available access to contraception. Career plans may also be affected, and poorly educated, unemployed and grant dependent youngsters pose an economic burden on the fiscus in the long term.

Health related factors

Teenagers may also face challenges in accessing reproductive health care in their communities. In some rural areas, the sparsity of clinics, long distances, and lack of transport may present barriers to access to reproductive health services. Judgemental attitudes of staff, particularly to teenagers seeking contraception or termination of pregnancy services should be avoided. Poor staff attitudes at termination of pregnancy clinics, may drive teenagers to seek "back street" terminations, with potential morbidity and even mortality.

The Covid epidemic may have exacerbated the problem further, with resultant school closures and access to contraception and healthcare services being unavailable or restricted during this period. A lock down of recreational, sporting, and other youth activities that keep youngsters occupied may also be a contributing factor. During the Covid period, secondary school girls in rural western Kenya were more likely to be sexually active, less likely to report their first sexual encounter, and reported increased hours of non-school-related work (26). Higher rates of teenage pregnancies were also seen in SA in the past 2 years, possibly in relation to the Covid 19 pandemic (27).

Unprotected sex, either consensual or resulting from sexual co-ercion and exploitation, predisposes young girls to contracting sexually transmitted infections and HIV. Evidence shows that adolescent girls and young women have the highest rate of acquisition of HIV currently (28). Most teenage pregnancies are unplanned and often concealed, and not only have a disruptive effect on the schooling trajectory of children, but are also associated with complicated pregnancies, difficult labour, challenges with breastfeeding and issues with the ongoing healthcare of the baby.

Mapping the way forward

Bold steps need to be taken and concerted efforts must be made to turn the tide of this trend. There should be a consolidation of efforts from various state and non-state actors to achieve a reduction in ABR's in SSA and globally. Data from South Asia, Middle East and North Africa indicates that ABR's dropped by between 75% and 80% by 2019 and continues to show a consistent decline (2). Activities that have proven to be effective in reducing adolescent pregnancy include the implementation of sexual and reproductive health policies, educational and vocational programs, empowerment initiatives, training activities, school retention programs and behaviour change campaigns (29).

Lessons can also be learnt from other countries which have had some success in reducing their ABR. In the Dominican Republic, a soft skills and vocational youth training program was shown to reduce the probability of teenage pregnancy by about 20% after implementation (30). In Mexico, the National Strategy for the Prevention of Adolescent Pregnancy (ENAPEA), a multisectoral approach is currently in the process of implementation to curb this phenomenon (31). In Northern Ireland live births from mothers aged 19 and younger dropped in 2020, largely due to progressive improvements in access to contraception and sexual education (32), and in the US the overall birth rate among 15- to 19-year-old girls dropped to half of what it had been in 2008 following various initiatives (33).

Similarly, many countries in SSA have developed and implemented national policies and programmes aimed at dealing with adolescent sexual and reproductive health (ASRH), including adolescent pregnancy (34).

In Ghana, the adolescent fertility rate declined steadily, and the country has also made progress in decreasing the rates of child marriage and school dropouts of girls (2). One of the key national policies for reducing adolescent pregnancy in Ghana is their Adolescent Health Service Policy and Strategy, which focuses on mainstreaming ASRH information, and gender-sensitive and responsive health services (35). These national policies coexist with programmes which are developed and implemented by both governmental and non-governmental organisations (36). In South Africa, the Department of Basic Education (DBE) has announced their implementation of comprehensive sexuality education (CSE) program in schools, which aims to empower young people with age-appropriate information about the cognitive, emotional, physical and social aspects of sexuality (37).

In Uganda, the Ministry of Education published revised guidelines for the prevention and management of teenage pregnancy in school settings, providing a policy to clarify the role of schools in adolescent pregnancies (38). At least 30 African Union countries now have laws, policies, and strategies in place that protect the rights of pregnant students and adolescent mothers to education (39).

Support grants are seen by some as a double edge sword in preventing teenage pregnancies. Perceptions that some recipients do not utilise the grant in the best interest of their children exist, and therefore need close monitoring by authorities. An alternate approach exists in Columbia, where a conditional cash transfer (CCT) program allows adolescent girls to receive a subsidy if they attended school, complete their school year, and enrol in the following year. This initiative was also effective in reducing pregnancy among adolescents across all grades included in the program (40).

A paradigm shift is required in the behaviour and attitude amongst teenagers themselves, supported by collective efforts from parents, teachers, healthcare providers and policy makers. Policymakers and community organisations should work in unison to develop and promote adolescent sexual and reproductive health policies and programmes, and emphasis should also be placed on human rights issues and gender empowerment programmes. The attitude of healthcare workers should be supportive rather than judgemental, and separate facilities should be considered for adolescent reproductive health services. Policy development, implementation strategies and quality assurance programmes are necessary to reduce adolescent pregnancies and meet the objectives of the United Nations Sustainable Development Goals (SDGs) (5).

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. World Health Organisation. Adolescent pregnancies. Available from: https://www.who.int/news-room/fact-sheets/detail/adolescent-pregnancy (Updated September 15, 2022; Accessed October 18, 2022).

2. World Bank. The social and educational consequences of adolescent childbearing. Available from: https://genderdata.worldbank.org/data-stories/adolescent-fertility (Updated February 25, 2022; Accessed September 30, 2022).

3. United Nations, Department of Economic and Social Affairs, Population Division. World population prospects. Available from: https://population.un.org/wpp/Download/Standard/Fertility (Updated 2022; Accessed October 18, 2022).

4. Ahinkorah BO, Kang M, Perry L, Brooks F, Hayen A. Prevalence of first adolescent pregnancy and its associated factors in sub-Saharan Africa: a multi-country analysis. *PLoS One*. (2021) 16(2):e0246308. doi: 10.1371/journal. pone.0246308

5. Inter-Agency and Expert Group in Sustainable Development Goal Indicators. Final list of proposed sustainable development goal indicators. Available from: https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf (Updated 2016; Accessed October 20, 2022).

6. Kassa GM, Arowojolu AO, Odukogbe AA, Yalew AW. Prevalence and determinants of adolescent pregnancy in Africa: a systematic review and meta-analysis. *Reprod Health*. (2018) 15(1):1–17. doi: 10.1186/s12978-018-0640-2

7. Yakubu I, Salisu WJ. Determinants of adolescent pregnancy in sub-Saharan Africa: a systematic review. *Reprod Health*. (2018) 15(1):1–15. doi: 10.1186/s12978-018-0460-4

8. Gunawardena N, Fantaye AW, Yaya S. Predictors of pregnancy among young people in sub-Saharan Africa: a systematic review and narrative synthesis. *BMJ Global Health*. (2019) 4(3):e001499. doi: 10.1136/bmjgh-2019-001499

9. Krugu JK, Mevissen FE, Prinsen A, Ruiter RA. Who's that girl? a qualitative analysis of adolescent girls' views on factors associated with teenage pregnancies in Bolgatanga, Ghana. *Reprod Health*. (2016) 13:39. doi: 10.1186/s12978-016-0161-9

10. Wood L, Hendricks F. A participatory action research approach to developing youth-friendly strategies for the prevention of teenage pregnancy. *Educ Action Res*. (2017) 25(1):103–18. doi: 10.1080/09650792.2016.1169198

11. Silberschmidt M, Rasch V. Adolescent girls, illegal abortions and "sugar-daddies" in Dar es salaam: vulnerable victims and active social agents. *Soc Sci Med*. (2001) 52(12):1815–26. doi: 10.1016/S0277-9536(00)00299-9

12. Lambani MN. Poverty the cause of teenage pregnancy in Thulamela municipality. *JSSA*. (2015) 6(2):171–6. doi: 10.1080/09766634.2015.11885656

13. Africa Check. Factsheet: understanding Nigeria's teenage pregnancy burden. Available from: https://africacheck.org/fact-checks/factsheets/factsheet-understanding-nigerias-teenage-pregnancy-burden (Updated June 21, 2021; Accessed September 27, 2021).

14. Kamer L. African countries with the highest Gross Domestic Product (GDP) in 2021. Statista. Available from: https://www.statista.com/statistics/1120999/gdp-of-african-countries-by-country (Updated May 17, 2021; Accessed October 2, 2022).

15. Ncwane N. Experts unpack causes of teenage pregnancy. IOL. Available from: https://www.iol.co.za/pretoria-news/news/experts-unpack-causes-of-teenage-pregnancy (Updated September 01, 2021; Accessed October 02, 2022).

16. Barron P, Subedar H, Letsoko M, Makua M, Pillay Y. Teenage births and pregnancies in South Africa, 2017–2021 - a reflection of a troubled country: analysis of public sector data. *SAMJ*. (2022) 112(4):252–8. doi: 10.7196/SAMJ.2022.v112i4.16327

17. World Population Review. Poorest countries in Africa. Available from: https://worldpopulationreview.com › country-rankings (Updated 2022; Accessed October 20, 2022).

18. Unicef. Adolescent investment case Burundi-Estimating the impacts of social sector investments for adolescents. Available from: https://www.unicef.org/esa/media/6111/file/UNICEF_ Burundi-Adolescent_Investment_Case-2020-English.pdf (Updated December 2019; Accessed September 23, 2022).

19. Poudel S, Upadhaya N, Khatri RB, Ghimire PR. Trends and factors associated with pregnancies among adolescent women in Nepal: pooled analysis of Nepal demographic and health surveys (2006, 2011 and 2016). *PloS One*. (2018) 13(8):e0202107. doi: 10.1371/journal.pone.0202107

20. UNICEF. Child marriage. Available from: https://data.unicef.org/topic/child-protection/child-marriage (Updated May 22, 2020; Accessed October 19, 2022).

21. Yaya S, Odusina EK, Bishwajit G. Prevalence of child marriage and its impact on fertility outcomes in 34 sub-Saharan African countries. *BMC Int Health Hum Rights*. (2019) 19(1):33. doi: 10.1186/s12914-019-0219-1

22. de Groot R, Kuunyem MY, Palermo T. Child marriage and associated outcomes in northern Ghana: a cross-sectional study. *BMC Public Health*. (2018) 18(1):1–12. doi: 10.1186/s12889-018-5166-6

23. UNICEF. *Ending child marriage: Progress and prospects*. New York: Northwest University (2014).

24. Machaka BJ. *The cultural practice of ukuthwala in South Africa* [*Dissertation*]. NWU (2019).

25. Boamah EA, Asante KP, Mahama E, Manu G, Ayipah EK, Adeniji E, et al. Use of contraceptives among adolescents in kintampo, Ghana: a cross-sectional study. *J Open Access J Contracept*. (2014) 5:7–15. doi: 10.2147/OAJC.S56485

26. Zulaika G, Bulbarelli M, Nyothach E, van Eijk A, Mason L, Eunice Fwaya E, et al. Impact of COVID-19 lockdowns on adolescent pregnancy and school dropout among secondary schoolgirls in Kenya. *BMJ Global Health*. (2022) 7:e007666. doi: 10.1136/bmjgh-2021-007666

27. Kim J. Teenage pregnancy during COVID-19 in South Africa: a double pandemic. Available from: https://www.samrc.ac.za/news/teenage-pregnancy-during-covid-19-south-africa-double-pandemic (Updated October 21, 2021; Accessed October 20, 2022).

28. Govender K, Beckett S, Reddy T, Cowden RG, Cawood C, Khanyile D, et al. Association of HIV intervention uptake with HIV prevalence in adolescent girls and young women in South Africa. *JAMA Netw Open*. (2022) 5(4):e228640. doi: 10.1001/jamanetworkopen.2022.8640

29. Cadena K, Hernandez PB, Inchauste G. Preventing teenage pregnancy: a priority for the well-being of women in Mexico. Available from: https://www.https://blogs.worldbank.org/latinamerica/preventing-teenage-pregnancy-priority-well-being-women-mexico (Updated April 13, 2022; Accessed October 19, 2022).

30. Novella R, Ripani L. Are you (not) expecting? The unforeseen benefits of job training on teenage pregnancy. *IZA J Labor Develop*. (2016) 5:19. doi: 10.1186/s40175-016-0065-7

31. ENAPEA. Government of Mexico (2019). Available from: https://enapea.segob.gob.mx/es/ENAPEA (Accessed Oct 22, 2022).

32. BBC News. Why are there fewer teenager mothers in Northern Ireland? (2021). Available from: https://www.bbc.com/news/uk-northern-ireland-59001641.

33. Martin JA, Brady E, Hamilton BE, Osterman M. Births in the United States, (2018). NCHS Data Brief; vol 3462019 Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/chs/data/databriefs/db346-h.pdf (Accessed Oct 2, 2022).

34. Ahinkorah BO, Kang M, Perry L. Prevention of adolescent pregnancy in anglophone sub-Saharan Africa: a scoping review of national policies. *Int J Health Policy Manag*. (2020) 11:726–39. doi: 10.34172/IJHPM.2020.185

35. Republic of Ghana. *Adolescent health service policy and strategy 2016-2020*. Accra: Ghana: The Republic of Ghana (2016).

36. Awuni A. NGO rolls out project to combat teenage pregnancy in upper East. Accra, Ghana, (2016). Available from: https://citifmonline.com/2016/04/ngo-rolls-out-project-to-combat-alarming-teenagepregnancy-in-ue/.

37. Department of Basic Education. Sexuality education lesson plans (2021). Available from: https://www.education.gov.za/Home/ComprehensiveSexualityEducation.aspx (Accessed Oct 17, 2022).

38. Ministry of Education and Sports. Revised guidelines for the prevention and management of teenage pregnancy in Uganda (2020). Available from: https://www.ungei.org/sites/default/files/2021-02/Revised-Guidelines.

39. Human Rights Watch. Africa: Rights progress for pregnant students. Available from: https://www.hrw.org/news/2021/09/29/africa-rights-progress-pregnant-students (Accessed on 20 Oct, 2022).

40. Cortés D, Gallego J, Maldonado D. Design of educational conditional cash transfer programs and their impact on non-education outcomes: the case of teenage pregnancy. *B.E. J Econ Anal Policy.* (2016) 16(1):219–58. doi: 10.1515/bejeap-2014-0162

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Self-care can be an alternative to expand access to universal health care: What policy makers, governments and implementers can consider for South Africa

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As a result of collaboration amongst the various decision-makers in the field of healthcare, there has been an improvement in the access to healthcare and living conditions globally. Nonetheless, poorer communities continue to benefit the least from public investment. To bridge the gap, self-care can be a viable alternative as it allows individuals and communities to reduce their dependence on government healthcare solutions. Barriers to self-care do exist. Some of these are cost effectiveness, usability of self-care instruments, differentiated strategies and linkage to care. In identifying these obstacles, it is also worthwhile to investigate how they can be mitigated. To encourage sustained self-care in the HIV continuum, contextual factors as well as the manner in which individuals and communities engage with self-care must be considered. In South Africa, multiple variables come into play: literacy levels, cultural influences, socio-economic conditions and access to resources are some of these. Evidence demonstrates how self-care can be promoted by various stakeholders re-strategising to tweak and in some cases totally change existing structures. This paper explores some of the transformations, like at a governmental level where the supply of HIV self-testing kits is increased, at a production level where instructions for use are reformatting, in communities where sports programmes fulfil the dual purpose of developing sport skills and providing HIV education concurrently, and at an individual level where greater awareness invites greater participation in self-care. While self-care is a promising proposal, it is not a replacement for traditional health-care practices, but a complementary approach

KEYWORDS
personal health management, comprehensive care, linkage to care, equitable healthcare, HIV

Introduction

The 1978 Alma-Ata declaration (1) directs governments and all stakeholders within the primary healthcare domain to promote and facilitate equitable healthcare for all. Some of the commendable global milestones achieved as a result, are that childhood deaths have decreased significantly, availing essential drugs has become more commonplace and antenatal care has improved (2). Unfortunately, the financially privileged continue to benefit more from public/government investment thus consuming the most care, at the expense of the poor, for whom the opposite holds true (3, 4). The global response to the COVID-19 pandemic exemplifies this unfortunate reality where inequity with regard to COVID-19 vaccine production and access persists (5). Given the impact that a country's economic state has on the quality of primary healthcare it provides, it would seem prudent to explore alternatives than depending solely on governments to satisfy citizens' healthcare needs. Self-care is one such alternative.

The WHO defines self-care as "the ability of individuals, families and communities to promote health, prevent disease, maintain health, and to cope with illness and disability with or without the support of a healthcare provider" (6). Working within the ambit of this definition, self-care will primarily refer to activities related to the self-management of health, such as: lifestyle modifications and behaviour change, self-screening and self-testing (e.g., for HIV and Hepatitis), self-monitoring (e.g., tracking blood sugar and blood pressure levels), self-management of acute illnesses and adherence to medication. With the rapid increase in self-care interventions, there is a shift in the way healthcare is perceived, understood, and accessed (7).

In South Africa, the need for self-care is becoming increasingly apparent. Patients seeking care have frequently not been able to receive it due to service-delivery shortfalls (8, 9). This, coupled with the fact that by 2019, 84% of South Africans depended on public health systems to fulfil their healthcare needs (8). Self-care interventions can unburden primary healthcare clinics (PHCs), and provide convenient ways for patients to manage their health. During the Covid-19 pandemic, the need for self-care interventions became more evident particularly for patients with co-morbidities like diabetes mellitus, since self-care can allow diabetes patients to engage in healthcare behaviour that makes them more likely to survive Covid-19, should they contract it (10). For self-care to be feasible as an alternate means of accessing health care and decongesting facilities, cost effectiveness, usability of self-care instruments, differentiated self-care strategies and linkage to care concerns need to be considered.

In South Africa, healthcare coverage particularly in relation to HIV and Tuberculosis declined in some regions due to COVID care taking precedence over routine health services (11). In order to mitigate for this and losses resulting from other possible unforeseen future health crises, self-care may well be a practical solution. While this may be so, El-Osta A, et al. in their self-care matrix (**Figure 1**) illustrates that self-care does not begin and end with the patient. For it to be workable and sustainable, it needs the support of both community (at a meso level) and policy-makers (at a macro level). For example, while an HIV positive patient might adopt a healthier life-style, they still require support within their communities by being able to easily access the assistance of health care workers in their vicinity, but this can only be possible if systems and policies are in place to supply the required number of HCW and provide the necessary facilities (12).

Viability of self-care

Cost effectiveness

While the functional approach to increasing access to healthcare is to reduce its cost, it should not compromise the quality of healthcare (13). With regard to self-care, the financial demands it places on the patient affects the extent to which they can interact with self-care activities, irrespective of the patient's desire to embrace it (14).

Because of the nature of self-care interventions like self-monitoring, or self-screening, people expect such interventions to provide them with immediate or direct benefits (15). However, these benefits may not outweigh their costs, particularly if individuals are responsible for the costs themselves. Although self-care often means self-financed, ideally, interventions begun in health facilities and shifted to home settings should not garner additional costs to the patient nor require further subsidisation. There is a fair amount of evidence to suggest that self-care could reduce direct patient costs and the risk of financial hardships (16). The HIV Self-Testing in Africa (STAR) Phase 2 Evaluation Report shows how HIV self-testing (HIVST) cost will potentially decrease as newer products enter the market (17).

Furthermore, patients who opt for self-care, can often obviate their transport costs and needing to visit hospitals for HIV related care (18). This is crucial for patients in low income settings whose financial constraints are a barrier to seeking medical attention (19). Cost efficiency resulting from self-care can extend beyond the patient too. Increased numbers of patients who engage in self-care practices, means that healthcare facilities and healthcare workers will likely experience reduced and possibly manageably patient loads (20). Thus, health systems stand a greater chance of being more efficient and more targeted (16).

Various reports estimate large cost savings from self-care, however, whether all patients are able to care for themselves competently independently of a healthcare worker must be considered.

Usability of self-care instruments

Self-care interventions play a pivotal role in the prevention, identification, management, treatment optimisation, and decreasing disease incidence (21). For self-care to be a viable option, patients need to demonstrate a level of self-efficacy, which can be defined as a person's belief in their own ability

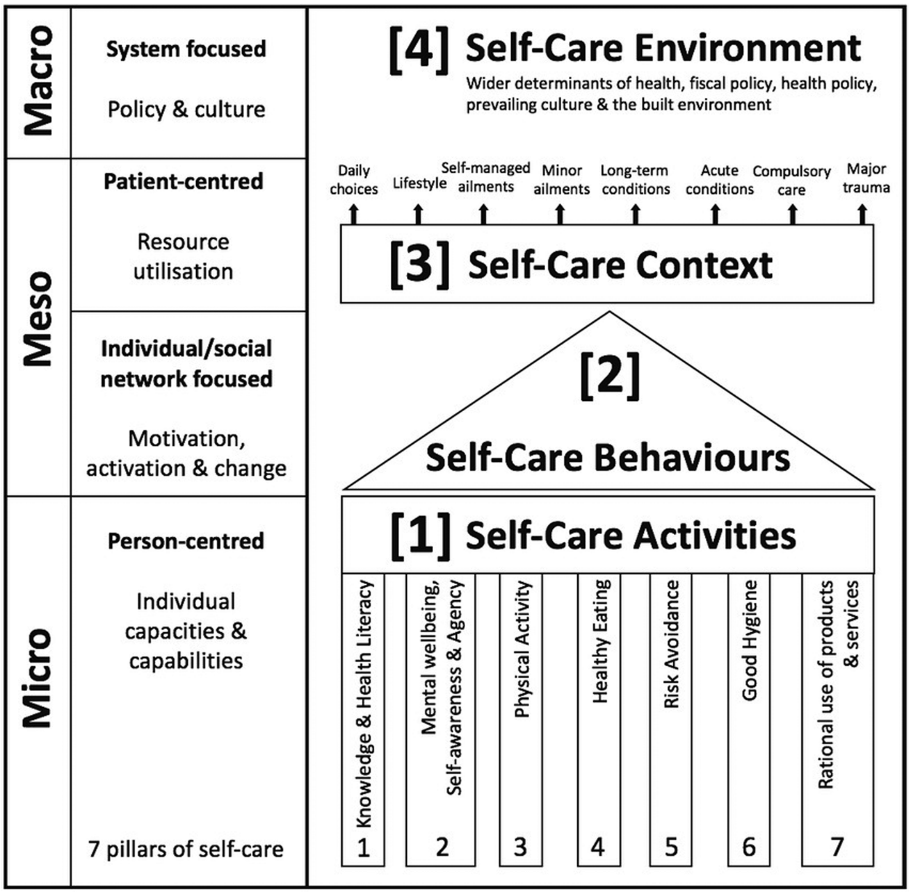

FIGURE 1
The self-care matrix (SCM).

to organise their behaviour for the purpose of achieving the desired outcome (22). Within the healthcare context, this would mean patients being able to engage with instructions for use (IFU), instruments and equipment and availing alternate monitoring methods in an independent manner.

Independence hinges on the end user being able to comprehend instructions for the use of medication and instruments (23). In South Africa, over 4 million adults are illiterate (24, 25), so it is to be expected that for poorly literate patients, there will be limitations in their ability, particularly when it comes to comprehending written IFU, resulting in the correct engagement with various self-care activities being compromised. One common effect of poor comprehension of IFU is patients taking the incorrect dosage of medication (26, 27).

To combat the pre-requisite of being literate for a person to be able to adopt self-care, methods of information dissemination that go beyond the written word, such as videos, need to be employed (28, 29). Similar considerations need to be made with regards to the language used in IFU, given that SA has 11 official languages. Therefore, for successful use of self-monitoring devices, patient autonomy and its relationship to literacy and comprehension levels of end-users must be considered (30).

Compared to people without HIV, people living with HIV (PLHIV) find themselves twice as likely to be at risk for cardiovascular disease (CVD) and their mortality risk increases if the CVD risk is left unmitigated (31). Hypertension (HTN) is a recognised contributor to PLHIV developing CVD, yet its monitoring particularly in Sub Saharan Africa remains underwhelming. Among the many reasons for this, like stigmatisation and insufficient personnel, non-optimisation of blood pressure (BP) monitoring devices is one (32). Teshome DF et al. identify the lack of sufficient BP monitors and appropriately skilled health extension workers as being hindrances to home-based HTN screening in a rural Ethiopian region. They put forward that establishing systems that address the minimising of these obstacles would render home-based HTN monitoring to be a practicable option (33). Moreover, availing testing instruments and equipment, like blood pressure (BP) monitors and wearables to patients, which can be used in their homes, is a further means to promote independence. Such is the need that the WHO developed interventions for primary health care in low-resource settings, some of which include the self-monitoring of BP to manage hypertension for example, where access and cost are not hindering factors (14).

On a systemic level, digital health platforms provide further solutions to promote self-care, as these also have the advantage of allowing patients to monitor (34) their health without needing to visit healthcare facilities. South Africa has a significant rural population for whom accessing healthcare services is often problematic. Rural communities can benefit significantly from telehealth offerings that would otherwise be unavailable to them in person (35). This possibility becomes particularly important when information needs to be disseminated urgently, as we experienced during the Covid-19 pandemic. Research into the viability of HIV related health apps like iThemba (36) which facilitate the monitoring and medication of HIV patients, have already shown that they can be beneficial to patients who ordinarily would need to visit clinics at short intervals and pick up medications at centralised healthcare facilities.

Irrespective of how encouraging these interventions are, overcoming the current obstacles to its uptake needs more robust efforts to mitigate the costs and practicalities associated with establishing e-/ telehealth pathways (37, 38). A further complement to patients being able to monitor their own health, is the strengthening of individual and community engagement in the promotion of healthcare.

Differentiated healthcare

Among the variables which influence an individual's willingness to embrace self-management of their health, are the intersectionalities of culture, sex, gender, age and class (39, 40). To address particular needs of various sections of society, differentiation in health-management is a practical approach. Differentiated care support is not new in South Africa's healthcare system, and was envisioned as a client-centred approach that simplifies and adapts chronic services to manage HIV across the cascade of care, while decongesting burdened health facilities (41).

Differentiated care support needs to expand, to address the additional self-care activities required for effective self-management of chronic conditions. Some of these additional interventions include education and community engagement to promote behaviour and lifestyle modifications (42).

Health education is pivotal in promoting healthy life-styles, encouraging individuals to take accountability for their health (43). Perhaps to kickstart community-based initiatives, investing in national educational programmes that target youth might be a feasible approach. The Grassroots SS (44) of which SKILLZ Street (45) is an example of how health education can be included within youth empowerment projects. In this initiative, young girls learn about their sexual reproductive health and rights, and general life skills which are essential in steering their decision making in terms of sexual behaviour and reproductive health (44–46). While innovative educational strategies such as this are promising, such interventions need to be enhanced and sustained as innovative health education strategies have been shown to enjoy success when entrenched at a structural level (29, 47).

However, society does not only have to rely solely on directives from health authorities in how to manage their health. Malama K et al. (2022) explain that ensuring that communities have adequate education on HIV self-care practices as well how to avail such, can play a significant role in promoting HIV self-care (48). This is especially true for vulnerable populations like the elderly. A recent South African study revealed that healthcare for the aged particularly in low-resource communities is sorely lacking in patient-centredness, resulting in inadequate health care for this sector of the population (49). A means to overcoming this marginalisation of the elderly (43) is to provide them with the skills and opportunities that they require to adopt and maintain self-care whenever possible. Studies conducted on the viability of self-care among older persons following an acute illness admission show a decline in ones' s ability to perform activities of daily living such as bathing, eating, and walking (50, 51), therefore, one's ability to self-care post hospitalization necessitates binary support systems such as home based care (52).

Knight L, et al. (2018) suggest the formulation of *Chronic Care Clubs* in a community setting, which decentralise HIV treatment and monitoring for the elderly with co-morbidities, thereby providing them with a workable way to manage their conditions (53). Understanding these dynamics, and their implications can provide valuable insight to allow for the planning and execution of alternative healthcare interventions to cater particularly to people in low income and vulnerable communities (54), including women who require emergency maternal care (55).

On a more individualised level, differentiation can also take into consideration the cultural (40) values and attitudes that influence gender roles. In African and Asian societies, these values play a major role in health decisions: men are largely the sole decision makers in their families. However, studies show that in such circumstances, women are often eager to bypass the cultural expectations. For example, when offered self-care approaches to HIV testing, most women in rural SA opted for HIV self-testing because they felt more empowered, and independent (56).

Thus it is important to understand all enabling factors that help or disturb self-care behaviours and strategize ways in which to mitigate them. In doing so, deep-rooted behaviour and attitudes which are detrimental to health and self-care may be able to be changed.

Policy makers, implementers and governments should also consider fostering collective healthy living through community exercise sessions (42), to support self-care practice.

Delayed linkage to care concerns

Linkage to care is a self-management intervention which offers strategies that promote active participation of individuals in their health, and ways to reach improved outcomes like increased access to testing (57). However, for self-care to be viable, patients must understand that synergies between self-care, and facility-based health provision are negotiated by the severity of a condition, the complexity of its care, and the expertise required to manage a patient's health (13). So, despite the promising future of self-care, it must be remembered that practising self-care activities is an accompaniment to, not an obliteration of the need to link to professional care.

The term "linkage to care" was first coined to define a patient's initial clinical visit, following an HIV positive, and most recently, reactive self-screening result. It is regarded as a crucial step in the management of HIV and viral suppression (58). In South Africa, while HIV self-screening can be attributed to an increase in access to HIV testing, it is also reported to have worsened the rate at which people link to care (59).

Evidence points to financial constraints and time needed to access health facilities, patient and provider relationships (60–62), as well as transport vulnerability (63, 55) as being key indicators to delayed care. Like in Kenya and Tanzania, decreased linkage and retention in care in SA can also be attributed to discrimination (64) and staff attitudes (65, 66).

While various initiatives such as mobile health clinics (67) for hard to reach communities, mobile health for pregnant mothers (68) and Pulmonary Tuberculosis patients (69),, self-triage apps for acute illnesses (70) and community tracking initiatives have been instrumental in addressing some of the gaps in linkage to care, a lot of work is required in addressing barriers to facility attendance, such as patient satisfaction and provider communication (71).

Limited access to the internet, language barrier and in some instances, infrastructural resources such as mobile health cars can pose limitations to these recommendations, particularly in poorer countries.

Discussion

The integral role that self-care plays in empowering lay people to assume responsibility for their own health has been advocated as a method to mitigate non-communicable diseases (NCD) (72) and most recently, even the COVID-19 pandemic (73).These interventions necessitate varying levels of self-care activities on the part of the patient, and to be successful, patients must adhere to medication and lifestyle modifications, and with HIV, self-monitor their conditions. Some factors which need to be considered when contemplating the extent to which self-care can be initiated and sustained is cost effectiveness, usability of self-care instruments, differentiated self-care strategies and linkage to care.

A key driver in self-care decision making is the financial implications at personal and institutional levels. There is an acknowledgement that access to health insurance plans have a positive impact on a patient's inclination to enter into self-care (74). For self-care interventions to be sustainably financed, a combination of government subsidies, private financing, insurance coverage, and partial out-of-pocket payments will need to be considered. In some countries with social health insurance, insurance providers partially cover healthcare, and various studies/reports estimate large cost savings from self-care.. Be that as it may, the health system is still accountable for the outcomes from the use of self-care and needs to closely monitor the economic consequences of self-care (16, 21).

Apart from economic concerns, in South Africa for example, one of the barriers to linkage to care in HIV patients is that while patients are willing and able to collect medication from alternative facilities like community based ones, the lack of interface with health workers resulted in patients being more reluctant to visit these facilities (75). The fear of stigmatisation, real or perceived, around having HIV is also a considerable barrier to care linkage (76). A recent study highlights how urban and rural communities approach self-management of HIV differently, where rural communities are less keen to embrace support because of fears of being discriminated against (77). In light of the above-mentioned concerns, it is clear that even though efforts can be made to reduce the costs involved with linking to care, more effort needs to be placed in mitigating the personal distress of HIV patients, which are often borne from cultural and context-related biases.

Creating awareness related to one's health is an integral part of self-care, and one study postulates that awareness of the indications of having contracted HIV plays the most powerful role in whether an individual links to care (78). In response to the COVID-19 pandemic, coproduction has been suggested as a means for communities to minimising their reliance on government-initiated healthcare strategies. Furthermore, communities can also draw on their own experiences and strategise ways in which to work around the barriers that compromise their engagement in personal health maintenance (79). The same argument could well be applied to motivating communities to extend responsibility for their health beyond COVID-19.

While the self-care interventions discussed in this paper are drawn from the lessons learned from HIV and/or COVID-19, the paper points out common issues about self-care that are relevant to other health conditions, such as Diabetes (54).

Self-care interventions will not work in isolation and should not replace traditional, conventional healthcare. Further research is required to understand how best to link self-care practices to service delivery in facilities. Therefore, to bridge the gap between self-management of disease, treatment, and support, policy makers and governments should consider how linkage to care can be facilitated.

Conclusion

To reimagine health systems that can withstand pressure from growing health concerns, a portion of healthcare must be patient-led, and self-administered. However, while self-care interventions are an important aspect of healthcare provision, and can address some barriers, such as waiting times, privacy, confidentiality and cost, self-care practices do not negate the need to visit a health facility for further management.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Materials, further inquiries can be directed to the corresponding author/s.

Author contributions

Conceptualization was done by AN. First drafts were written by AN, SN, TJ and SG. AN and LS proof-read and edited the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. World Health Organization. Regional Office for E. Declaration of Alma-Ata. Copenhagen: World Health Organization. Regional Office for Europe; 1978 1978. Contract No.: WHO/EURO:1978-3938-43697-61471.

2. World Health O. *The world health report 2008: Primary health care now more than ever*. Geneva: World Health Organization (2008).

3. Hart JT. The inverse care law. *Lancet*. (1971) 1(7696):405–12. doi: 10.1016/S0140-6736(71)92410-X

4. Filmer D. The incidence of public expenditures on health and education. Background note for the World Development Report. 2004.

5. Ye Y, Zhang Q, Wei X, Cao Z, Yuan H-Y, Zeng DD. Equitable access to COVID-19 vaccines makes a life-saving difference to all countries. *Nat. Human Behav*. (2022) 6(2):207–16. doi: 10.1038/s41562-022-01289-8

6. WHO Guidelines Approved by the Guidelines Review Committee. *WHO Consolidated guideline on self-care interventions for health: sexual and reproductive health and rights*. Geneva: World Health Organization © World Health Organization (2019).

7. WHO. Self care during COVID-19. 2020.

8. Maphumulo WT, Bhengu BR. Challenges of quality improvement in the healthcare of South Africa post-apartheid: a critical review. *Curationis*. (2019) 42(1):e1–9. doi: 10.4102/curationis.v42i1.1901

9. Malakoane B, Heunis JC, Chikobvu P, Kigozi NG, Kruger WH. Public health system challenges in the free state, South Africa: a situation appraisal to inform health system strengthening. *BMC Health Serv Res*. (2020) 20(1):58. doi: 10.1186/s12913-019-4862-y

10. Mukona DM, Zvinavashe M. Self- management of diabetes mellitus during the COVID-19 pandemic: recommendations for a resource limited setting. *Diabetes Metab Syndr*. (2020) 14(6):1575–8. doi: 10.1016/j.dsx.2020.08.022

11. Pillay Y, Pienaar S, Barron P, Zondi T. Impact of COVID-19 on routine primary healthcare services in South Africa. *S Afr Med J*. (2021) 111(8):714–9. doi: 10.7196/SAMJ.2021.v111i8.15786

12. El-Osta A. The self-care matrix: a unifying framework for self-care. *Int J Self Help Self Care*. (2019) 10:38–56. https://selfcarejournal.com/article/the-self-care-matrix-a-unifying-framework-for-self-care/

13. Ryan A, Greenfield S, McManus R, Wilson S. Self-care–has DIY gone too far? *Br J Gen Pract*. (2006) 56(533):907–8. PMID: 17132376; PMCID: PMC1934048

14. Narasimhan M, Allotey P, Hardon A. Self care interventions to advance health and wellbeing: a conceptual framework to inform normative guidance. *Br Med J*. (2019) 365:l688. doi: 10.1136/bmj.l688

15. Bryant KB, Sheppard JP, Ruiz-Negrón N, Kronish IM, Fontil V, King JB, et al. Impact of self monitoring of blood pressure on processes of hypertension care and long; term blood pressure control. *J Am Heart Assoc*. (2020) 9(15):e016174. doi: 10.1161/JAHA.120.016174

16. Remme M, Narasimhan M, Wilson D, Ali M, Vijayasingham L, Ghani F, et al. Self care interventions for sexual and reproductive health and rights: costs, benefits, and financing. *Br Med J*. (2019) 365:l1228. doi: 10.1136/bmj.l1228

17. UNITAID STAR. (self-testing Africa) Initiative: Phase 2 end of project evaluation. 2021.

18. d'Elbée M, Makhetha MC, Jubilee M, Taole M, Nkomo C, Machinda A, et al. Using HIV self-testing to increase the affordability of community-based HIV testing services. *Aids*. (2020) 34(14):2115–23. doi: 10.1097/QAD.0000000000002664

19. Hopkins J, Narasimhan M. Access to self-care interventions can improve health outcomes for people experiencing homelessness. *Br Med J*. (2022) 376:e068700. doi: 10.1136/bmj-2021-068700

20. McBain H, Shipley M, Newman S. The impact of self-monitoring in chronic illness on healthcare utilisation: a systematic review of reviews. *BMC Health Serv Res.* (2015) 15(1):565. doi: 10.1186/s12913-015-1221-5

21. Narasimhan M, Kapila M. Implications of self-care for health service provision. *Bull World Health Organ.* (2019) 97(2):76. -a. doi: 10.2471/BLT.18.228890

22. Luszczynska A, Scholz U, Schwarzer R. The general self-efficacy scale: multicultural validation studies. *J Psychol.* (2005) 139:439–57. doi: 10.3200/JRLP.139.5.439-457

23. Branaghan RJ, O'Brian JS, Hildebrand EA, Foster LB. Designing instructions for use(rs). In: RJ Branaghan, JS O'Brian, EA Hildebrand, LB Foster, editors. *Humanizing healthcare – human factors for medical device design*. Cham: Springer International Publishing (2021). p. 333–50.

24. Adult Illiteracy in South Africa.

25. Janse van Rensburg Z. Levels of health literacy and English comprehension in patients presenting to South African primary healthcare facilities. *Afr J Prim Health Care Fam Med.* (2020) 12(1):e1–6. doi: 10.4102/phcfm.v12i1.2104

26. DeWalt DA, Berkman ND, Sheridan S, Lohr KN, Pignone MP. Literacy and health outcomes. *J Gen Intern Med.* (2004) 19(12):1228–39. doi: 10.1111/j.1525-1497.2004.40153.x

27. Bailey SC, Agarwal N, Sleath B, Gumusoglu S, Wolf MS. Improving drug labeling and counseling for limited English proficient adults. *J Health Care Poor Underserved.* (2011) 22(4):1131–43. doi: 10.1353/hpu.2011.0145

28. Mbanda N, Dada S, Bastable K, Ingalill G-B, Ralf WS. A scoping review of the use of visual aids in health education materials for persons with low-literacy levels. *Patient Educ Couns.* (2021) 104(5):998–1017. doi: 10.1016/j.pec.2020.11.034

29. Adam M, McMahon SA, Prober C, Bärnighausen T. Human-centered design of video-based health education: an iterative, collaborative, community-based approach. *J Med Internet Res.* (2019) 21(1):e12128. doi: 10.2196/12128

30. Rabie T, Klopper HC, Watson MJ. Relation of socio-economic status to the independent application of self-care in older persons of South Africa. *Health SA Gesondheid.* (2016) 21(1):155–61. doi: 10.1016/j.hsag.2015.02.007

31. Galaviz KI, Colasanti JA, Kalokhe AS, Ali MK, Ofotokun I, Fernandez A. Factors associated with adherence to guideline-recommended cardiovascular disease prevention among HIV clinicians. *Transl Behav Med.* (2021) 12 (1):142–8. doi: 10.1093/tbm/ibab125

32. Okello S, Amir A, Bloomfield GS, Kentoffio K, Lugobe HM, Reynolds Z, et al. Prevention of cardiovascular disease among people living with HIV in sub-saharan Africa. *Prog Cardiovasc Dis.* (2020) 63(2):149–59. doi: 10.1016/j.pcad.2020.02.004

33. Teshome DF, Balcha SA, Ayele TA, Atnafu A, Sisay M, Asfaw MG, et al. Perceived barriers and enablers influencing health extension workers toward home-based hypertension screening in rural northwest Ethiopia: interpretive descriptive study. *BMC Health Serv Res.* (2022) 22(1):1156. doi: 10.1186/s12913-022-08523-z

34. Gajarawala SN, Pelkowski JN. Telehealth benefits and barriers. *J Nurse Pract.* (2021) 17(2):218–21. doi: 10.1016/j.nurpra.2020.09.013

35. Moreno-Chaparro J, Parra Esquivel EI, Santos Quintero AL, Paez L, Martinez Quinto S, Rojas Barrios BE, et al. Telehealth interventions aimed at parents and caregivers of children living in rural settings: a systematic review. *Child CarePract.* (2022):1–25. doi: 10.1080/13575279.2022.2083075. https://www.tandfonline.com/doi/full/10.1080/13575279.2022.2083075

36. Lalla-Edward ST, Mashabane N, Stewart-Isherwood L, Scott L, Fyvie K, Duncan D, et al. Implementation of an mHealth app to promote engagement during HIV care and viral load suppression in Johannesburg. *S Afr (IThemba Life).* (2022) 6(2):e26033. doi: 10.2196/26033

37. Aveling EL, Martin G, Herbert G, Armstrong N. Optimising the community-based approach to healthcare improvement: comparative case studies of the clinical community model in practice. *Soc Sci Med.* (2017) 173:96–103. doi: 10.1016/j.socscimed.2016.11.026

38. Mustafa AS, Na A, Dhillon JS, Alkawsi G, Baashar Y. User engagement and abandonment of mHealth: a cross-sectional survey. *Healthcare.* (2022) 10(2):221. doi: 10.3390/healthcare10020221

39. Gkiouleka A, Huijts T, Beckfield J, Bambra C. Understanding the micro and macro politics of health: inequalities, intersectionality & institutions - A research agenda. *Soc Sci Med.* (2018) 200:92–8. doi: 10.1016/j.socscimed.2018.01.025

40. Osokpo O, Riegel B. Cultural factors influencing self-care by persons with cardiovascular disease: an integrative review. *Int J Nurs Stud.* (2021) 116 (103383):1–9. doi: 10.1016/j.ijnurstu.2019.06.014

41. Huber A, Pascoe S, Nichols B, Long L, Kuchukhidze S, Phiri B, et al. Differentiated service delivery models for HIV treatment in Malawi. *South Afr Zambia.* (2021) 9(2):296–307. doi: 10.9745/GHSP-D-20-00532

42. Broyles ST, Gollub EA, Tohme A, Katzmarzyk PT. Improving health behaviors through community engagement: challenge for a healthier Louisiana. *Health Promot Pract.* (2020) 21(1):106–13. doi: 10.1177/1524839918792018

43. Heine M, Lategan F, Erasmus M, Lombaard C-M, Mc Carthy N, Olivier J, et al. Health education interventions to promote health literacy in adults with selected non-communicable diseases living in low-to-middle income countries: a systematic review and meta-analysis. *J Eval Clin Pract.* (2021) 27(6):1417–28. doi: 10.1111/jep.13554

44. Africa) GSSAGS. Grassroot Soccer South Africa (GRS South Africa).

45. SKILLZ STREET - Grassroot soccer

46. Peacock-Villada P, DeCelles J, Banda PS. Grassroot Soccer resiliency pilot program: building resiliency through sport-based education in Zambia and South Africa. *New Dir Youth Dev.* (2007) 2007(116):141–54. doi: 10.1002/yd.241

47. Brieger WR, Delano GE, Lane CG, Oladepo O, Oyediran KA. West African youth initiative: outcome of a reproductive health education program. *J Adolesc Health.* (2001) 29(6):436–46. doi: 10.1016/S1054-139X(01)00264-6

48. Malama K, Logie CH, Narasimhan M, Ouedraogo L, Asmani C, Elamin H, et al. Short communication: awareness of HIV self-care interventions across global regions: results from a values and preferences survey. *AIDS Res Hum Retroviruses.* (2022) 38(8):645–8. doi: 10.1089/aid.2021.0200

49. Kelly G, Mrengqwa L, Geffen L. "They don"t care about us": older people's experiences of primary healthcare in Cape Town, South Africa. *BMC Geriatr.* (2019) 19(1):98. doi: 10.1186/s12877-019-1116-0

50. Covinsky KE, Palmer RM, Fortinsky RH, Counsell SR, Stewart AL, Kresevic D, et al. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. *J Am Geriatr Soc.* (2003) 51(4):451–8. doi: 10.1046/j.1532-5415.2003.51152.x

51. Ehlenbach WJ, Larson EB, Randall Curtis J, Hough CL. Physical function and disability after acute care and critical illness hospitalizations in a prospective cohort of older adults. *J Am Geriatr Soc.* (2015) 63(10):2061–9. doi: 10.1111/jgs.13663

52. Lin I, Glinsky J, Dean C, Graham P, Scrivener K. Effectiveness of home-based exercise for improving physical activity, quality of life and function in older adults after hospitalisation: a systematic review and meta-analysis. *Clin Rehabil.* (2022) 36(9):1170–85. doi: 10.1177/02692155221095936

53. Knight L, Schatz E, Mukumbang FC. "I attend at Vanguard and I attend here as well": barriers to accessing healthcare services among older South Africans with HIV and non-communicable diseases. *Int J Equity Health.* (2018) 17(1):147. doi: 10.1186/s12939-018-0863-4

54. Werfalli MM, Kalula SZ, Manning K, Levitt NS. Does social support effect knowledge and diabetes self-management practices in older persons with Type 2 diabetes attending primary care clinics in Cape Town, South Africa? *PLoS One.* (2020) 15(3):e0230173. doi: 10.1371/journal.pone.0230173

55. Oluwaseun Aladesanmi APD, Storey A. Senior Director, Maternal, Newborn and Reproductive Health. Bridging emergency transportation gaps during the COVID-19 pandemic. 2020.

56. Pettifor A, Lippman SA, Kimaru L, Haber N, Mayakayaka Z, Selin A, 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. *eClinicalMedicine.* (2020) 21:1–10. doi: 10.1016/j.eclinm.2020.100327

57. Ingold H, Mwerinde O, Ross AL, Leach R, Corbett EL, Hatzold K, 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(Suppl Suppl 1)]:e25249. doi: 10.1002/jia2.25249

58. Croxford S, Raben D, Jakobsen SF, Burns F, Copas A, Brown AE, et al. Defining linkage to care following human immunodeficiency virus (HIV) diagnosis for public health monitoring in Europe. *Euro Surveill.* (2018) 23 (48):1–5. doi: 10.2807/1560-7917.ES.2018.23.48.1700858

59. Witzel TC, Eshun-Wilson I, Jamil MS, Tilouche N, Figueroa C, Johnson CC, 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 (1):381. doi: 10.1186/s12916-020-01835-z

60. Sanga ES, Mukumbang FC, Mushi AK, Lerebo W, Zarowsky C. Understanding factors influencing linkage to HIV care in a rural setting, Mbeya, Tanzania: qualitative findings of a mixed methods study. *BMC Public Health.* (2019) 19(1):383. doi: 10.1186/s12889-019-6691-7

61. Mason L, Dellicour S, Ter Kuile F, Ouma P, Phillips-Howard P, Were F, et al. Barriers and facilitators to antenatal and delivery care in western Kenya: a qualitative study. *BMC Pregnancy Childbirth.* (2015) 15(1):26. doi: 10.1186/s12884-015-0453-z

62. Alberti H, Boudriga N, Nabli M. Primary care management of diabetes in a low/middle income country: a multi-method, qualitative study of

barriers and facilitators to care. *BMC Fam Pract*. (2007) 8(1):63. doi: 10.1186/1471-2296-8-63

63. Sagrestano L, Clay J, Finerman R, Gooch J, Rapino M. Transportation vulnerability as a barrier to service utilization for HIV-positive individuals. *AIDS Care*. (2013) 26(3):314–9. doi: 10.1080/09540121.2013.819403

64. Müller A. Scrambling for access: availability, accessibility, acceptability and quality of healthcare for lesbian, gay, bisexual and transgender people in South Africa. *BMC Int Health Hum Rights*. (2017) 17(1):16. doi: 10.1186/s12914-017-0124-4

65. Ameh S, Klipstein-Grobusch K, D'ambruoso L, Kahn K, Tollman SM, Gómez-Olivé FX. Quality of integrated chronic disease care in rural South Africa: user and provider perspectives. *Health Policy Plan*. (2016) 32(2):257–66. doi: 10.1093/heapol/czw118

66. Versfeld A, McBride A, Scheibe A, Spearman CW. Motivations, facilitators and barriers to accessing hepatitis C treatment among people who inject drugs in two South African cities. *Harm Reduct J*. (2020) 17(1):39. doi: 10.1186/s12954-020-00382-3

67. Smith P, Tolla T, Marcus R, Bekker L-G. Mobile sexual health services for adolescents: investigating the acceptability of youth-directed mobile clinic services in Cape Town, South Africa. *BMC Health Serv Res*. (2019) 19(1):584. doi: 10.1186/s12913-019-4423-4

68. Skinner D, Delobelle P, Pappin M, Pieterse D, Esterhuizen TM, Barron P, et al. User assessments and the use of information from MomConnect, a mobile phone text-based information service, by pregnant women and new mothers in South Africa. *BMJ Global Health*. (2018) 3(Suppl 2):e000561. doi: 10.1136/bmjgh-2017-000561

69. Bao Y, Wang C, Xu H, Lai Y, Yan Y, Ma Y, et al. Effects of an mHealth intervention for pulmonary Tuberculosis self-management based on the integrated theory of health behavior change: randomized controlled trial. *JMIR Public Health Surveill*. (2022) 8(7):e34277. doi: 10.2196/34277

70. Verzantvoort NCM, Teunis T, Verheij TJM, van der Velden AW. Self-triage for acute primary care via a smartphone application: practical, safe and efficient? *PLoS One*. (2018) 13(6):e0199284. doi: 10.1371/journal.pone.0199284

71. Mabuto T, Charalambous S, Hoffmann CJ. Effective interpersonal health communication for linkage to care after HIV diagnosis in South Africa. *J Acquir Immune Defic Syndr*. (2017) 74(Suppl 1):S23–s8. doi: 10.1097/QAI.0000000000001205

72. World Health Organization. *Regional office for South-East A, editor self-care in the context of primary health care2009 2009*. New Delhi: WHO Regional Office for South-East Asia (2009).

73. Hofmann K. PaC, PSI 3 HOT TRENDS IN GLOBAL HEALTH. 2022.

74. Erlangga D, Suhrcke M, Ali S, Bloor K. The impact of public health insurance on health care utilisation, financial protection and health status in low- and middle-income countries: a systematic review. *PLoS One*. (2019) 14(8):e0219731. doi: 10.1371/journal.pone.0219731

75. Duffy M, Sharer M, Davis N, Eagan S, Haruzivishe C, Katana M, et al. Differentiated antiretroviral therapy distribution models: enablers and barriers to universal HIV treatment in South Africa, Uganda, and Zimbabwe. *J Assoc Nurses AIDS Care*. (2019) 30(5):e132–e43. doi: 10.1097/JNC.0000000000000097

76. Hargreaves JR, Pliakas T, Hoddinott G, Mainga T, Mubekapi-Musadaidzwa C, Donnell D, et al. HIV stigma and viral suppression among people living with HIV in the context of universal test and treat: analysis of data from the HPTN 071 (PopART) trial in Zambia and South Africa. *J Acquir Immune Defic Syndr*. (2020) 85(5):561–70. doi: 10.1097/QAI.0000000000002504

77. Areri H, Marshall A, Harvey G. Factors influencing self-management of adults living with HIV on antiretroviral therapy in Northwest Ethiopia: a cross-sectional study. *BMC Infect Dis*. (2020) 20(1):879. doi: 10.1186/s12879-020-05618-y

78. Meehan S-A, Sloot R, Draper HR, Naidoo P, Burger R, Beyers N. Factors associated with linkage to HIV care and TB treatment at community-based HIV testing services in Cape Town, South Africa. *PLoS One*. (2018) 13(4):e0195208. doi: 10.1371/journal.pone.0195208

79. Marston C, Renedo A, Miles S. Community participation is crucial in a pandemic. *Lancet*. (2020) 395(10238):1676–8. doi: 10.1016/S0140-6736(20)31054-0

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The role of machine learning in HIV risk prediction

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Despite advances in reducing HIV-related mortality, persistently high HIV incidence rates are undermining global efforts to end the epidemic by 2030. The UNAIDS Fast-track targets as well as other preventative strategies, such as pre-exposure prophylaxis, have been identified as priority areas to reduce the ongoing transmission threatening to undermine recent progress. Accurate and granular risk prediction is critical for these campaigns but is often lacking in regions where the burden is highest. Owing to their ability to capture complex interactions between data, machine learning and artificial intelligence algorithms have proven effective at predicting the risk of HIV infection in both high resource and low resource settings. However, interpretability of these algorithms presents a challenge to the understanding and adoption of these algorithms. In this perspectives article, we provide an introduction to machine learning and discuss some of the important considerations when choosing the variables used in model development and when evaluating the performance of different machine learning algorithms, as well as the role emerging tools such as Shapely Additive Explanations may play in helping understand and decompose these models in the context of HIV. Finally, we discuss some of the potential public health and clinical use cases for such decomposed risk assessment models in directing testing and preventative interventions including pre-exposure prophylaxis, as well as highlight the potential integration synergies with algorithms that predict the risk of sexually transmitted infections and tuberculosis.

KEYWORDS
HIV, machine learning, risk prediction, artificial intelligence, prevention, PrEP

Introduction

Since the start of the HIV epidemic, the virus has infect an estimated 76 million people worldwide, roughly 33 million of whom have died (1). While there has been a roughly 60% reduction in estimated AIDS-related annual deaths this progress has not been reflected in HIV incidence with only a 17% decrease in HIV incidence across a similar period leading to a significant rise in the number of people living with HIV (1–3). In recognition of the limited successes in reducing HIV infection incidence globally, the UNAIDS "Fast-track" targets of 95–95–95 have become accepted as foundational for accelerating HIV incidence reductions to achieve the goal of ending the HIV epidemic by 2030 (4). The updated targets seek to have 95% of people living with HIV know their status (diagnosis), 95% of those diagnosed on antiretroviral therapy (ART), and 95% of those on ART virally suppressed by 2030 (4). Fundamental to achieving this goal in Sub-Saharan Africa is comprehensive diagnosis including populations unaware that they are at high risk of having HIV (5). However, a major challenge to this is that the relative importance of different at-risk and missed groups varies significantly both between and within different countries.

Beyond the Fast-track targets other preventative strategies remain vital to the global efforts to end the HIV epidemic, with Pre-Exposure Prophylaxis (PrEP), behaviour change communication, and early ART as prevention considered to be the three most effective strategies for preventing HIV transmission (6). When taken correctly, both PrEP and ART as prevention has been shown to be up to 100% effective in preventing HIV transmission (7–10). Critical to directing both HIV testing campaigns (required to meet the first goal of 95–95–95) as well as PrEP prescription and other targeted preventative strategies is a capacity for granular HIV risk estimation. This unmet need coupled with the initial successes of more traditional modelling techniques in delineating HIV risk (11), has led to a growing interest in the role machine learning (ML) and artificial intelligence (AI) could play in helping quantify individual risk of HIV infection. To this end, various ML models and AI algorithms have been developed using diverse datasets from both data-rich high income settings and more data-sparse low-to-middle income countries (LMICs) (12–19). In this perspective article we seek to describe the benefits and limitations to using ML for HIV risk prediction as well as discuss some of the potential future use cases of ML-guided HIV risk prediction algorithms in both meeting the UNAIDS targets as well as guiding the roll-out of other preventative strategies such as PrEP.

Machine learning for HIV risk prediction

Machine learning (ML) can be described as a collection of scientific techniques that focus on how computers learn relationships between data (20, 21). The automated pattern recognition of ML has found growing utility in medical statistics owing to the increasing size and complexity of medical data (22). ML can be classified into supervised or unsupervised learning by whether the algorithm is trained on labelled data or the algorithm self-defines the data structure from unlabelled data (20, 23, 24). Supervised learning can then be further subclassified into classification and regression algorithms based on whether the outcome being predicted is a categorical or continuous variable respectively (24). Common examples of classification problems include email spam filters (25), movie or online shopping recommendations (26), differentiating malignant and benign skin lesions (27), modelling the risk of ICU admission (28), and chest radiograph pneumonia detection (29).

The output of a classification algorithm is typically interpreted as a probability which is then binarized by means of a threshold that can be altered to increase either the sensitivity or specificity based on the model's clinical requirements (30). This makes classification models particularly useful in risk prediction. Given the persistent global burden of infectious diseases, there has been growing interest in the use of ML in risk prediction in this field (31, 32). Within HIV specifically there has been substantial attempt to try and identify individuals at high risk of infection. Initially people were classified using single risk factors, such as sero-discordant spouses (12). Subsequent approaches have largely focused on risk scores calculated *via* traditional clinical prediction tools based on regression modelling (33), with different models attempting to quantify risk of HIV seroconversion among different risk groups including men-who-have-sex-with-men (MSM), women, and sero-discordant couples (11, 34–38). Most recently, various authors have used ML approaches to attempt to quantify the complex relationships between risk factors that contribute to HIV risk (12–19). Balzer et al. directly evaluated these three approaches by comparing traditional risk factors, a risk score estimated by logistical regression, and an ML model estimated using the Super Learner algorithm and showed that ML significantly improved both the efficiency and sensitivity in identifying HIV seroconversions (12).

ML: model development and evaluation

Feature selection and model building

The predictor variables used in a ML model are called features. While the ability to handle higher numbers of features and learn the complex associations between them is one of the inherent advantages of ML, in general fewer features reduces the risks of model overfitting and leads to improved generalisability of the algorithm (39). Model overfitting is where a model's predictions are too finely tuned to the statistical noise or spurious statistical correlations in the dataset used to build the model and leads to significant limitations with generalising the model's output to new data (40). For this reason, parsimonious inclusion of features is important. Some supervised learning algorithms inherently only select the most predictive features, while for other algorithms this process needs to be made explicit (41). In addition to careful feature selection and design, another fundamental component of ML model building that helps prevent overfitting is the random splitting of the initial dataset into training, validation, and test datasets (24). Different models are then developed (trained) and compared using the validation dataset with the final model applied to the features of the holdout test dataset to evaluate the model's performance. This explicit separation of data attempts to select for models that have extracted useful features that at a minimum generalise across unseen subsets of the dataset. Variants of this such as a bootstrapping or cross validation exist with the overall gold standard being the use of an external dataset for testing (42).

Within HIV, exact risk factors for transmission vary significantly by population but are typically behavioural and socio-demographic in nature (43). This has led to such factors featuring prominently in ML algorithms attempting to estimate HIV risk (19). The propensity of these features to have complex and poorly understood interactions has given ML-based approaches a distinct advantage in adjusting and quantifying aggregate infection risk but simultaneously introduces particular risk of overfitting. In addition, a significant challenge with modelling HIV risk is that incidence varies significantly by population impacting the prior or baseline probability of infection. A possible way to manage this challenges across difference populations is to include geography as a feature either as a ZIP/postal code (13) or as a longitude, latitude, and altitude (44). Finally, ML is increasingly used in combination with other AI techniques such natural language processing to assist with extracting important features from the narrative text of electronic health records to further enhance an automated process of HIV risk prediction (17).

Performance metrics

In contrast to traditional statistics where the primary purpose is inference, in classification ML the primary focus is on accurate prediction (24). Given that prediction is the primary concern, the confusion matrix (**Figure 1**) is a useful method to assess the performance of a given model. To generate a confusion matrix, the model is applied to the features of the holdout test dataset and the predicted outcomes (at a set probability threshold) are compared to the actual outcomes seen in the dataset. From there the performance metrics of sensitivity, specificity, accuracy, precision, and negative predictive value are calculated. However, one of the challenges with the confusion matrix is the fact the predictions are made at a particular threshold probability and thus it is difficult to assess what would happen at different probability cut-offs. In this respect receiver operator curves (ROCs), and particularly the area under the ROC (AUROC), provides a useful way of visualising and describing the trade-off between sensitivity and specificity in a model at all probability thresholds and is considered among the gold standard measures of ML model performance when applied to clinical risk prediction (45). The AUROC is especially relevant to healthcare applications as the results are not dependent on the relative prevalence of the outcome.

Understanding the model

ML's advantage in predictive performance often comes at the expense of the more typical research goal of interpretability. A common heuristic in estimating this trade-off is in the number of parameters a model utilises to make predictions (46). A simple logistic regression model has a single parameter per predictive feature whereas large-scale modern deep neural networks may have several billion (47). This presents a clear challenge to utilising ML models in practice as it becomes difficult to trust predictions that are based off unknown combinations of features, especially with concerns that models may automatically learn specific biases inherent to the dataset

	Predicted Positive	**Predicted Negative**	
Positive	True Positive (TP)	False Negative (FN)	***Sensitivity*** $\frac{TP}{(TP+FN)}$
Negative	False Positive (FP)	True Negative (TN)	***Specificity*** $\frac{TN}{(TN+FP)}$
Accuracy $\frac{(TP+TN)}{(TP+FN+TN+FP)}$	*Precision* $\frac{TP}{(TP+FP)}$	***Negative Predictive Value*** $\frac{TN}{(TN+FN)}$	

FIGURE 1
Performance metrics calculated from a confusion matrix.

(48–50). Interpretable ML is the domain interested in combining these two paradigms by providing techniques that enable explanations to be extracted from models several orders of magnitude more complex than is typically feasible (51).

A method that has gained substantial popularity in recent years for this task is the Shapley Additive exPlanations (SHAP) framework (52). These tools utilise an approach rooted in game theory to provide so called 'SHAP values'. These values indicate the influence each predictive feature exerted on the final model prediction and can be used to gain substantial insight into the most discriminative features a model may utilise. In addition, this assists in model trust by enabling an individual to sanity check the model's feature attribution in making a final determination. This decomposition allows for model utilisation beyond simple prediction, and can be employed to, for example, provide separate estimates of modifiable and non-modifiable risk factors despite the use of a more complex model.

The authors have developed a ML model using socio-demographic and behavioural data collected prospectively with a digital survey as described in the published protocol (53). The cohort is described in detail in a manuscript currently under review and **Figure 2** is a sub-analysis of this data presented as a visual explanation of the potential utility of SHAP-based metrics in decomposing HIV risk at both an aggregate (**Figure 2A**) and individual (**Figure 2B**) level. Given that the social and behavioural risk factors for HIV vary by context (43), the relative predictive value of these features seen in **Figure 2** is specific to this cohort and likely varies across cultures and regions. This underscores the importance of local validation and fine-tuning of any risk prediction algorithm that utilises socio-behavioural features prior to deployment emphasises the importance of model decomposition in understanding the contributors to risk in a given population.

The main limitation of SHAP-based metrics is that while they provide explanations of how a model reached a particular prediction, they do not quantify how accurate that prediction is (52, 54). Multiple methods exist that attempt to determine the relationship between the inclusion of a variable and overall model performance. Permutation Importance (PIMP) is one such tool that attempts to provide a structured approach to determine variable importance (54). This method randomly shuffles one column of the dataset at a time for several thousand iterations, one set with the outcome preserved and another with the outcome also shuffled. This provides two distributions the overlap of which provides a measure of significance and scale to which a variable improves a model. The main challenges with this methodology are that it can be computationally intensive to run enough replications and that certain variables may be highly correlated and may need to be shuffled together to gain an accurate estimation of importance (54).

Discussion

Modifying the public health response: community and individual orientated care

A major limitation to the use of ML models in HIV risk prediction thus far has been the limited interpretability of

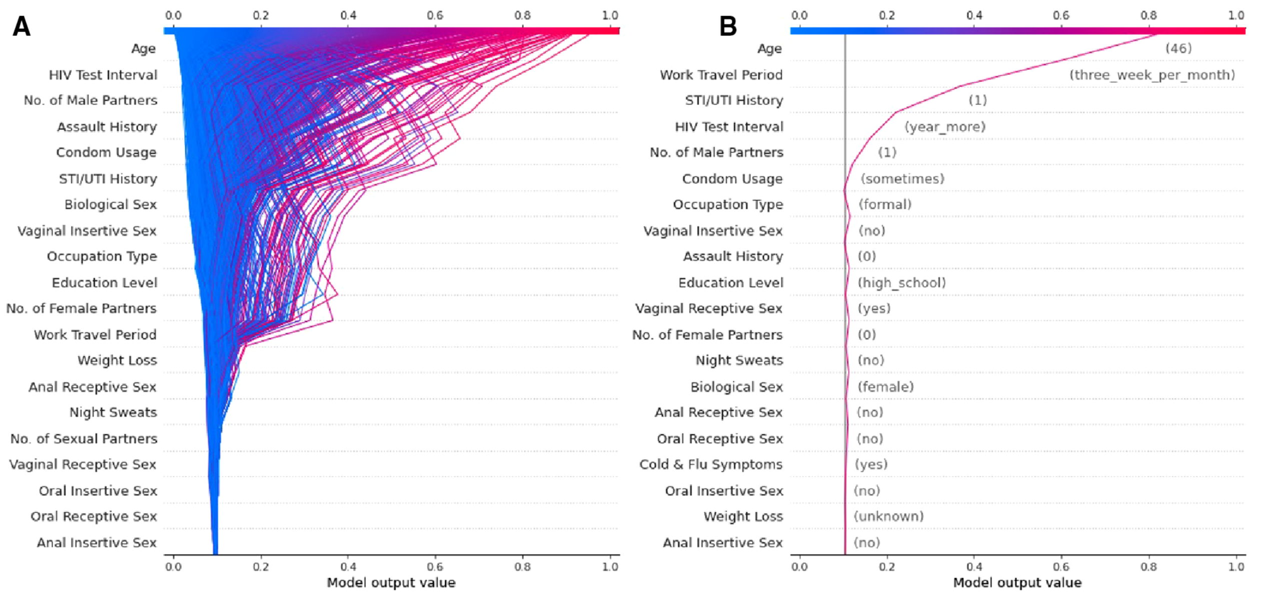

FIGURE 2
Examples of a SHAP-based feature explanation for a ML model showing (A) overall model risk output for all individuals in the test dataset and (B) an example individual at high risk for contracting HIV.

these models beyond their predictive capacity. However, we argue that tools such as PIMP and particularly SHAP allow these models to have clinical implications beyond simple prediction. Specifically, these tools allow for the decomposition of the features that make up "risk" at both an aggregate level (**Figure 2A**) and an individual level (**Figure 2B**). We believe this can translate into clinical practice by facilitating more efficient and targeted use of the interventions currently available.

If a model is appropriately contextualised and locally validated, a feature decomposition such as that presented in **Figure 2A** should provide an overview of the most important contributors to risk in a given community. In this example, age, duration since last HIV test, and the number of male sexual partners appears to convey the largest risk component. These features can then be considered in terms of modifiable risk (e.g., low levels of condom usage) or non-modifiable risk (e.g., high rates of work travel) and the public health response tailored towards either behaviour change communication or PrEP as guided by a given population's overall risk distribution. Similarly, by identifying specific risks at the individual level (**Figure 2B**), one is able to offer directed counselling and personalised interventions for risk factors that are most impacting the individual's chance of contracting HIV. For example, the major contributors to risk for the example individual in **Figure 2B** are non-modifiable and thus they may well be a good candidate for PrEP and counselling for this intervention can be directed by the risk profile generated. By identifying these factors, public health interventions could be targeted at specific issues rather than attempting to solve a heterogenous problem with blanket solutions that are not necessarily applicable to specific individuals or communities.

Utility in PrEP initiation

PrEP is widely regarded as one of the most effective strategy in the prevention of HIV transmission (55–57) and has been shown to be a cost-effective method to address the HIV epidemic (58). The recent advent of an injectable PrEP preparation containing cabotegravir heralds much excitement as the drug persists for long periods in those exposed allowing long intervals between dosing (56) which is required only every second month. The ease of administration this enables promises to alleviate some of the adherence issues faced in PrEP strategies (56). The agent has recently been approved by the Federal Drug Administration and is currently under review by various local agencies including in some LMICs, providing an opportunity to renew efforts to promote large-scale global uptake of PrEP.

Much of the current discussion around PrEP strategies centres around the issue of to whom PrEP should be offered (14, 16, 55). Identification of individuals at risk forms the basis of this discussion. Thus far strategies have directed PrEP administration at particular population groups such as MSM or particular geographical regions known to have a high prevalence of HIV (14), however there is a need to better identify candidates for PrEP in order to optimize its benefit (16). Methods in this area have aimed to identify individuals that would glean the greatest benefit from PrEP administration by identifying individuals at the greatest risk of HIV acquisition or seroconversion (14). Recognition of various individual level data as conferring risk for seroconversion has been the topic of much literature. These factors include non-modifiable factors such as age, sex, sexual-orientation and behaviour, as well as modifiable factors such as number of sexual partners or condom use (14, 16). Combinations of various factors of this type have been used to identify the most at-risk individuals and therefore those that would benefit most from PrEP. The complex matrix of data points that arises from analysis of this data is not always captured by simple calculations of risk. As such, there is significant benefit to ML as a method to augment the use of such data (14, 16). These strategies allow the capturing of the intricate interaction between factors and better identifies individuals at risk of contracting HIV and seroconverting. By using these methodologies, the efficient use of PrEP is increased as its administration is targeted at individuals with a greater likelihood of contracting HIV.

Future uses of ML in HIV associated conditions

Given the important interactions between the risk factors for sexually transmitted infections (STIs) and HIV and ML's strength in this area, it is logical to build an integrated tool that predicts the risk of both conditions. Xu et al. (2022) have recently built such a tool with a web-based interface that delivered reasonable predictive performance for HIV (AUROC = 0.72), syphilis (AUROC = 0.75), gonorrhoea (AUROC = 0.73), and chlamydia (AUROC = 0.67) (18). Given the biologically-based increased risk of HIV infection conferred by STIs (59), as well as the persistent use of syndromic management in treating STIs in many LMICs (60), algorithms that incorporate both conditions likely have significant potential synergies and utility in LMIC settings. In addition, tuberculosis (TB) is perhaps the most importance HIV-associated disease as it is estimated be responsible for around a third of deaths among people living with HIV (61). ML has been shown to be effective in assisting with both the screening and diagnosis of TB as well as predicting the risk of TB drug resistance (62). However, to the best of our knowledge ML-based TB and HIV risk assessment models have not yet been integrated into a single tool. While the combination of TB and HIV prediction algorithms offers less potential predictive synergy there is valuable overlap in possible clinical utility.

Conclusion

As authors, we believe ML as applied to HIV risk prediction has the potential to make a significant contribution towards ending the HIV epidemic. Specifically, we see it as a critical tool in directing testing, behaviour change communication, and PrEP towards individuals and communities at high risk of infection in a resource efficient manner. Yet, while these models have been shown to be scientifically valid there remain significant barriers to them having a tangible impact. The most important of these challenges include establishing the tools for the collection of socio-demographic and behavioural data, the appropriate contextualisation and local validation of models, and the successful integration of such systems into routine HIV prevention services, particularly in resource constrained LMIC settings.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Materials, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving human participants were reviewed and approved by University of the Witwatersrand Medical Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

Author contributions

JF, ES, and BS contributed to writing the manuscript. All authors contributed to reviewing and editing the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

Phithos Technologies is currently building an HIV risk assessment tool and all contributing authors are involved in the development of that tool.

The handling editor SL-E declared a past co-authorship with the author LA.

Publisher's note

References

1. UNAIDS. Global HIV & AIDS statistics — 2020 fact sheet. 2020 [cited 2020 Aug 13]. Available at: https://www.unaids.org/en/resources/fact-sheet

2. Frank TD, Carter A, Jahagirdar D, Biehl MH, Douwes-Schultz D, Larson SL, et al. Global, regional, and national incidence, prevalence, and mortality of HIV, 1980–2017, and forecasts to 2030, for 195 countries and territories: a systematic analysis for the global burden of diseases, injuries, and risk factors study 2017. *lancet HIV*. (2019) 6(12):e831–59. doi: 10.1016/S2352-3018(19)30196-1

3. Pandey A, Galvani AP. The global burden of HIV and prospects for control. *Lancet HIV*. (2019) 6(12):e809–11. doi: 10.1016/S2352-3018(19)30230-9

4. UNAIDS. 95-95-95 Fast-track targets.

5. Lebelonyane R, Bachanas P, Block L, Ussery F, Alwano MG, Marukutira T, et al. To achieve 95-95-95 targets we must reach men and youth: high level of knowledge of HIV status, ART coverage, and viral suppression in the Botswana combination prevention project through universal test and treat approach. *PLoS One*. (2021) 16(8):e0255227. doi: 10.1371/journal.pone.0255227

6. McGillen JB, Anderson S-J, Dybul MR, Hallett TB. Optimum resource allocation to reduce HIV incidence across sub-saharan Africa: a mathematical modelling study. *lancet HIV*. (2016) 3(9):e441–8. doi: 10.1016/S2352-3018(16)30051-0

7. Rodger AJ, Cambiano V, Bruun T, Vernazza P, Collins S, Degen O, et al. Risk of HIV transmission through condomless sex in serodifferent gay couples with the HIV-positive partner taking suppressive antiretroviral therapy (PARTNER): final results of a multicentre, prospective, observational study. *Lancet*. (2019) 393 (10189):2428–38. doi: 10.1016/S0140-6736(19)30418-0

8. Rodger AJ, Cambiano V, Bruun T, Vernazza P, Collins S, van Lunzen J, et al. Sexual activity without condoms and risk of HIV transmission in serodifferent couples when the HIV-positive partner is using suppressive antiretroviral therapy. *JAMA*. (2016) 316(2):171–81. doi: 10.1001/jama.2016.5148

9. McCormack S, Dunn DT, Desai M, Dolling DI, Gafos M, Gilson R, et al. Pre-exposure prophylaxis to prevent the acquisition of HIV-1 infection (PROUD): effectiveness results from the pilot phase of a pragmatic open-label randomised trial. *Lancet*. (2016) 387(10013):53–60. doi: 10.1016/S0140-6736 (15)00056-2

10. Grant RM, Anderson PL, McMahan V, Liu A, Amico KR, Mehrotra M, et al. An observational study of preexposure prophylaxis uptake, sexual practices, and HIV incidence among men and transgender women who have sex with men. *Lancet Infect Dis*. (2014) 14(9):820. doi: 10.1016/S1473-3099 (14)70847-3

11. Wand H, Reddy T, Naidoo S, Moonsamy S, Siva S, Morar NS, et al. A simple risk prediction algorithm for HIV transmission: results from HIV prevention trials in KwaZulu natal, South Africa (2002–2012). *AIDS Behav*. (2018) 22(1):325–36. doi: 10.1007/s10461-017-1785-7

12. Balzer LB, Havlir D V, Kamya MR, Chamie G, Charlebois ED, Clark TD, et al. Machine learning to identify persons at high-risk of human immunodeficiency virus acquisition in rural Kenya and Uganda. *Clin Infect Dis*. (2020) 71(9):2326–33. doi: 10.1093/cid/ciz1096

13. Marcus JL, Hurley LB, Krakower DS, Alexeeff S, Silverberg MJ, Volk JE. Use of electronic health record data and machine learning to identify candidates for HIV pre-exposure prophylaxis: a modelling study. *lancet HIV*. (2019) 6(10): e688–95. doi: 10.1016/S2352-3018(19)30137-7

14. Zheng W, Balzer L, van der Laan M, Petersen M, Collaboration S. Constrained binary classification using ensemble learning: an application to cost-efficient targeted PrEP strategies. *Stat Med*. (2018) 37(2):261–79. doi: 10.1002/sim.7296

15. Orel E, Esra R, Estill J, Marchand-Maillet S, Merzouki A, Keiser O. Prediction of HIV status based on socio-behavioural characteristics in East and Southern Africa. *PloS one*. (2022) 17(3):e0264429. doi: 10.1371/journal.pone.0264429

16. Krakower DS, Gruber S, Hsu K, Menchaca JT, Maro JC, Kruskal BA, et al. Development and validation of an automated HIV prediction algorithm to identify candidates for pre-exposure prophylaxis: a modelling study. *Lancet HIV*. (2019) 6(10):e696–704. doi: 10.1016/S2352-3018(19)30139-0

17. Feller DJ, Zucker J, Yin MT, Gordon P, Elhadad N. Using clinical notes and natural language processing for automated HIV risk assessment. *J Acquir Immune Defic Syndr*. (2018) 77(2):160. doi: 10.1097/QAI.0000000000001580

18. Xu X, Ge Z, Chow EPF, Yu Z, Lee D, Wu J, et al. A machine-learning-based risk-prediction tool for HIV and sexually transmitted infections acquisition over the next 12 months. *J Clin Med*. (2022) 11(7):1818. doi: 10.3390/jcm11071818

19. Mutai CK, McSharry PE, Ngaruye I, Musabanganji E. Use of machine learning techniques to identify HIV predictors for screening in sub-saharan Africa. *BMC Med Res Methodol*. (2021) 21(1):1–11. doi: 10.1186/s12874-021-01346-2

20. Deo RC. Machine learning in medicine. *Circ*. (2015) 132(20):1920–30. doi: 10.1161/CIRCULATIONAHA.115.001593

21. Hastie T, Tibshirani R, Friedman JH, Friedman JH. *The elements of statistical learning: Data mining, inference, and prediction*. Vol. 2. New York: Springer (2009).

22. Waring J, Lindvall C, Umeton R. Automated machine learning: review of the state-of-the-art and opportunities for healthcare. *Artif Intell Med*. (2020) 104:101822. doi: 10.1016/j.artmed.2020.101822

23. Goecks J, Jalili V, Heiser LM, Gray JW. How machine learning will transform biomedicine. *Cell*. (2020) 181(1):92–101. doi: 10.1016/j.cell.2020.03.022

24. Sidey-Gibbons JAM, Sidey-Gibbons CJ. Machine learning in medicine: a practical introduction. *BMC Med Res Methodol*. (2019) 19(1):1–18. doi: 10.1186/s12874-018-0650-3

25. Mansoor R, Jayasinghe ND, Muslam MMA. *In: 2021 international conference on information networking (ICOIN). IEEE. A comprehensive review on email spam classification using machine learning algorithms* (2021). p. 327–32

26. Zheng Y, Mobasher B, Burke R. *In: 2014 IEEE/WIC/ACM international joint conferences on web intelligence (WI) and intelligent agent technologies (IAT). IEEE. Context recommendation using multi-label classification* (2014). p. 288–95

27. Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, et al. Dermatologist-level classification of skin cancer with deep neural networks. *Nature*. (2017) 542(7639):115–8. doi: 10.1038/nature21056

28. Escobar GJ, Turk BJ, Ragins A, Ha J, Hoberman B, LeVine SM, et al. Piloting electronic medical record–based early detection of inpatient deterioration in community hospitals. *J Hosp Med*. (2016) 11:S18–24. doi: 10.1002/jhm.2652

29. Rajpurkar P, Irvin J, Zhu K, Yang B, Mehta H, Duan T, et al. Chexnet: radiologist-level pneumonia detection on chest x-rays with deep learning. *arXiv Prepr ArXiv*. (2017) 1711:05225.

30. Han SS, Kim MS, Lim W, Park GH, Park I, Chang SE. Classification of the clinical images for benign and malignant cutaneous tumors using a deep learning algorithm. *J Invest Dermatol*. (2018) 138(7):1529–38. doi: 10.1016/j.jid.2018.01.028

31. Agrebi S, Larbi A. Use of artificial intelligence in infectious diseases. In: *Artificial intelligence in precision health*. Cambridge: Elsevier (2020). p. 415–38.

32. Chiu H-YR, Hwang C-K, Chen S-Y, Shih F-Y, Han H-C, King C-C, et al. Machine learning for emerging infectious disease field responses. *Sci Rep*. (2022) 12(1):1–13. doi: 10.1038/s41598-021-99269-x

33. Laupacis A, Sekar N. Clinical prediction rules: a review and suggested modifications of methodological standards. *Jama*. (1997) 277(6):488–94. doi: 10.1001/jama.1997.03540300056034

34. Kahle EM, Hughes JP, Lingappa JR, Grace J-S, Celum C, Nakku-Joloba E, et al. An empiric risk scoring tool for identifying high-risk heterosexual HIV-1 serodiscordant couples for targeted HIV-1 prevention. *J Acquir Immune Defic Syndr*. (2013) 62(3):339. doi: 10.1097/QAI.0b013e31827e622d

35. Pintye J, Drake AL, Kinuthia J, Unger JA, Matemo D, Heffron RA, et al. A risk assessment tool for identifying pregnant and postpartum women who may benefit from preexposure prophylaxis. *Clin Infect Dis*. (2017) 64(6):751–8. doi: 10.1093/cid/ciw850

36. Balkus JE, Brown E, Palanee T, Nair G, Gafoor Z, Zhang J, et al. An empiric HIV risk scoring tool to predict HIV-1 acquisition in African women. *J Acquir Immune Defic Syndr*. (2016) 72(3):333. doi: 10.1097/QAI.0000000000000974

37. Wahome E, Thiong'o AN, Mwashigadi G, Chirro O, Mohamed K, Gichuru E, et al. An empiric risk score to guide PrEP targeting among MSM in coastal Kenya. *AIDS Behav*. (2018) 22(1):35–44. doi: 10.1007/s10461-018-2141-2

38. Wahome E, Fegan G, Okuku HS, Mugo P, Price MA, Mwashigadi G, et al. Evaluation of an empiric risk screening score to identify acute and early HIV-1 infection among MSM in coastal Kenya. *AIDS*. (2013) 27(13):2163. doi: 10.1097/QAD.0b013e3283629095

39. Tan P-N, Steinbach M, Kumar V. Introduction to data mining. Pearson Education India; 2016.

40. Obermeyer Z, Emanuel EJ. Predicting the future—big data, machine learning, and clinical medicine. *N Engl J Med*. (2016) 375(13):1216. doi: 10.1056/NEJMp1606181

41. Bisaso KR, Anguzu GT, Karungi SA, Kiragga A, Castelnuovo B. A survey of machine learning applications in HIV clinical research and care. *Comput Biol Med*. (2017) 91:366–71. doi: 10.1016/j.compbiomed.2017.11.001

42. El Naqa I, Ruan D, Valdes G, Dekker A, McNutt T, Ge Y, et al. Machine learning and modeling: data, validation, communication challenges. *Med Phys*. (2018) 45(10):e834–40. doi: 10.1002/mp.12811

43. Ordóñez CE, Marconi VC. Understanding HIV risk behavior from a sociocultural perspective. *J AIDS Clin Res*. (2012) 3(7):1–3. doi: 10.4172/2155-6113.1000e108

44. Cuadros DF, Li J, Branscum AJ, Akullian A, Jia P, Mziray EN, et al. Mapping the spatial variability of HIV infection in sub-saharan Africa: effective information for localized HIV prevention and control. *Sci Rep*. (2017) 7(1):1–11. doi: 10.1038/s41598-017-09464-y

45. Narkhede S. Understanding auc-roc curve. *Towar Data Sci*. (2018) 26 (1):220–7.

46. Johansson U, Sönströd C, Norinder U, Boström H. Trade-off between accuracy and interpretability for predictive in silico modeling. *Future Med Chem*. (2011) 3(6):647–63. doi: 10.4155/fmc.11.23

47. Kaplan J, McCandlish S, Henighan T, Brown TB, Chess B, Child R, et al. Scaling laws for neural language models. *arXiv Prepr ArXiv*. (2020) 2001::08361.

48. Banerjee I, Bhimireddy AR, Burns JL, Celi LA, Chen L-C, Correa R, et al. Reading Race: aI recognises Patient's Racial identity in medical images. *arXiv Prepr ArXiv*. (2021) 2107:10356. doi: 10.48550/arXiv.2107.10356

49. Obermeyer Z, Powers B, Vogeli C, Mullainathan S. Dissecting racial bias in an algorithm used to manage the health of populations. *Science (80-)*. (2019) 366 (6464):447–53. doi: 10.1126/science.aax2342

50. Mehrabi N, Morstatter F, Saxena N, Lerman K, Galstyan A. A survey on bias and fairness in machine learning. *ACM Comput Surv*. (2021) 54(6):1–35. doi: 10.1145/3457607

51. Murdoch WJ, Singh C, Kumbier K, Abbasi-Asl R, Yu B. Definitions, methods, and applications in interpretable machine learning. *Proc Natl Acad Sci*. (2019) 116(44):22071–80. doi: 10.1073/pnas.1900654116

52. Lundberg SM, Lee S-I. A unified approach to interpreting model predictions. *Adv Neural Inf Process Syst*. (2017) 30:1–10.

53. Majam M, Phatsoane M, Hanna K, Faul C, Arora L, Makthal S, et al. Utility of a machine-guided tool for assessing risk behavior associated with contracting HIV in three sites in South Africa: protocol for an in-field evaluation. *JMIR Res Protoc*. (2021) 10(12):e30304. doi: 10.2196/30304

54. Altmann A, Toloşi L, Sander O, Lengauer T. Permutation importance: a corrected feature importance measure. *Bioinformatics*. (2010) 26(10):1340–7. doi: 10.1093/bioinformatics/btq134

55. Okwundu CI, Uthman OA, Okoromah CAN. Antiretroviral pre-exposure prophylaxis (PrEP) for preventing HIV in high-risk individuals. *Cochrane Database Syst Rev*. (2012) 7:1–41. doi: 10.1002/14651858.CD007189.pub3

56. Clement ME, Kofron R, Landovitz RJ. Long-acting injectable cabotegravir for the prevention of HIV infection. *Curr Opin HIV AIDS*. (2020) 15(1):19. doi: 10.1097/COH.0000000000000597

57. Jiang J, Yang X, Ye L, Zhou B, Ning C, Huang J, et al. Pre-exposure prophylaxis for the prevention of HIV infection in high risk populations: a meta-analysis of randomized controlled trials. *PLoS One*. (2014) 9(2):e87674. doi: 10.1371/journal.pone.0087674

58. Pretorius C, Stover J, Bollinger L, Bacaër N, Williams B. Evaluating the cost-effectiveness of pre-exposure prophylaxis (PrEP) and its impact on HIV-1 transmission in South Africa. *PLoS One*. (2010) 5(11):e13646. doi: 10.1371/journal.pone.0013646

59. Cohen MS, Council OD, Chen JS. Sexually transmitted infections and HIV in the era of antiretroviral treatment and prevention: the biologic basis for epidemiologic synergy. *J Int AIDS Soc*. (2019) 22:e25355. doi: 10.1002/jia2.25355

60. Garrett NJ, Osman F, Maharaj B, Naicker N, Gibbs A, Norman E, et al. Beyond syndromic management: opportunities for diagnosis-based treatment of sexually transmitted infections in low-and middle-income countries. *PLoS One*. (2018) 13(4):e0196209. doi: 10.1371/journal.pone.0196209

61. Global WHO. tuberculosis report 2017. Geneva, Switz World Heal Organ. 2017.

62. Peiffer-Smadja N, Rawson TM, Ahmad R, Buchard A, Georgiou P, Lescure F-X, et al. Machine learning for clinical decision support in infectious diseases: a narrative review of current applications. *Clin Microbiol Infect*. (2020) 26 (5):584–95. doi: 10.1016/j.cmi.2019.09.009

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eSexualHealth: Preferences to use technology to promote sexual health among men who have sex with men and trans and gender diverse people

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Objectives: Gay, bisexual and other men who have sex with men (GBMSM) and trans and gender diverse (TGD) people are disproportionately affected by poorer sexual health outcomes compared to heterosexual populations. We aimed to explore the preferences of GBMSM and TGD for using eHealth for sexual health (eSexualHealth).

Methods: We distributed an anonymous online survey from April to August 2021among the lesbian, gay, bisexual, transgender, intersex, queer and other people of diverse sexuality or gender (LGBTIQA+) community in Australia. The survey collected data on sociodemographic characteristics and sexual behaviors, their preferences for app/website functions and preferred HIV and sexually transmitted infection (STI) testing reminders. We used descriptive statistics to summarize the characteristics of the study population. Free-text responses were thematically analyzed.

Results: Of 466 participants included, most identified as cisgender males (92.7%). The median age was 48 [interquartile range (IQR): 37–56]. For accessing sexual health-related information, 160 (34.6%) would use either a website or an app, 165 (32.7%) would prefer a website, 119 (25.8%) would prefer an app, and 33 (7.1%) would not use either platform. There was no significant difference between GBMSM and TGD people. Participants were most interested in information about STI clinics, HIV/STI hotspots, and sexual health education. Participants stressed the need for privacy and anonymity when using eHealth. Regarding reminders to test for HIV/STIs, receiving regular SMS was most popular (112/293, 38.2%), followed by regular emails (55/293 18.8%) and a reminder function on their phone (48/293, 16.4%).

Conclusion: Our study suggests a promising future for eHealth among GBMSM and TGD people. Sexual health is still a stigmatized area, and eHealth may circumvent barriers this population faces.

KEYWORDS

lesbian, gay, bisexual and transgender (LGBT) issues, sexual health, sexually transmitted infections, eHealth (mobile health), mHealth (mobile health)

1. Introduction

While HIV notification rates have decreased in Australia in recent years, gay and bisexual men who have sex with men (GBMSM) continue to be disproportionally affected compared to their heterosexual counterparts (1). Furthermore, STI incidence rates are higher among GBMSM living with HIV than among HIV-negative GBMSM (2). A 2018 survey of trans and gender diverse (TGD) people found that more than half believed they received poor sexual health education during their school years. Additionally, 51.2% reported receiving insensitive sexual health care. Most participants (65%) also reported inconsistent condom use with casual sexual partners. Combined with their poor experiences in sexual health care, it increases their risk for HIV/STIs (3). As a result, greater effort needs to be put into educating and facilitating HIV/STI testing among GBMSM and TGD people.

GBMSM and TGD people can face several barriers when accessing healthcare, such as: experiencing stigma due to their sexuality, a lack of knowledge and culturally appropriate training amongst healthcare providers; and personal concerns around disclosing their sexual identity (4–6). Specialized sexual healthcare is scarce in Australia, and patients can face long waiting times or high costs if they need to access these services through a general practitioner or private clinic (7). Digital health interventions, also known as eHealth, can improve healthcare access among LGBTIQA+ people (8). These can be delivered through mobile devices, laptops, websites (e.g., acon.org.au and transhub.org.au, or smartphone apps, and can provide private, personalized content that is easily accessible (9). However, to be successful, input from the target audience is essential in creating an intervention that addresses their needs and, in turn, results in increased uptake (10, 11). Previous studies have determined that there is a promising future for an eHealth app among GBMSM (12). However, few studies have investigated the preferences and types of features for different platforms.

This study sought to understand the features of a website or smartphone app that GBMSM and TGD people prefer to access information related to sexual health. We also aimed to measure whether GBMSM and TGD people currently use eHealth for reminding themselves to test for HIV/STIs.

2. Methods

2.1. Study population

This was an anonymous online survey distributed among the LGBTIQA+ community in Australia. We included all respondents aged 16 years and above who identified as LGBTQIA+. Completion of the survey was taken as implied consent. The online survey link was disseminated through the authors' professional networks, social media, and clients at Melbourne Sexual Health Centre (MSHC), a public sexual health clinic in Australia. This included a short messaging service (SMS) or email from MSHC (if they had previously consented to receive them), a dating app (Grindr), and LGBTIQA+ community groups. These community groups included Equinox, Your Community Health, Switchboard, Minus18, QLife, and Rainbow Health Victoria. The survey was run from 10 April 2021 to 3 August 2021. Given that most respondents identified as GBMSM or TGD, the decision was made to limit the analysis to only include these respondents.

2.2. Survey instrument

The survey instrument was developed by the researcher team which included clinicians, sexual health researchers and community members. A pilot test was conducted among ten individuals who were part of the target population to check the comprehensibility and feasibility of the survey (data was not included in the final analysis). This resulted in minor edits to how questions were phrased. The survey was accessed through an online link (hosted by Qualtrics). The survey collected data on sociodemographic characteristics and sexual practices. Respondents were provided with a list of app/website functions and asked to rate how useful each function would be using a five-point Likert scale. Participants were also asked about current and preferred HIV/STI testing reminders and were able to rank their top three answers. Participants were not required to answer all questions and could rank less than three options if desired. Free text response to the questions: "*If you could design an app, website, or health service for LGBTIQA+ people that would make it easier to get tested for HIV/STIs? What would it do? Feel free* *to be creative–all answers and ideas are welcome!*" this allowed participants to expand on any features they intervention.

2.3. Statistical analysis

We cleaned the data and used descriptive statistics to summarize the characteristics of the study population, using Stata (version 17, StataCorp, College Station, TX). Differences between GBMSM and TGD were assessed using Chi-squared test. Statistical significance was defined as a p-value of <0.05.The free-text responses were thematically analyzed using NVivo (Release 1.6, QSR International Pty Ltd., Melbourne, Australia).

2.4. Ethical considerations

Ethics approval was granted by the Alfred Ethics Committee (670/20), including allowing respondents from age 16 onwards to participate. There was no financial reimbursement for survey completion.

3. Results

The survey was accessed 727 times during the study period, and 704 people consented to participate of whom 513 (72.9%) completed the survey. There were 47 (9.2%) participants who did not identify as GBMSM or TGD and were excluded, leaving a total of 466 participants for the analysis. Most were recruited through an SMS or email from MSHC (306/466, 65.7%), followed by Grindr (93/466, 20.0%), then community groups (41/466, 8.8%).

Table 1 summarizes the sociodemographic characteristics of the study population. Of the 466 participants, the majority identified as cisgender males (92.7%). The median age was 48 [interquartile range (IQR): 37–56] and three-quarters were born in Australia. There were 98 (21.2%) of participants living with HIV and had an undetectable viral load. Among those not living with HIV, 139 (37.8%) reported PrEP use.

TABLE 1 Sociodemographic characteristics of the study population ($N = 466$).

Characteristic	*n* (%)
Current gender identity	
Cisgender male	432 (92.7)
Transgender male	8 (1.7)
Transgender female	1 (0.2)
Non-binary or gender-fluid	21 (4.5)
Different identity^{A}	4 (0.9)
Sexual identity	
Gay	410 (88.0)
Bisexual	36 (7.7)
Queer	14 (3.0)
Lesbian	1 (0.2)
Straight/heterosexual^{B}	1 (0.2)
Other, please specify^{C}	3 (0.6)
Prefer not to answer	1 (0.2)
Age group (years)	
≤25	27 (5.8)
26–35	70 (15.0)
36–45	116 (24.9)
≥46	253 (54.3)
Country of birth	
Australia	346 (74.3)
Outside of Australia	120 (25.8)
HIV status	
HIV negative	351 (75.3)
Positive & undetectable	98 (21.0)
I don't know my status	13 (2.8)
Prefer not to answer	4 (0.9)
Reports PrEP use^{D}	
Yes	139 (37.8)
No	225 (61.1)
I don't know	2 (0.5)
Prefer not to answer	2 (0.5)

^{A}Different gender identity included (verbatim), "Genderqueer", "Mostly male, except on Saturday nights", "Trans femme", and "Trans (agender)".
^{B}Identified as Trans or gender diverse.
^{C}Different sexual identities included: 1. Pansexual, 2. Bisexual and queer, 3. Trixic (Non-binary person who loves women).
^{D}Denominator excludes those who are HIV positive and undetectable ($n = 98$) and is thus $N = 368$.

3.1. Website vs. app

Overall, there was no clear preference for an app or website-based sexual health platform. Of the 462 participants that answered the question, 160 (34.6%) would use either a website or an app, 165 (32.7%) would prefer a website, 119 (25.8%) would prefer an app, and 33 (7.1%) would not use either platform. There was no significant difference between GBMSM and TGD people (Supplementary Table S1). Figures 1, 2 provide the preferences for functions on an app and web-based platform, respectively. Supplementary Figures S1–S4 separates out preferences of GBMSM and TGD, and found that GBMSM were more likely to priorities information about

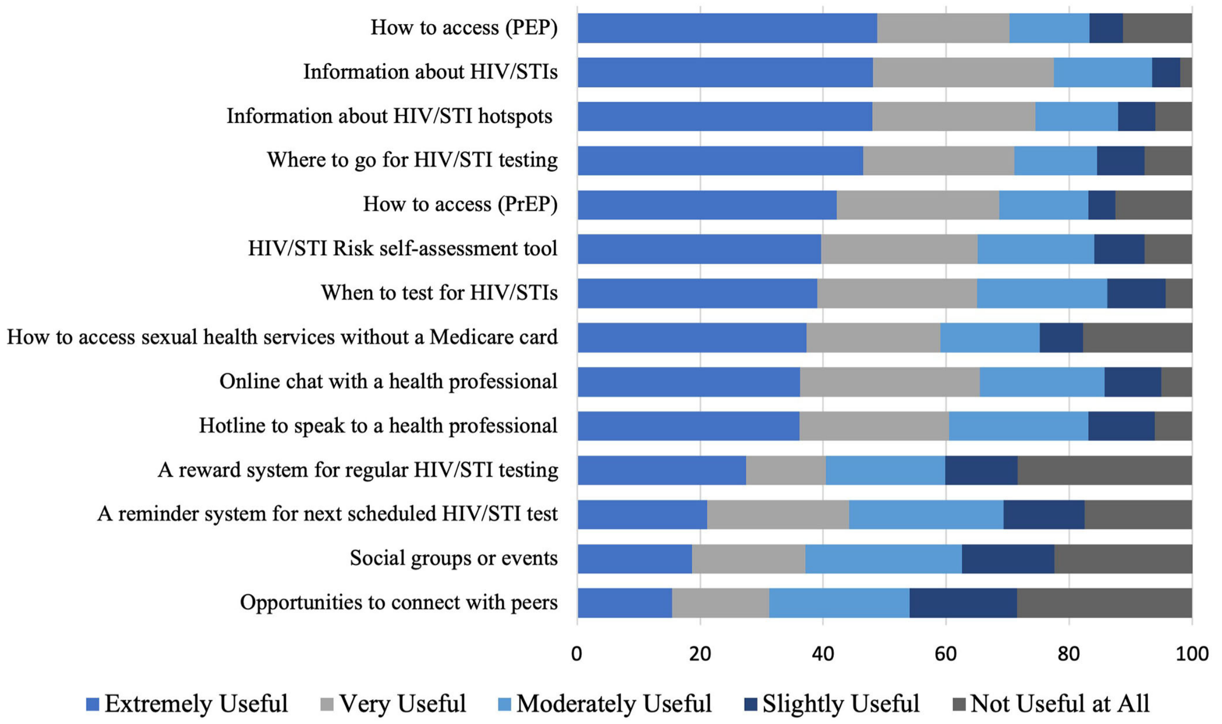

FIGURE 1
Preferences for functions on an app-based platform among GBMSM and TGD.

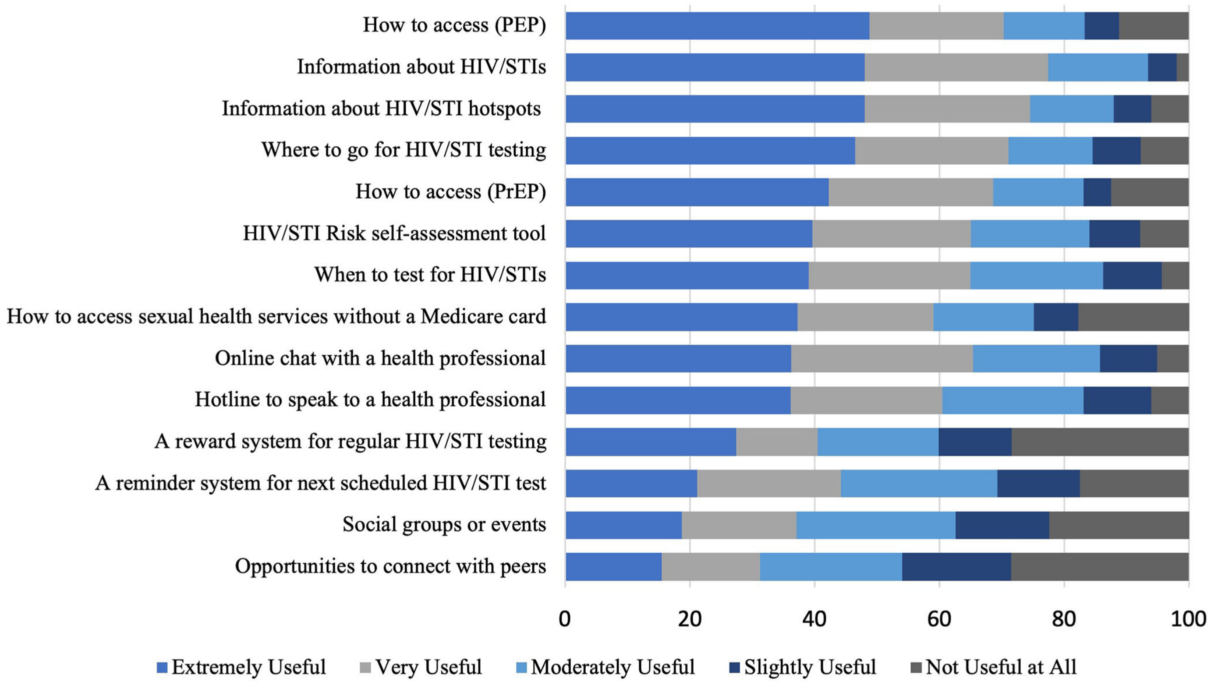

FIGURE 2
Preferences for functions on a web-based platform among GBMSM and TGD.

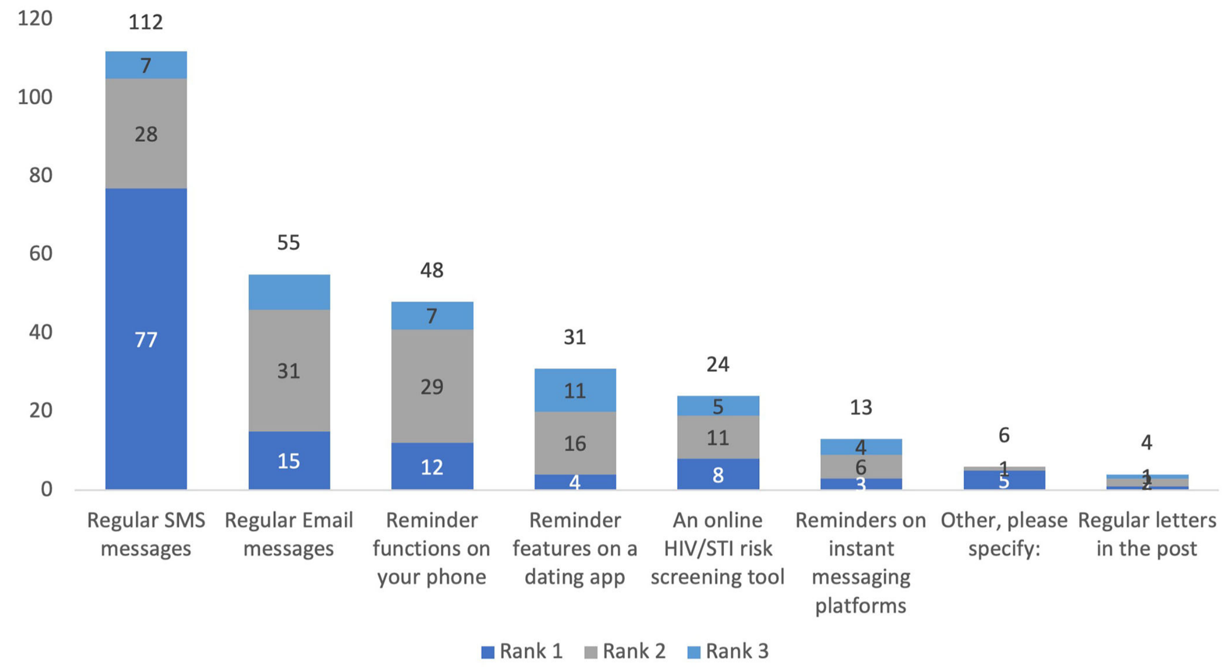

FIGURE 3
Preferred HIV/STI testing reminder system on an eHealth platform, stratified by rank.

pre-exposure prophylaxis (PrEP) and post-exposure prophylaxis (PEP) (Supplementary Figures S1–S4).

In the free-text response, there was a strong emphasis on the need for information, particularly about STI clinics, HIV/STI hotspots (geographical areas with high levels of STI diagnoses), and sexual health education. Concerning STI clinics, most respondents wanted information on their location, opening hours, contact details, and the cost of the services. Other themes that emerged included the need for anonymity, accessibility, and a simple user interface. A few participants also highlighted that they would want a discreet app. Most participants were interested in features such as a sexual activity tracker (i.e., an online diary that recorded sexual encounters), a daily PrEP reminder system, and an HIV/STI testing reminder system. Some participants suggested introducing an online booking system for clinics, which would allow them to book an appointment in advance.

3.2. HIV/STI testing reminder

Over a third of respondents would prefer regular SMS reminders (112/293, 38.2%), followed by regular email reminders (55/293, 18.8%) and a reminder function on their phone (48/293, 16.4%) (Figure 3). Testing reminder preferences were similar between GBMSM and TGD people (Supplementary Figures S5–S6).

4. Discussion

This study provided insights into how GBMSM and TGD people viewed the use of eHealth for sexual health. Specifically, we identified what features may be desirable for a new eHealth intervention, providing useful information for future implementation research to optimize the use of eHealth among GBMSM and TGD. Participants highlighted their desire for privacy and sexual health information. Furthermore, we found that GBMSM were more likely to priorities wanting information about PrEP and PEP in comparison to TGD people.

The use of eHealth is a relatively new concept, and international data suggests that this has been accepted elsewhere. A study among 495 GBMSM from the USA found that 91% would be interested in an app with sexual health features tailored to GBMSM (12). A 2015 study using qualitative interviews of 35 MSM in China found that they supported the use of mobile phones and websites for sexual health (13). Most participants agreed that this provided a level of convenience, and provided information about testing services. Similarly, Nguyen et al. conducted five focus group discussions among MSM in Vietnam. The majority of participants were agreeable to eHealth. They also requested similar content to our participants, such as information about HIV/STIs and testing, and safe sex practice (14). The dissemination of sexual health information through social media and dating apps was acceptable to GBMSM in England, however, some participants felt that receiving this information on dating apps could negatively impact user experience (15). These participants felt that it may dampen the mood when searching for sexual partners, and create negative connotations with new partners.

Ensuring privacy when accessing the services was a prominent theme. It is unclear whether these concerns were due to the stigma surrounding sexual health or whether they resulted from a previous negative experience. Muessig et al. also reported concerns about privacy and confidentiality when accessing eHealth for sexual health (13). Another study found that the use of eHealth would depend on the privacy policy for most participants in the study (16). As a result, they may feel that they need to attend a specialist clinic to meet their healthcare needs. However, this can be difficult to access, and these barriers can discourage GBMSM and TGD people from seeking traditional sexual health services such as face-to-face consultations with health care professionals (17). eHealth could address these barriers by offering privacy and easy access to sexual health services, however more empirical data is required to assess its feasibility. These eHealth interventions can be delivered through computers, websites, and personal devices and can deliver content tailored to an individual's needs. In turn, these address barriers to health care access like cost and accessibility (18). This was a major concern for respondents, and our findings suggest that future eHealth interventions should priorities anonymity to ensure uptake and continued use of the services.

SMS for HIV/STI testing reminders was the most popular choice among respondents in our survey. Several studies have already evaluated the use of an SMS reminder system on HIV/STI testing. A minority of participants from our study indicated that they would prefer an email reminder, however, this has not been evaluated previously. A 2013 study conducted by Zou et al. at MSHC found that GBMSM who received quarterly STI testing reminders by text or email were more likely to return for a test (median 3 vs. 1 test in 12 months) than controls (19). However, this study did not stratify results by the modality used. A 2011 study looking at STI testing rates among Australian GBMSM found that those who received 3 to 6-monthly SMS reminders were 4.4 times more likely to retest for HIV/STIs than those who did not receive a text (20). Similarly, a 2019 USA study reported that men who received a quarterly SMS testing reminder had a shorter interval between HIV tests than men who did not receive a text (21). SMS reminders are a feasible intervention that is relatively affordable and can help increase STI testing rates and has a lower burden on the health system than phone calls or other in-person interventions. Second, mobile technology is almost universally used and can effectively reach a wider population. A 2020 meta-analysis found that there were high levels of feasibility for mHealth tailored to GBMSM. However, most studies reviewed were pilot trials, and it is unclear whether these mHealth interventions would be successful on a larger scale (22).

Our study has several limitations. First, this is a cross-sectional study, and thus we cannot make causal inferences. Secondly, our study only recruited through one gay dating app (Grindr) but no other mainstream apps, such as Tinder, Bumble, and Hinge. This may have skewed the results, and as a result, we only included GBMSM and TGD people in the analysis; thus, our findings are not generalizable to other members of the LGBTIQA+ population. Relatedly, the median age of our study population was 48 years old and therefore, our reported preferences may differ among younger GBMSM and TGD. To make any future intervention successful, it will require further collaboration between developers and a more representative sample of the population. Third, our sample was mostly derived from men who had recently attended a sexual health service. These individuals would therefore be biased toward individuals who are comfortable attending services and so our estimates are likely to underestimate preferences for eHealth services. Future studies should seek the views of individuals who are at risk but not attending services although we appreciate undertaking such a study is difficult. Fourth, whilst Qualtrics records IP addresses to identify duplicates, it is possible, though unlikely, that the same person could submit multiple surveys from different devices. Finally, HIV/STI-related stigma, potentially influencing perceived engagement with digital platforms and data security, was not measured.

5. Conclusion

Overall, our study suggests a promising future for eHealth among GBMSM and TGD people. Sexual health is still a stigmatized area, and eHealth may circumvent barriers this population faces. Further research that provides in-depth data on the themes raised in this study is required to ensure the acceptability and feasibility of any future interventions. Specifically, confidentiality and options to remain anonymous should be considered in future developments of eHealth for sexual health.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Alfred Ethics Committee. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

JO conceived the idea. EC, DL, FK, LM, JG, BB, BS, SJ, and JW assisted with recruitment. EA and TP analyzed the data. EA wrote the first draft of the paper. Community members as part of the target population were involved in the design, conduct, reporting, and dissemination plans of our research. All authors contributed to writing the manuscript and approved the final version for submission.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1064408/full#supplementary-material

References

1. Kirby Institute. *Nation HIV Notification Q1 2016 - Q4 2020*. Sydney: University of New South Wales (2020).

2. Kirby Institute. *National Update on HIV, Viral Hepatitis and Sexually Transmissible Infections in Australia: 2009–2018*. Kensington, NSW: The Kirby Institute, UNSW Sydney (2020).

3. Callander D, Wiggins J, Rosenberg S, Cornelisse V, Duck-Chong E, Holt M, et al. *The 2018 Australian Trans and Gender Diverse Sexual Health Survey: Report of Findings*. Kensington, NSW: Syd NSW Kirby Inst UNSW Syd (2019).

4. Brown A, Rice SM, Rickwood DJ, Parker AG. Systematic review of barriers and facilitators to accessing and engaging with mental health care among at-risk young people. *Asia-Pacific Psychiatry.* (2016) 8:3–22. doi: 10.1111/appy.12199

5. Sanchez NF, Sanchez JP, Danoff A. Health care utilization, barriers to care, and hormone usage among male-to-female transgender persons in New York City. *Am J Public Health.* (2009) 99:713–9. doi: 10.2105/AJPH.2007.132035

6. Bien-Gund CH, Zhao P, Cao B, Tang W, Ong JJ, Baral SD, et al. Providing competent, comprehensive and inclusive sexual health services for men who have sex with men in low- and middle-income countries: a scoping review. *Sex Health.* (2019) 16:320–31. doi: 10.1071/SH18191

7. Conway DP, Holt M, Couldwell DL, Smith DE, Davies SC, McNulty A, et al. Barriers to HIV testing and characteristics associated with never testing among gay and bisexual men attending sexual health clinics in Sydney. *J Int AIDS Soc.* (2015) 18:20221. doi: 10.7448/IAS.18.1.20221

8. Minichiello V, Rahman S, Dune T, Scott J, Dowsett G. E-health: potential benefits and challenges in providing and accessing sexual health services. *BMC Public Health.* (2013) 13:1–7. doi: 10.1186/1471-2458-13-790

9. Sun CJ, Anderson KM, Mayer L, Kuhn T, Klein CH. Findings from Formative Research to Develop a Strength-Based HIV Prevention and Sexual Health Promotion mHealth Intervention for Transgender Women. *Transgend Health.* (2019) 4:350–8. doi: 10.1089/trgh.2019.0032

10. McCurdie T, Taneva S, Casselman M, Yeung M, McDaniel C, Ho W, et al. mHealth consumer apps: the case for user-centered design. *Biomed Instrum Technol.* (2012) 46:49. doi: 10.2345/0899-8205-46.s2.49

11. Yardley L, Spring BJ, Riper H, Morrison LG, Crane DH, Curtis K, et al. Understanding and promoting effective engagement with digital behavior change interventions. *Am J Prev Med.* (2016) 51:833–42. doi: 10.1016/j.amepre.2016.06.015

12. Ventuneac A, John SA, Whitfield TH, Mustanski B, Parsons JT. Preferences for sexual health smartphone app features among gay and bisexual men. *AIDS Behav.* (2018) 22:3384–94. doi: 10.1007/s10461-018-2171-9

13. Muessig KE, Bien CH, Wei C, Lo EJ, Yang M, Tucker JD, et al. A mixed-methods study on the acceptability of using eHealth for HIV prevention and sexual health care among men who have sex with men in China. *J Med Internet Res.* (2015) 17:e100. doi: 10.2196/jmir.3370

14. Nguyen LH, Nguyen HLT, Larsson M, Tran BXL, Stein M, Rocha LEC, et al. An exploratory assessment of the preference for eHealth interventions to prevent HIV and sexually transmitted infections among men who have sex with men in Hanoi, Vietnam. *BMC Public Health.* (2020) 20:1387. doi: 10.1186/s12889-020-09449-z

15. Kesten JM, Dias K, Burns F, Crook P, Howarth A, Mercer CH, et al. Acceptability and potential impact of delivering sexual health promotion information through social media and dating apps to MSM in England: a qualitative study. *BMC Public Health.* (2019) 19:1236. doi: 10.1186/s12889-019-7558-7

16. Goldman J, Hudson Z. Perspective: virtually exposed: privacy and e-health. *Health Aff.* (2000) 19:140–8. doi: 10.1377/hlthaff.19.6.140

17. Scheim AI, Travers R. Barriers and facilitators to HIV and sexually transmitted infections testing for gay, bisexual, and other transgender men who have sex with men. *AIDS Care.* (2017) 29:990–5. doi: 10.1080/09540121.2016.1271937

18. Shrestha R, Lim SH, Altice FL, Copenhaver M, Wickersham JA, Saifi R, et al. Use of smartphone to seek sexual health information online among Malaysian men who have sex with men (MSM): implications for mHealth intervention to increase HIV testing and reduce HIV risks. *J Community Health.* (2020) 45:10–9. doi: 10.1007/s10900-019-00713-x

19. Zou H, Fairley CK, Guy R, Bilardi J, Bradshaw CS, Garland SM, et al. Automated, computer generated reminders and increased detection of gonorrhoea, chlamydia and syphilis in men who have sex with men. *PLoS ONE.* (2013) 8:e61972-e. doi: 10.1371/journal.pone.0061972

20. Bourne C, Knight V, Guy R, Wand H, Lu H, McNulty A. Short message service reminder intervention doubles sexually transmitted infection/HIV re-testing rates among men who have sex with men. *Sex Transm Infect.* (2011) 87:229–31. doi: 10.1136/sti.2010.048397

21. Ronen K, Golden MR, Dombrowski JC, Kerani RP, Bell TR, Katz DA. Uptake and impact of short message service reminders via STI partner services on HIV/STI testing frequency among men who have sex with men. *Sex Transm Dis.* (2019).

22. Nelson KM, Perry NS, Horvath KJ, Smith LR, A. systematic review of mHealth interventions for HIV prevention and treatment among gay, bisexual, and other men who have sex with men. *Transl Behav Med.* (2020) 10:1211–20. doi: 10.1093/tbm/ibaa007

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Enrollment and retention of female sex workers in HIV care in health facilities in Mbarara city

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Background: Sex work is a global driver of the HIV epidemic, and the risk of acquiring HIV is 13 times higher for female sex workers (FSWs) compared to the general population. The enrollment and retention of FSWs in HIV care is a challenge and has been a major contributing factor to increased new HIV infections.
Methods: We conducted a qualitative study among 30 FSWs and 21 healthcare workers (HCWs) working in antiretroviral therapy (ART) clinics at the selected three primary health facilities in Mbarara City, Southwestern Uganda. The study participants were enrolled by both purposive and snowball sampling techniques. We obtained informed consent from all the participants, and data were collected using in-depth interviews and thematically analyzed.
Results: Three themes emerged as facilitators toward enrollment and retention of FSWs into HIV care, namely, (1) good health living, (2) receptive HCWs and availability of health services, and (3) community outreach services and peer support. The barriers are summarized into four major themes: (1) stigma, community discrimination, and beliefs; (2) social obstacles; (3) adverse effects of ART; and (4) inadequate services at the health facilities.
Conclusion: FSWs are challenged by unsupportive environments and communities where they live and work, which hinders their enrollment and retention in HIV care. Creating awareness of the utilization of HIV care services and extending such services to hotspot communities could enhance the response of HIV-positive FSWs to ART.

KEYWORDS
HIV healthcare, female sex workers, enrollment, retention, Mbarara City

1. Introduction

Sex work is a global driver of the HIV epidemic, with approximately 11.5%–18.6% of new HIV infections in women involved in sex work (1). Globally, the risk of acquiring HIV is 13 times higher for female sex workers (FSWs) compared to the general population (2). In sub-Saharan Africa, more than half of all new HIV infections are

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Abbreviations
FSWs, female sex workers; HIV/AIDS, human immunodeficiency virus/acquired immunodeficiency syndrome; MUST-REC, Mbarara University Research Ethics Committee.

attributed to women engaged in sex work and their sexual partners (3); HIV prevalence among FSWs is high, estimated at 50% in Rwanda (4), 37% in Uganda (5), and 26.6% in Tanzania (6), compared to 6.5% among the general population of adult women (7).

FSWs are defined as women receiving money or gifts in exchange for consensual sexual services or erotic performances, either regularly or occasionally, and because of having multiple partners and sexual contacts, they are vulnerable to sexual health risks (8). FSWs living with HIV in sub-Saharan Africa have a poor engagement in HIV care and treatment (9); their enrollment and retention in HIV care is a challenge and has been a major contributing factor to increased new HIV infections (10). Retention in HIV care is defined as the continued engagement in health services, from enrollment in care to discharge or death of an individual living with HIV (11).

Sex workers are often marginalized, criminalized, and stigmatized by the societies in which they live, which increases their vulnerability to HIV infection (12). In Uganda, sex work is illegal, which negatively affects HIV care-seeking behaviors among FSWs (13) due to fear of stigma, discrimination, criminalization, and confidentiality issues (14). Thus, FSWs are a socially hidden and highly mobile population, transitioning in and out of sex work as dictated by economic needs (15). FSWs require tailored public health interventions that address critical gaps in HIV prevention and testing, linkage, enrollment, and retention to antiretroviral therapy (ART) (15).

Several models of service delivery among sex workers (integrated facility-based and stand-alone targeted services as well as outreach services delivered at various hours through the day and night) have been described (16). In Uganda, the Ministry of Health (MOH) developed guidelines for service delivery among sex workers (17); however, it is unclear to what extent these services meet the needs of FSWs and what gaps still exist.

According to the Ministry of Health in Uganda, Mbarara City, in the southwestern region, ranks second in the country with the highest prevalence of HIV at 13.5% despite the availability of health facilities and HIV care services; this could be due to poor enrollment and retention of FSWs in HIV care, which increases the risks of spreading HIV among themselves, their partners, and the entire community (18). Therefore, this study explored the factors linked to the enrollment and retention of female sex workers in HIV care in Mbarara City.

1.1. Specific objectives

The specific objectives are to assess factors that contribute to the linkage of FSWs living with HIV in care at individual and community levels.

1.2. Research questions

What factors contribute to the linkage to HIV care for FSWs living with HIV in Mbarara City?

2. Materials and methods

2.1. Study design

This was a descriptive cross-sectional study that employed a phenomenological qualitative approach. We collected data by conducting in-depth interviews to explore the facilitators and barriers toward enrollment and retention of FSWs in HIV care in Mbarara City. Qualitative research is an approach that seeks to tell the story of a particular topic under study based on the experiences of the individuals and/or groups using their own words. We conducted this study between February and April 2022.

2.2. Study setting

We conducted this study in three public healthcare facilities in Mbarara City, Southwestern Uganda. Mbarara is the largest city in Southwestern Uganda, located 269.6 km from Kampala, the main capital city. The facilities offer free HIV counseling and testing services, ART adherence counseling, laboratory services, and prevention of mother-to-child transmission. Primary health facilities were purposively selected because they offer HIV care services to FSWs within the city.

2.3. Study participants

We recruited and enrolled (1) FSWs living with HIV aged 18 years and above, staying and or working in Mbarara City, that have ever enrolled for HIV care in the selected three public health facilities in Mbarara City; and (2) health care workers (HCWs) working in the ART clinics in the selected public health facilities within Mbarara City for the last 12 months. The selected HCWs have been in close contact and interacting with FSWs. The study excluded FSWs who were critically ill and HCWs who were not available at the time of data collection.

2.4. Sample size

We enrolled 30 FSWs and 21 HCWs in the study as determined by the saturation of information. Study participants aged 18 years or older, able to provide informed consent, were recruited in the study.

2.5. Sampling criteria and data collection

1) HCWs in ART clinics: We purposively recruited HCWs who had worked in the ART clinics for the last 12 months and have been in close contact and interacting with the FSWs. We thought 12 months is enough period for any HCW to have experienced the facilitators and barriers encountered by FSWs while enrolling and retaining in HIV care.
2) FSWs: With the help of expert clients and HCWs, we purposively identified FSWs who were retained in HIV care. Using the snowball sampling technique, we identified other FSWs who had ever enrolled in HIV care, whether retained on care or not.

We collected data using an interview guide and an audio recorder. We translated the interview guide developed from the existing literature into a local language (Runyankole) for the participants who did not understand English to freely give information. The study tools were pilot-tested at Kitagata Hospital and Mbarara Regional Referral Hospital. The final adjustments were made to make the questions clear to the participants.

We obtained written informed consent from the participants before they participated in the study. The interviews were conducted in private and quiet places, and each interview lasted between 30 and 45 min. For bracketing purposes, the researchers documented the participant's experiences and nonverbal cues.

2.6. Data management and analysis

The recorded interviews were transcribed verbatim immediately after data collection. The researchers listened to the recordings and compared them with the transcripts to ensure that the transcribed information was from the recordings. The transcripts were translated from Runyankole to English and backtranslated to Runyankole by independent translators to check for consistency.

Data were analyzed manually using inductive thematic content analysis. This was done through the following steps: reading and rereading the participants' descriptions of the phenomenon to acquire a feeling for their experience and roles and making sense of their account. Thereafter, similar statements were coded. Similar codes were categorized to form subthemes. Finally, related subthemes were merged to form themes.

2.7. Ethical consideration

This study was conducted according to the Declaration of Helsinki 2013. Ethical approval was obtained from the Mbarara University of Science and Technology Research Ethics Committee (MUST-REC, No. MUST-2021-293), and clearance to access archives for the study was granted by the Uganda National Council of Science and Technology (UNCST). Administrative clearance was obtained from the Resident District Commissioner's Office, the Mbarara City Health Officer, and the respective facility in charge. All participants provided written informed consent.

2.8. Positionality statement

The team was led by highly experienced and trained researchers, who are alive, work in Mbarara City, and have enough experience in HIV research. Like all qualitative studies, there might be bias in data collection and translation that may affect the findings of the study.

3. Results

3.1. Sociodemographic characteristics of the study participants

This section brings out the characteristics of the study participants. Details are provided in **Table 1**. Results are further presented below with narratives.

3.2. Healthcare workers

As seen in **Table 1**, most of the HCWs (9) were aged between 30 and 40 years. All 21 HCWs had attained tertiary education, and most of them (15) were married. Twelve of the HCWs have been working in HIV care for more than 5 years.

3.3. Female sex workers

As seen in **Table 1**, out of 30 FSWs, 20 were aged between 21 and 30 years. Seventeen of the FSWs attained secondary education, and those enrolled in HIV care were aged between 21 and 30 years. Eleven FSWs were single, and only three were married. Fifteen FSWs had spent less than a year in HIV care.

TABLE 1 Demographic characteristics of female sex workers.

Variable	Category	FSWs (*n*)	Health workers (*n*)
Age	21–30	20	5
	31–40	8	9
	41–50	2	7
Level of education	Primary	7	0
	Secondary	17	0
	Tertiary	6	21
Marital status	Single	12	4
	Married	3	15
	Separated	11	0
	Widowed	4	2
Duration in HIV care	Less than 1 year	15	0
	2–5 years	5	9
	Above 5 years	10	12

FSWs, female sex workers.

3.4. Facilitators of enrollment and retention of FSWs in HIV care

Three themes emerged as facilitators toward enrollment and retention of FSWs in HIV care to include (1) good health living, (2) receptive HCWs and availability of health services, and (3) community outreach services and peer support (Table 2).

3.4.1. Theme 1: Good health living

This theme emerged from three subthemes; (a) good health, (b) love for their family, and (c) fear of AIDS.

3.4.1.1. Good health

Across all the interviews that were conducted, the majority of FSWs revealed that the primary reasons why they enrolled and remained in HIV care were because of their wish to keep in good health and live longer, although they were HIV-positive and sexually active. Participants articulated that enrolling in HIV care would keep them healthy after receiving HIV drugs. FSWs reported that taking ART will improve their body's immunity and help them stay healthy and live longer.

> *"We take those drugs because they help us to remain healthy and live long however much we remain HIV positive, and that's why most of us go to hospital" (FSW, 30 years).*

3.4.1.2. Love for their family

The study findings indicated that most of the FSWs who were married with children enrolled and remained in HIV care to live healthy and accomplish their life roles, such as taking care of their children and their beloved family members. FSWs' desire to see their children going to school encouraged them to seek HIV care services to live healthier, stronger lives and take care of their children and beloved ones.

> *"I want to take care of my children and I love my self. I had a friend who was on ART, but after she stopped taking it, she later died. When I look at the orphans she left and how they are suffering … I don't want my children to suffer like them" (FSW, 25 years).*

3.4.1.3. Fear of AIDS and other complications

HIV/AIDS is characterized by a wasting syndrome and opportunistic infections (Kaposi's sarcoma and tuberculosis). This is the most feared state of HIV among FSWs because even their customers run away from them at this stage. Having a positive HIV test status created fear among FSWs, which encouraged them to enroll and stay in care. FSWs feared that if they dropped out, they would present with the signs and symptoms of AIDS. Of the fear of HIV/AIDS, FSWs were forced to enroll in HIV care.

> *"If you don't go to the hospital and get the medicine, you become slim and develop rashes on body, even you can't get customers because they start fearing you" (FSW, 28 years).*

> *"Some of them fear to come early, but when they start losing weight, that forces them to come and test and if they test positive, we immediately initiate them on ART" (HCW, 45 years, female).*

FSWs also reported that to keep their business of sex work running, they must have a good-looking body to attract their customers, so they are forced to test, and if they find themselves positive, they initiate ART to keep looking healthy and attractive to their customers.

> *"To remain in the business, you must be healthy, the customers always pick the good-looking ones" (FSW, 23 years).*

3.4.1.4. Demand for unprotected sex

The FSWs verbalized a high demand for unprotected sex from their customers, and they did not test them before having intercourse; this exposed them to more risk of HIV/AIDS-related complications. However, FSWs stated that unprotected sex pays more than protected sex and most men demand it. FSWs reported that because of unprotected sex they are exposed to HIV, which also forces them to

TABLE 2 Facilitators of enrollment and retention of FSWs in HIV care.

Statements	Keywords	Subtheme	Theme
• Keep in good health and live longer • Avoid developing signs of AIDS	Good health	Good health	Good health living
• Love to keep business • Love for family • Need to produce healthy babies and taking care of them	Love for family	Love for family	
• Being sick and my child • Continuous demand for unprotected sex • Death of a partner	Continuous sickness, HIV-positive results, pregnancy, death of a partner	Fear of AIDS and other complications	
• Availability of trained HCWs • Good reception • Good reception at health centers • Care by healthcare workers	Trained HCWs Trained expert clients/peer support Reception and care	Trained HCWs Expert clients Receptiveness	Receptive HCWs and availability of HIV services
• Availability of ART • Free counseling and testing services	Counseling, ART	Counseling, access to ART	
• Follow-up and tracing lost clients • HCWs found us in business centers • Convenience of test and treatment option	Follow-up in communities, access to testing and treatment services, community outreach, assisted partner notification	Community outreach, testing and treatment, follow-up, contact tracing	Peer support and community outreaches
• Peer support • Availability of counseling services • Follow-up by HCWs	Involvement of peer helpers Support from expert clients	Peer helpers	

FSWs, female sex workers; HCWs, healthcare workers.
It consists of statements, subthemes, and themes.

visit health facilities for testing, and most find when they are HIV-positive.

> *"With a condom its 10,000 Ug shillings, without a condom we double the price, but they like unprotected sex" (FSW, 30 years).*

> *"Because we always have unprotected sex, we go to test ourselves to know our HIV status" (FSW, 23 years).*

3.4.1.5. Death of a partner

FSWs reported that HIV is real and it kills. They reported that some of them started testing when their partners died because of HIV. People who started on ART and later dropped out of care die, forcing the FSWs to remain committed to HIV care and taking ART on a daily basis as prescribed by the HCWs. They also stated that they know of their customers that died of HIV and that forces them to remain in HIV care so that they can live longer.

> *"My husband died of HIV, that's why for me I cannot miss taking my drugs in time and on daily basis, because I know what it means when you refuse to take it" (FSW, 34 years).*

From the theme above, it can be stated that personal initiatives aimed at having good healthy living enhanced enrollment and retention in HIV care among FSWs.

3.4.2. Theme 2: Trained HCWs and availability of HIV care services

This theme emerged from four subthemes detailing how the availability of services at the health facilities in addition to welcoming HCWs enabled FSWs to enroll and remain in HIV care in Mbarara City. These include (1) trained HCWs and expert clients, (2) positive attitude of HCWs, (3) counseling and testing services, and (4) availability of ART.

3.4.2.1. Trained HCWs and expert clients

The Ministry of Health, with support from international organizations, has extended HIV services to every health facility and continuously provides refresher training to the HCWs and the expert clients working in the ART clinics to update them with the current guidelines. This is evidenced by the quality of services the HCWs and expert clients provide to FSWs. HCWs reported that they receive monthly training, and this helps them to provide quality care to people living with HIV, especially FSWs.

> *"We receive regular trainings from Ministry of Health experts, and we always follow the World Health Guidelines while providing HIV services to FSWs" (HCW, 32 years, male).*

> *"The expert clients are also trained with us, and they help us so much …"(HCW, 40 years, male).*

FSWs reported that they enroll and remain in HIV care because they know they are in the safe hands of trained HCWs. FSW also reported that each time they visit the primary health clinic/facility, HCWs provide HIV care services (HIV counseling, testing, and provision of ART). If there is evidence of poor adherence to ART or drug resistance, patients are switched to other regimen options.

> *"We trust our HCWs and that keeps us going there when there is a problem or in case you need to ask them some questions" (FSW, 30 years).*

FSWs reported that they feel relieved when they find that some of them are working at the health facilities as expert clients/peer supporters, and that gives them hope in what they are doing. Furthermore, the HCWs also reported that the FSWs share their problems freely with the expert clients than they share with them.

> *"When you are talking to someone who is like you, it is much easier because we share the same challenges … the expert clients help us a lot" (FSW, 25 years).*

> *"They are free to share with expert clients, and that helps us to know what they do not tell us" (HCW, 35 years, female).*

3.4.2.2. Positive attitude of HCWs

FSWs reported that the positive attitude of HCWs has helped them to enroll and remain in HIV care. FSWs mentioned that the HCWs have a good and receptive attitude at the health facilities. They are willing to help at any time you go there. FSWs observed that the HCWs are willing to listen to their problems and provide solutions.

> *"The HCWs are receptive, and they are willing to help us, even when you call on a phone, they help…" (FSW, 35 years).*

> *"Our work is to provide care for all, but we give closer attention to the FSWs because they face a lot of problems in their worker" (HCW, 40 years, female).*

3.4.2.3. Counseling and testing services

The FSWs reported that the HCWs provide them with the best counseling and testing services. The FSWs reported that before anything is done, they first counsel you to get tested, and if you test positive, they initiate you on ART when you are ready. The counseling and testing services relieve stress and prepare the people living with HIV for the next steps of management and HIV care.

> *"They counsel you and you feel relieved and ready to start taking ART" (FSW 30 years).*

> *"We provide them with counseling services to prepare them before testing, and those who test positive, we counsel them to know how to take their ART and its importance" (HCW, 50 years, male).*

3.4.2.4. Availability of ART

Participants reported that they remained in care because of the availability of ART and other services. Participants stated that every time they visit health facilities, they find ART available at the health facilities, which kept them enrolled in HIV care. HCWs also mentioned that ART drugs are always available, ensuring that individuals living with HIV receive ART every time they visit primary health facilities.

> *"Every time you go to the health facility, you find drugs there, that keeps us going there" (FSW, 21 years).*

3.4.2.5. Availability of other services

FSWs stated that in addition to HIV services, they also get other services at health facilities, which is why they keep going. Some of the services include treatment for other sexual infections such as gonorrhea and syphilis as well as for common diseases like malaria and typhoid. Those who are pregnant also access antenatal services. Therefore, keeping health centers equipped with HCWs and enough drugs motivated and attracted FSWs living with HIV into healthcare to improve their wellbeing.

> *"When go to the health facility to pick drugs for HIV you also get other services like antenatal, if the nurses see that you have other infections, they also treat them" (FSW, 27 years).*

3.4.3. Theme 3: community outreach services and peer support

3.4.3.1. Female sex workers

In the HIV care system in Uganda, expert clients are trained to provide HIV care alongside HCWs to reduce the workload. The expert clients help provide counseling services and give health talks to people living with HIV. Peer support was given by fellow FSWs at health centers who worked alongside HCWs.

> *"The expert clients talk exactly what they went through and they are the challenges that we go through, so we listen to what advise us to do" (FSW, 24 years).*

The expert clients do not stop at providing counseling services at the health facilities; they also follow up with lost clients in their communities and try to bring them back to the health facilities; for those who remain hesitant, the expert clients pick their drugs from the health facilities and deliver to their homes. They have played a significant role in the retention of FSWs in HIV care.

> *"Expert clients help us to track their friends who drop off care by following them up to their homes and take for them drugs" (HCW, 36 years).*

Most FSWs indicated that they were recruited into HIV care through outreach services by HCWs to areas where they operate their business and in their clusters. This was done either through testing and treatment method or through contact tracing and counseling by expert clients. The community outreach services have helped to enroll many FSWs in HIV care from their communities. Community outreach services were effective in testing, enrolling, and tracing FSWs, especially those who were unknown HIV-positive initially.

> *"They found me at my workplace in the bar, that where they tested me from, when I was found positive, they counselled me and I initiated on ART" (FSW, 21 years).*

3.5. Barriers to enrollment and retention of FSWs in HIV care

The enrollment and retention of FSWs in HIV care has faced a number of barriers. The barriers have been summarized into four major themes: (1) stigma, community discrimination, and briefs; (2) social obstacles; (3) adverse effects of ART; and (4) inadequate services at the health facilities.

3.5.1. Theme 1: Stigma, community discrimination, and briefs

This theme emerged from two subthemes including fear of testing and enrolling in HIV care and fear of disclosing their status (Table 3).

3.5.1.1. Fear of testing and enrolling in HIV care

FSWs did not hesitate to report fear of having positive HIV test results as one of the major barriers to HIV testing and thus enrollment and retention into care. They mentioned that they fear testing, and most of them remain ignorant about their HIV status. They also reported that enrolling in HIV care is a challenge because they are seen by everyone when they go to pick medication from the health facilities, which is why most of them drop out of care.

> *"Majority of the young girls fear to be tested and those that test positive fear to come and pick their drugs" (HCW, 40 years, male).*

> *"Yes, it is true, we fear going to the HIV clinic to pick drugs because everybody there know that your also HIV positive" (FSW, 28 years).*

FSWs reported that having a positive HIV test means the end of life, so they do not find value in enrolling in HIV care and taking antiretroviral (ARVs). They instead blame themselves for contracting the infection from someone they do not know and also choose to spread the infection by having unprotected intercourse with other people since they also got it in the same way. The feeling of being close to death stops most FSWs from enrolling in HIV care.

> *"I refused to start on the medication because I knew I was going to die soon" (FSW, 24 years).*

> *"Some of them come when they have lost hope, but when we counsel and initiate them on ART, they regain their health and they are still alive" (HCW, 40 years, female).*

3.5.1.2. Fear of disclosing the HIV status

Most FSWs fear disclosing their HIV status to their friends because they do not want to be recognized as HIV-positive in their communities. Even married sex workers do not disclose to their family members due to the fear of being blamed.

> *"You cannot tell your secrets to everyone because when you tell them they start blaming you" (FSW, 32 years).*

TABLE 3 Barriers to enrollment and retention of FSWs in HIV care.

Statements (barriers)	Keywords	Subtheme	Theme
• Fear of testing for HIV and enrolling in care	Fear of enrolling	Fear of testing and enrolling in HIV care	Self-stigma, community discrimination, and beliefs
• Sex workers lose hope in life • Self-blame • Fear of death	Hopelessness Blame	Self-stigma	
• Family neglect after discovering their HIV status, Loss of hope in themselves, and some hate taking drugs daily • Some girls fear going for testing because of fear of being seen by others taking drugs • Fear of customers discovering their status	Discrimination Family neglect Fear of disclosing their HIV status	Discrimination Family neglect Fear of disclosing	
• Too much alcohol and drug abuse makes sex workers forget to take their drugs consistently • Lack of food, and yet drugs are strong to take while hungry • Distance from workplaces • Delay in going back home • Frequent movement when following clients	Alcoholism Forgetfulness Substance abuse Lack of food Tight schedule Lack of permanent places of work	Substance abuse Inadequate food Temporary nature of their work	Social obstacles
• I would have bad visions and would shiver at night while doing sexual activities	Dizziness, loss of work	Side effects	Adverse effects of ARVs
• Long queues and delays at the health facilities • Segregation in the community	Lines are always long at the facility	Long waiting hours	Inadequate services at the health facilities
• Shortage of supplemented drugs in hospitals for other infections like syphilis and gonorrhea	Lack of STI drugs	Inadequate supplies and drugs	
• Some HCWs are rude • Limited time at the facilities • Inadequate counseling services	Do not usually give time to patients	Poor attitude of health workers	

FSWs, female sex workers.

3.5.2. Theme 2: Social obstacles

Social obstacles refer to all social factors that act as barriers to the enrollment and retention of FSWs in HIV care. This includes the use and abuse of substances (alcohol and other drugs), inadequate food, long working hours, and the temporary nature of their work.

3.5.2.1. Alcoholism and substance abuse

Most FSWs work in places of entertainment (bars and clubs), and their use of toxic substances and alcohol is high. Unfortunately, this makes them forget to take their ART as prescribed by the HCWs. They stop returning to health facilities for refills and drop out of HIV care.

> *"Most of our clients take alcohol and when they are drunk, they can't take their drugs, they even forget to come back for the refills" (HCW, 50 years, female).*

3.5.2.2. Inadequate food

It is important for individuals living with HIV to have adequate and high-quality food. Adequate and high-quality food provides the required nutrients that the body needs to keep the immune system stronger and helps manage HIV-related symptoms and complications.

> *"To take those drugs requires eating adequate food, and most of us do not have it, that's why some of us stop taking them" (FSW, 28 years).*

3.5.2.3. Long working hours and temporary nature of their work

Most of the FSWs reported the challenging nature of their working condition, whereby they have long working hours from evening up to late in the morning. Most of them sleep during the day, and they do not find time to visit the health facilities during the day.

> *"We work the whole night and sleep during the day, so we do not have time to visit the hospitals" (FSW, 25 years).*

Furthermore, FSWs do not have stable working places; they keep moving to different bars and nightclubs depending on where most clients are; thus, they keep changing points of ART refilling. It is sometimes hard for the HCWs and expert clients to trace and follow them up.

> *"FSWs keep changing from one point to another, thus it becomes hard to retain them at one health facility" (HCW, 28 years, male).*

3.5.3. Theme 3: ART-related side effects and adverse events

Initiating ART comes with a number of side effects. Some people gain weight, while others lose weight. Others reported that they always get nightmares, which forces them to stop taking ART.

> *"Some say that when they swallow the drugs, they become dizzy, so they sacrifice taking ARVs to keep their sex job" (HCW 27 years).*

> *"We know of the side effects of ART, but those stop with time" (HCW, 45 years, female).*

> *"I was dreaming people burying me, but it later stopped, I would feel scared, but later I stopped dreaming and am now stable and healthy on ART" (FSW, 32 years).*

3.5.4. Theme 4: Inadequate services at the health facilities

This theme emerged from three subthemes, including inadequate supplies and drugs, long waiting hours, and poor attitude of some HCWs.

3.5.4.1. Inadequate supplies and drugs

Due to the low socioeconomic status, FSWs reported difficulties purchasing non-ART drugs and medical kits in case health facilities were out of stock. FSWs reported finding it difficult to buy or purchase medications from their own pockets and are discouraged from returning to health facilities that do not have adequate drug supply or provide all services.

> *"When you go to the hospital twice and there are no drugs you feel discouraged to go back there" (FSW, 34 years).*

3.5.4.2. Long queues and waiting hours

FSWs reported that they wait for many hours and in long queues in health facilities. They highlighted that it is discouraging to spend long hours in long queues.

> *"Long ques and delays at the health facilities discourage us" (FSW, 20 years).*

> *"We receive very many patients here and we have to work on them all, so sometimes they delay receiving care, but that is a general challenge" (HCW, 40 years, female).*

3.5.4.3. Negative attitude of some health workers

FSWs reported that sometimes the HCWs are rude, which discourages them from coming to health facilities, mostly if they get to know which HCWs are on duty. If it is the rude ones, they find themselves missing the appointment dates. However, the HCWs attribute this to the heavy workload, and they are already tired sometimes. They also tend to be rude when some FSWs skip their appointments for a long time. Such clients fear being reprimanded and subsequently will miss their appointment dates.

> *"Some HCWs are very rude, to us, and that discourages us from coming back to pick the drugs" (FSW 34 years).*

4. Discussion

Enrollment and retention in care are essential in HIV care continuum and necessary for the successful management of HIV infection. This study adds to the existing literature by exploring the enrollment and retention of FSWs in HIV care.

4.1. Facilitators of enrollment and retention of FSWs in HIV care

The need for every HIV-positive female sex worker to have good health and long life encourages them to enroll and remain in HIV care. Other studies reported that the desire to remain healthy, get married, and have children, in addition to the knowledge they had of the benefits of early treatment (19), kept FSWs enrolled in HIV care. This means that to remain healthy, FSWs must continue taking ART as prescribed. FSWs living with HIV know that taking ART is the only way to boost their immune system, stay healthy, and live longer. HCWs should continue health-educating the FSWs on the importance of ART for their lives and why they should remain in HIV care once enrolled.

Refresher training to the HCWs and expert clients working in the ART clinics to update them with the current guidelines improves the quality of services they provide to FSWs and promotes retention in HIV care. Results from other studies show that trained expert clients provide excellent health education, counseling, and outreach services, and their involvement is acceptable to most FSWs. Expert clients established strong personal relationships with other FSWs, thus improving enrollment and retention of HIV-positive

FSWs in HIV care (20). Continuous training should be implemented, and expert clients should be fully integrated into HIV care.

FSWs feel relieved when they find expert clients at health facilities. The HCWs also reported that the FSWs are free to share their problems with the expert clients than they would wish to share with health workers. It is reported in other studies that peer support with routine medical care is superior to routine clinic follow-up in improving outcomes for people living with HIV. The approach was also recommended as feasible and effective for linking and retaining HIV-positive sex workers to HIV care, which can help HCWs shoulder existing services (21, 22).

The positive attitudes of HCWs were found to have greatly influenced FSWs to enroll and remain in HIV care. The good and receptive attitude the FSWs find at the health facilities and the willingness to help and listen to their problems and provide solutions to their problems attracted HCWs to remain in HIV care. Similarly, attitudes of HCWs are positively associated with retention of FSWs on ART, and retention was 20% higher among the sex workers that perceived the HCWs' attitude to be good compared to those that perceived it to be fair (23). Measures to improve the attitudes of HCWs will greatly improve the enrollment and retention of HIV-positive FSWs in HIV care.

HIV counseling is key in the fight against stigma and in improving retention and enrollment in HIV care. With the best counseling services, FSWs reported willingness to start ART (21, 23). Therefore, the HCWs, in addition to clinical knowledge, should be equipped with knowledge and skills on how to provide HIV care services to FSWs living with HIV.

Provision of other healthcare services in addition to HIV, such as screening, testing, and treatment of sexually transmitted infections (STI), malaria, and typhoid, has motivated and attracted HIV-positive FSWs to enroll and remain in healthcare services, thus improving their wellbeing. Studies conducted in sub-Saharan Africa reported that the integration of HIV care services into non-HIV services (maternal, child healthcare, reproductive health services) had improved the enrollment and retention of FSWs in HIV care (24, 25). Therefore, integration of HIV care services into other routine health services is most likely to improve patient outcomes and overall efficiency of healthcare systems.

In Uganda, expert clients are trained to provide certain HIV care services such as counseling and health education, and this is done as part of task shifting and trying to reduce the workload for HCWs. Various studies have reported that FSWs living with HIV feel safe when assisted by other FSWs (peer experts) in the healthcare facility. In addition, peer experts are beneficial in helping fellow FSWs join clinic queues to receive ART medication faster, helping pick and deliver ART medication for those who cannot attend healthcare clinics, and providing psychosocial support (26). Peer supporters were very crucial in the enrollment of FSWs with respect to HIV healthcare and also in providing them with psychosocial support.

Our findings showed that some FSWs are recruited into HIV care through outreach services by HCWs to areas where they operate their business and in their clusters. The community outreach services have enabled us to enroll many FSWs in HIV care from their communities. It is reported that community initiatives such as outreach services by HCWs facilitated enrollment and retention of FSWs in HIV care. It is during such visits that FSWs who had never tested got to know their HIV status, while those who knew their status but feared to enroll were recruited (10). However, the shortage of HIV diagnostics and supplies hindered community-based HIV testing and delivery services and kept most FSWs away from care (27). Whereas community outreach services provide effective models for recruiting FSWs into HIV care, more strategies are required to link them to mainstream health facilities where they may receive consistent HIV care services.

4.2. Barriers to enrollment and retention of FSWs

HIV is associated with stigma and segregation from family and community members; however, it is worse when associated with sex work, which is a condemned and cursed business in Uganda, and that is why most sex workers do not enroll in HIV care. Stigma is a process by which an individual is labeled based on characteristics that may not adhere to socially accepted norms, resulting in reduced wellbeing and opportunities for that individual. Sex workers may experience stigma due to their engagement in sex work, HIV status, or other identities and behaviors (drug use, gender identity, sexual orientation, migration status) and the intersections of these characteristics. HIV-related stigma could be based on the actual or perceived status of living with HIV. This can lead to fear or avoidance of health services (28).

Fear of having a positive HIV test result has remained one of the major barriers to HIV testing and thus enrollment and retention in care. It has been mentioned that the fear of testing stopped most FSWs from enrolling and retaining in HIV care. Other studies reported that the gap between testing and enrollment among FSWs due to fear of testing and being seen by everyone when they are going to pick medication from the health facilities might reduce their chances to enroll in HIV care, and this could be the reason why most of them drop out of care (7). HCWs together with other stakeholders should strive to make the FSWs aware of the importance of early testing and treatment of HIV.

Discrimination, self-stigma, and segregation were found to be the major causes of poor health-seeking behaviors among the FSWs. Most FSWs were hesitant to seek HIV care due to the fear of being known or identified as HIV-positive. Fear of being known as HIV-positive led to clinic avoidance behaviors among HIV-infected FSWs. Home-based care interventions such as counseling were moved away from home to prevent neighbors and others from knowing about their participation in the intervention and, by inference, their HIV serostatus (29, 30). It was established that the main barriers to enrollment in HIV care among FSWs were perceived stigma, fear of being seen at outreach HIV clinics, fear and myths about antiretroviral therapy, lack of time to attend a clinic, and financial constraints (31). Extending HIV care services to communities can mitigate fear and stigma and may improve the retention of FSWs in care. Family members and close friends also tended to discriminate against them when they discovered that they were HIV-positive, and this affected their enrollment and retention in HIV care. Facilitated serostatus disclosure in the presence of trained health workers would help to solve major challenges associated with HIV disclosure.

Most FSWs work in bars and nightclubs where they got exposed to toxic substances and alcohol to keep them energetic and to work throughout the night. These substances however make them oversleep and forget to take their ART. This has further made the situation worse because the use of substances interferes with consistency in enrollment and retention in HIV care. Other studies reported that alcohol and drug abuse were among the barriers to the retention of FSWs in HIV care (5). Therefore, continuous health education on the dangerous effects of alcohol and other substances while on ART could reduce their use by HIV-positive FSWs.

Substance use, particularly alcohol use, has been reported as a barrier to HIV care among FSWs. Currently, there are few interventions related to HIV care that focus on reducing substance use among FSWs living with HIV (32). Substance use can impair cognitive functions, which may adversely affect health-seeking behaviors such as enrolling and retaining in HIV care (9).

In southern Africa, food insecurity has been linked to an increased risk of contracting HIV and difficulty remaining in HIV care for FSWs living with HIV. Food insecurity is defined as the state of having uncertain or limited access to sufficient and nutritious food (1). Food insecurity has been linked to high-risk sexual practices among women. This forces women to look for ways to provide food for their families that involves high-risk sexual practices that include sex work, transactional sex, and decreased condom use (1–4). It was further reported that FSWs in sub-Saharan Africa have suboptimal HIV care and treatment engagement outcomes as a result of poor nutrition, food insecurity, and substance use (9), which were commonly reported and associated with poor ART initiation and retention in care. While engagement in sex work can be income-generating, FSWs may continue to struggle with food insecurity (9). Measures to improve food security would improve retention in care of FSWs living with HIV and minimize the risks of sex work among young females.

The main challenges faced by FSWs include poor working conditions, health risks, violence, discrimination, poor access to substantial healthcare services, legal assistance, and social services. Due to their working hours, they often struggle to find time to visit healthcare facilities as they prefer to rest or sleep during the day to be productive in the evenings (33). Unfortunately, the nature of their work and its environment bring stress with cases of sexual assault and harassment noted in some instances (33). These issues have been reported as barriers for them to access HIV care services.

Due to their low economic status, FSWs find it hard to buy drugs and attain other healthcare services, such as pregnancy test kits and family planning, that are not offered in public health facilities when they are out of stock; high cost of other health services (health system) hinders retention of FSWs in HIV care (19).

Health facilities should be equipped with the required supplies so that they can offer integrated services to FSWs at any point of their visit to the health facilities.

FSWs spend long waiting hours at the facilities, which discourages them from further coming and hinders their retention; this is due to the unfavorable working conditions. Studies demonstrated that HCWs' shortage and high workload led to poor care provisions and long wait times for individuals living with HIV, contributing to suboptimal retention (30). Increasing the number of HCWs and expert clients could decrease the workload and the long waiting hours at the health facilities.

In some cases, HCWs are reported to mistreat FSWs and judge them for the kind of work they do, creating reluctance in routine facility visits. HCWs have attributed their negative attitudes toward FSWs to heavy workloads and abnormal working hours causing fatigue and burn out, which compromises the quality of work offered to FSWs (16, 19, 31).

Various studies have reported that the shortage of clinicians and lay health workers in healthcare facilities, accompanied by high workload, is linked to poor provision of services, poor quality of care, and long waiting hours for individuals living with HIV, leading to poor retention in care (30).

5. Conclusion

FSWs are challenged by the unsupportive environments and communities where they live and work, which hinders their enrollment and retention in HIV. It is important to integrate sex work-related services into other services within health facilities. Food security among FSWs such as developing comprehensive food security interventions for FSWs should be be integrated with HIV programs. Creating awareness of the utilization of HIV care services and extending such services to the communities could positively impact the lives of FSWs.

6. Limitations of the study

Being a qualitative study design, some of the participants might not have provided relevant information during interviews; however, much data collection was done at the convenience of the participant. This might have left a lot of information not captured in the study.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Mbarara University of Science and Technology Research Ethics Committee (MUST- REC: 2021-293). The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors contributed significantly to this work from the conception, design of the assessment, and interpretation of study results. All authors have contributed to the manuscript preparation and revision and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. World Health Organization. Progress report 2016: prevent HIV, test and treat all: WHO support for country impact. World Health Organization (2016).

2. Moyo I, Macherera M. The experiences of sex workers accessing HIV care services in Bulawayo, Zimbabwe. *Afr Health Sci*. (2021) 21(2):593–602. doi: 10.4314/ahs.v21i2.14

3. Jin H, Restar A, Beyrer C. Overview of the epidemiological conditions of HIV among key populations in Africa. *J Int AIDS Soc*. (2021) 24:e25716. doi: 10.1002/jia2.25716

4. Nsanzimana S, Mills EJ, Harari O, Mugwaneza P, Karita E, Uwizihiwe JP, et al. Prevalence and incidence of HIV among FSWs and their clients: modelling the potential effects of intervention in Rwanda. *BMJ Glob Health*. (2020) 5(8):e002300. doi: 10.1136/bmjgh-2020-002300

5. Witte SS, Filippone P, Ssewamala FM, Nabunya P, Bahar OS, Mayo-Wilson LJ, et al. PrEP acceptability and initiation among women engaged in sex work in Uganda: implications for HIV prevention. *EClinicalMedicine*. (2022) 44:101278. doi: 10.1016/j.eclinm.2022.101278

6. Mizinduko M, Moen K, Likindikoki S, Mwijage A, Leyna GH, Makyao N, et al. HIV prevalence and associated risk factors among FSWs in Dar es Salaam, Tanzania: tracking the epidemic. *Int J STD AIDS*. (2020) 31(10):950–7. doi: 10.1177/0956462420917848

7. Vu GT, Tran BX, Hoang CL, Hall BJ, Phan HT, Ha GH, et al. Global research on quality of life of patients with HIV/AIDS: is it socio-culturally addressed? (GAP$_{\text{RESEARCH}}$). *Int J Environ Res Public Health*. (2020) 17(6):2127. doi: 10.3390/ijerph17062127

8. Lafort Y, Lessitala F, Candrinho B, Greener L, Greener R, Beksinska M, et al. Barriers to HIV and sexual and reproductive health care for FSWs in Tete, Mozambique: results from a cross-sectional survey and focus group discussions. *BMC Public Health*. (2016) 16(1):1–8. doi: 10.1186/s12889-016-3305-5

9. Lancaster KE, Cernigliaro D, Zulliger R, Fleming PF. HIV care and treatment experiences among FSWs living with HIV in sub-Saharan Africa: a systematic review. *Afr J AIDS Res*. (2016) 15(4):377–86. doi: 10.2989/16085906.2016.1255652

10. Tun W, Apicella L, Casalini C, Bikaru D, Mbita G, Jeremiah K, et al. Community-based antiretroviral therapy (ART) delivery for FSWs in Tanzania: 6-month ART initiation and adherence. *AIDS Behav*. (2019) 23(2):142–52. doi: 10.1007/s10461-019-02549-x

11. Stricker SM, Fox KA, Baggaley R, Negussie E, de Pee S, Grede N, et al. Retention in care and adherence to ART are critical elements of HIV care interventions. *AIDS Behav*. (2014) 18(5):465–75. doi: 10.1007/s10461-013-0598-6

12. Abdella S, Demissie M, Worku A, Dheresa M, Berhane Y. HIV prevalence and associated factors among FSWs in Ethiopia, east Africa: a cross-sectional study using a respondent-driven sampling technique. *EClinicalMedicine*. (2022) 51:101540. doi: 10.1016/j.eclinm.2022.101540

13. Owachi D, Anguzu G, Kigozi J, Cox J, Castelnuovo B, Semitala F, et al. Virologic suppression and associated factors in HIV infected Ugandan FSWs: a cross-sectional study. *Afr Health Sci*. (2021) 21(2):603–13. doi: 10.4314/ahs.v21i2.15

14. Pilgrim N, Musheke M, Raymond HF, Keating R, Mwale J, Banda L, et al. Quality of care and HIV service utilization among key populations in Zambia: a qualitative comparative analysis among FSWs, men who have sex with men and people who use drugs. *AIDS Care*. (2019) 31(4):460–4. doi: 10.1080/09540121.2018.1524119

15. Hladik W, Baughman AL, Serwadda D, Tappero JW, Kwezi R, Nakato ND, et al. Burden and characteristics of HIV infection among FSWs in Kampala, Uganda—a respondent-driven sampling survey. *BMC Public Health*. (2017) 17 (1):1–12. doi: 10.1186/s12889-017-4428-z

16. Wanyenze RK, Musinguzi G, Kiguli J, Nuwaha F, Mujisha G, Musinguzi J, et al. "When they know that you are a sex worker, you will be the last person to be treated": perceptions and experiences of FSWs in accessing HIV services in Uganda. *BMC Int Health Hum Rights*. (2017) 17(1):1–11. doi: 10.1186/s12914-017-0119-1

17. Uganda AIDS Commission, HIV Uganda. National HIV and AIDS strategic plan 2015/2016-2019/2020: an AIDS free Uganda, my responsibility!: Uganda AIDS Commission (2015).

18. Andriyani L, Arina A, Widihastuti A, Nugroho A. Challenges and support to HIV care and treatment of FSWs living with HIV in Indonesia: a mixed method study. *Unnes J Public Health*. (2021) 10(2):169–79. doi: 10.15294/ujph.v10i2.40037

19. Muhindo R, Mujugira A, Castelnuovo B, Sewankambo NK, Parkes-Ratanshi R, Tumwesigye NM, et al. "I felt very small and embarrassed by the health care provider when I requested to be tested for syphilis": barriers and facilitators of regular syphilis and HIV testing among FSWs in Uganda. *BMC Public Health*. (2021) 21(1):1982. doi: 10.1186/s12889-021-12095-8

20. Alamo ST, Wabwire-mangen F, Kenneth EG, Sunday P, Laga M, Colebunders RL. Task-shifting to community health workers: evaluation of the performance of a peer-led model in an antiretroviral program in Uganda. *AIDS Patient Care STDS*. (2012) 26(2):101–7. doi: 10.1089/apc.2011.0279

21. McGowan M, Roche SD, Nakitende A, Wachinger J, Nanyiri E, Amongin J, et al. Understanding how social support influences peer-delivered HIV prevention interventions among Ugandan FSWs: a case study from HIV self-testing. *BMC Public Health*. (2022) 22(1):427. doi: 10.1186/s12889-022-12836-3

22. Berg RC, Page S, Øgård-Repål A. The effectiveness of peer-support for people living with HIV: a systematic review and meta-analysis. *PLoS ONE*. (2021) 16(6):e0252623. doi: 10.1371/journal.pone.0252623

23. James W, Atuhairwe C, Alege JB. Retention of FSWs at one month taking oral pre-exposure prophylaxis for HIV prevention in selected public health facilities in Kampala, Uganda. *medRxiv*. (2022). doi: 10.1101/2022.06.28.22277029

24. Katz DA, Dombrowski JC, Kerani RP, Aubin MR, Kern DA, Heal DD, et al. Integrating HIV testing as an outcome of STD partner services for men who have sex with men. *AIDS Patient Care STDS*. (2016) 30(5):208–14. doi: 10.1089/apc.2016.0027

25. Bulstra CA, Hontelez JA, Otto M, Stepanova A, Lamontagne E, Yakusik A, et al. Integrating HIV services and other health services: a systematic review and meta-analysis. *PLoS Med*. (2021) 18(11):e1003836. doi: 10.1371/journal.pmed.1003836

26. Atuhaire L, Shumba CS, Nyasulu PS. "My condition is my secret": perspectives of HIV positive FSWs on differentiated service delivery models in Kampala Uganda. *BMC Health Serv Res*. (2022) 22(1):1–13. doi: 10.1186/s12913-022-07561-x

27. Pande G, Bulage L, Kabwama S, Nsubuga F, Kyambadde P, Mugerwa S, et al. Preference and uptake of different community-based HIV testing service delivery models among FSWs along Malaba-Kampala highway, Uganda, 2017. *BMC Health Serv Res*. (2019) 19(1):1–11. doi: 10.1186/s12913-019-4610-3

28. Viswasam N, Schwartz S, Baral S. Characterizing the role of intersecting stigmas and sustained inequities in driving HIV syndemics across low-and middle-income settings. *Curr Opin HIV AIDS*. (2020) 15(4):243. doi: 10.1097/COH.0000000000000630

29. Bezabhe WM, Chalmers L, Bereznicki LR, Peterson GM, Bimirew MA, Kassie DM. Barriers and facilitators of adherence to antiretroviral drug therapy and retention in care among adult HIV-positive patients: a qualitative study from Ethiopia. *PLoS One*. (2014) 9(5):e97353. doi: 10.1371/journal.pone.0097353

30. Hall BJ, Sou K-L, Beanland R, Lacky M, Tso LS, Ma Q, et al. Barriers and facilitators to interventions improving retention in HIV care: a qualitative evidence meta-synthesis. *AIDS Behav*. (2017) 21(6):1755–67. doi: 10.1007/s10461-016-1537-0

31. Nakanwagi S, Matovu JK, Kintu BN, Kaharuza F, Wanyenze RK. Facilitators and barriers to linkage to HIV care among FSWs receiving HIV testing services at a community-based organization in Periurban Uganda: a qualitative study. *J Sex Transm Dis*. (2016) 2016. doi: 10.1155/2016/7673014

32. Donastorg Y, Barrington C, Perez M, Kerrigan D. Abriendo Puertas: baseline findings from an integrated intervention to promote prevention, treatment and care among FSW living with HIV in the Dominican Republic. *PloS One*. (2014) 9(2):e88157. doi: 10.1371/journal.pone.0088157

33. Duff P, Sou J, Chapman J, Dobrer S, Braschel M, Goldenberg S, et al. Poor working conditions and work stress among Canadian sex workers. *Occup Med*. (2017) 67(7):515–21. doi: 10.1093/occmed/kqx092

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Prevalence and risk factors for subclinical atherosclerosis amongst adults living with HIV in University of Abuja Teaching Hospital, Gwagwalada

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Background: Subclinical atherosclerosis characterizes cardiovascular diseases (CVD), and Human Immunodeficiency Virus (HIV) infection and antiretroviral therapy (ART) are identified risk factors for atherosclerosis. Meanwhile, data on HIV and atherosclerosis in Nigeria are limited.

Objectives: We sought to estimate the prevalence of subclinical atherosclerosis and associated risk factors amongst adult persons living with HIV/AIDS (PLHIV) enrolled at University of Abuja Teaching Hospital, Gwagwalada, Abuja (UATH).

Methods: This was a cross-sectional study of 277 consecutively selected PLHIV ≥18 years enrolled for HIV care and treatment at UATH. Pretested structured questionnaire was used to collect data from consenting ART-experienced and ART-naïve patients on risk factors of atherosclerosis. Carotid intima media thickness (CIMT) ≥0.71 mm as measured by Doppler ultrasonography was used to identify patients with sub-clinical atherosclerosis. Two logistic regression models with (Model-A) and without (Model-B) traditional risk factors were fitted to identify risk factors of subclinical atherosclerosis.

Results: Participants' mean age was 39.44 ± 10.71 years with female preponderance (64.26%). Overall prevalence of subclinical atherosclerosis was 43.32% (62.25% in ART-experienced). Model-A identified male sex [AOR 4.33(1.74–10.76), $p = 0.002$], advancing age [30–39 years AOR 5.95(1.31–26.96), $p = 0.021$]; ≥40 years AOR 19.51 (4.30–88.56), $p \le 0.001$), advancing HIV infection [≥WHO stage II AOR 4.19(1.11–15.92), $p = 0.035$], hypercholesterolemia [AOR 3.88(1.47–10.25), $p \le 0.001$] and ≥5 year duration on ART [AOR 9.05(3.16–25.92), $p \le 0.001$] as risk factors of subclinical atherosclerosis. In Model-B (excluding traditional risk factors) on the other hand, advancing HIV infection [≥WHO stage II AOR 3.93(1.19–13.042), $p = 0.025$] and duration on ART [≥5 years AOR 11.43(4.62–28.29), $p = 0.001$] were found as risk factors of subclinical atherosclerosis.

Conclusion: Subclinical atherosclerosis was higher in ART-experienced patients, and this was irrespective of presence or absence of traditional risk factors. And advancing HIV disease and duration on ART were found as significant risk factors for subclinical atherosclerosis. We therefore recommend routine CVD risk screening in PLHIV.

KEYWORDS

ART, CIMT (Carotid intima-media thickness), CVD (cardiovascular disease), HIV - human immunodeficiency virus, sub-clinical atherosclerosis

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Background

Human Immunodeficiency Virus (HIV) infected individuals appear to have significantly higher risk of myocardial infarction and coronary heart disease relative to HIV negative individuals (1–4). With the advent of lifelong antiretroviral treatment (ART), HIV positive persons have increased life expectancy (5, 6). This increasing life expectancy is subsequently associated with increased risk of cardiovascular diseases (CVD) as increasing age is an independent risk for CVD (7–9). In addition to the identified traditional risk factors of CVD, persons living with HIV have increased risk of atherosclerosis due to use of antiretroviral (ARV) drugs and inflammatory factors related to HIV infection (10–13). Several studies have found an association between use of ARV drugs especially protease inhibitors and the development of atherosclerosis (14–17). Protease inhibitors are specifically associated with dyslipidaemia, thus increasing the risk of atherosclerosis (18), which is the hallmark of CVD (19, 20). Atherosclerosis which is characterized by hardening of arteries through the accumulation of plaques presents clinically as cardiovascular disease (CVD) events such as stroke and myocardial infarction (20). Due to the increasing morbidity and mortality associated with CVD (4), it is desirable to detect subclinical signs of CVD early so as to institute prompt management and delay the manifestation of the overt disease.

Meanwhile, the presence of atherosclerosis can be diagnosed early at subclinical levels using carotid intima media thickness (CIMT) as a measure (21–23), and increases in CIMT has been shown to be predictive of future CVD events (19). Both common carotid intima media thickness (CCA IMT) and internal carotid artery intima media thickness (ICA IMT) have been used as a measure of subclinical atherosclerosis. Common carotid intima media thickness (CCA IMT) is however preferred because it is easier to measure and results are more reproducible (24–26).

A Ugandan study to estimate the prevalence of subclinical atherosclerosis among HIV infected adults using a CIMT of ≥ 0.78 mm as cut off found an 18% prevalence (27). However, other studies among PLHIV in high income countries using higher CIMT cut-off values of 0.80 mm and 0.90 mm found prevalence of 65% and 41.7% respectively (28, 29). A Nigerian study by Yunusa et al. (30), comparing CIMT in normotensives and hypertensives found a mean CIMT of 0.61 ± 0.10 mm in normotensive individuals. In our environment, there is limited literature regarding the prevalence of subclinical atherosclerosis in HIV positive persons and the interplay of traditional risk factors of CVD and HIV infection and treatment, thus necessitating this study. This study estimated the prevalence of subclinical atherosclerosis amongst PLHIV enrolled at University of Abuja Teaching Hospital, Gwagwalada and describes the associated risk factors amongst this population.

Materials and methods

Study design

We conducted a cross-sectional study amongst HIV infected adults 18 years and above at the University of Abuja Teaching Hospital, Gwagwalada (UATH). Our study population comprised both ART experienced patients with at least six months of ART as well as ART naïve patients who were newly enrolled into care.

Study setting and context

UATH is a 350-bedded tertiary facility located in Gwagwalada in the Federal Capital Territory in Nigeria. UATH runs clinic for persons infected with HIV with about 4,864 patients currently receiving life-long ART as of December 2018 (3,832 on first-line regimen and 1,032 on second-line regimen), and an average monthly ART enrollment rate of about 30 patients per month.

HIV testing services at UATH are routinely provided at multiple service delivery points including the general outpatient department, inpatient wards, the main laboratory, antenatal clinic, labour ward, TB clinic, family planning clinic, and sexually transmitted infection clinic using serial algorithm based on the Nigerian guidelines (31). Patients testing positive are retested by another tester using the same algorithm before referral to the ART clinic for enrollment into care (32). Nigeria's HIV treatment guidelines currently adopts the WHO "test and treat" strategy, hence all HIV positive persons are considered eligible for ART irrespective of CD4 counts or WHO staging. Following enrollment, patients are commenced on adherence counselling and are expected to initiate treatment immediately or as soon as possible, preferably within two weeks of testing HIV positive. ART clinics are run by physicians daily at the UATH and patients on treatment are provided with one-month prescription for the first time, subsequently 3-monthly at each visit. Laboratory monitoring with viral load estimation is carried out after six months on ART and annually subsequently. Preferred first-line regimen for adults based on national ART guidelines are tenofovir + lamivudine + dolutegravir (TDF + 3TC + DTG). Alternate first-line options include tenofovir + lamivudine (or emtricitabine) + efavirenz (or nevirapine) (TDF + 3TC (or FTC) + EFV (or NVP)), or zidovudine + lamivudine + efavirenz (or nevirapine) [AZT + 3TC + EFV (or NVP)], or abacavir + lamivudine + dolutegravir (ABC + 3TC + DTG) all as fixed dose combinations (33), while the preferred second-line ART regimen are zidovudine or tenofovir + lamivudine + lopinavir or atazanavir (AZT or TDF + 3TC + LPV/r or ATV/r) (32).

Sampling and sample size estimation

Using Kish and Leslie's formula for prevalence studies, and assuming a prevalence of 18% (27) for subclinical atherosclerosis, and a precision of 5% between the assumed (referenced) prevalence and our study estimates, at a 5% level of significance with a 10% correction for non-response, we estimated a minimum sample size of 252 for this study. Our sample distribution was 50% for ART naïve patients and 50% for ART experienced patients. ART experienced patients were recruited into the study using a proportional allocation of samples of 4 first-line to 1 second line based on the numbers currently on ART in the facility. Based on the sampling plan, participants sample distribution was expected to be 126 ART naïve HIV positive persons, 101 HIV positive persons on first-line regimen and 25 persons on second-line regimen. However, the number of patients on second-line ART were doubled to achieve a minimum sample size of 50 for regression analysis based on statistical rule of thumb (34) to have a more robust sample for analysis, making a total sample size of 277.

Eligible patients enrolled into HIV care and treatment who consented to take part in the study were consecutively enrolled into the study until the required sample size was achieved for each group. Persons with history of cardiovascular risk including hypertension, diabetes, peripheral vascular disorder, myocardial infarction, heart failure, or stroke, who are likely to have clinical evidence of atherosclerosis were excluded from the study. Other exclusion criteria include persons with life-threatening opportunistic infection requiring critical care, or cognitive impairment precluding the patient from providing appropriate responses to interview questions or providing consent.

Data collection and outcome measures

A structured data collection tool divided into four sections was used for data collection. These sections are: (1) screening questions to rule out study exclusion criteria, (2) sociodemographic and HIV related clinical characteristics of participants, (3) physical examination findings, and (4) laboratory and radiology results. The data collection tool was pretested and validated with 10 patients at UATH preceding the study. Pretest data were excluded from the analysis.

The primary outcome measure for this study was the presence of subclinical atherosclerosis amongst PLHIV enrolled in this study. Subclinical atherosclerosis was defined as carotid intima media thickness ≥0.71 mm as measured by Doppler ultrasonography (30). Informed consent was obtained from eligible participants identified and study identification number assigned. Survey questions were administered, and physical examinations were carried out, following which referrals were made for radiological and laboratory investigations. ART naïve patients were recruited into the study at the ART clinic at the time of enrollment into care just before they commenced ART, while ART experienced patients were recruited when they visited the facility for their routine clinical check-up and drug refills.

Physical examination

Physical examination was carried out to check for signs and symptoms of opportunistic infections with classification of participant into applicable WHO clinical stages as elucidated in the WHO clinical staging criteria (35, 36). Blood pressure measurement was carried out in accordance with European Society of Cardiology (ESC) guideline recommendations (37) using a mercury sphygmomanometer (Accoson, England). The mean of the last two of three consecutive blood pressure measurements at 2-minutes intervals was used for the analysis. Participants' were weighed using a Seca digital weighing scale to the nearest 0.5 kilograms (38). Height was measured to the nearest 0.5 meters. The waist/hip ratio was estimated for each participant by measuring both the waist and hip circumference in centimeters and taking the ratio. The waist circumference was obtained by placing the measuring tape midway between the uppermost border of the iliac crest and the lower margin of the costal margin (39). The hip circumference was obtained by placing the tape parallel to the floor and around the widest portion of the buttocks.

Laboratory/radiological procedures

Carotid Doppler ultrasonography was performed using a high resolution 10 MHz linear array transducer of LOGIC F series GE ultrasound machine (© 2016, General Electric Company, UK) by a trained cardiologist. Participants were requested to remove jewelry around the neck. Ultrasound of the carotid intima media was performed with the subject lying supine on the couch to the right of the examiner with pillow support under the neck to achieve the desired neck extension and head turned 45° away from the side being scanned. Adequate amount of coupling gel was applied to the scan area to eliminate air gap between probe and skin surface. Right and left CCA were located by longitudinal and transverse scans. Three measurements of the CIMT were obtained at the far wall on each side, each at 1 cm proximal to the right and left carotid bulb. The mean of three point measurements each of CIMT thickness for both right and left CCA were calculated and used for the analysis.

Laboratory request forms carrying the participant's study identification number were given to the patient and requested to return the following day for laboratory tests after an overnight fast of 8 to 12 h. On return, about 10 mls of venous blood sample was obtained under aseptic conditions. One drop of blood was used to test for fasting blood sugar using an Accucheck glucometer, while the rest of the sample was divided in aliquots of about 5 mls into vacutainer tube containing ethylene diamine tetra-acetic acid (EDTA) anticoagulant by Becton Dickinson, and plain bottle, for viral load testing and lipid profile, respectively. The blood was centrifuged for 10 min at 3,000 rpm within 2–4 h of collection, and the separated plasma and serum respectively were stored at −20°C. Lipid profile analysis was done using Landwind C100 Plus Chemistry Autoanalyzer for the total cholesterol (TC), High density lipoprotein-cholesterol (HDL-C), and triglycerides (TG). Low density lipoprotein-cholesterol (LDL-C) was calculated from TC, HDL-C and TG using Friedewald formulae (LDL-C = TC-TG/ 5 + HDL-C) (40, 41).On the day of analysis, the plasma aliquots were thawed, vortexed and analyzed for viral load using Roche COBAS® AmpliPrep/COBAS® TaqMan viral assay (42).

Data analysis

Explanatory variables included age, sex, history and duration of smoking habits, history of use of alcohol, systolic blood pressure, diastolic blood pressure, fasting blood sugar, serum lipid profiles (LDL, HDL, TG, TC), body mass index, waist circumference, history of ARV use, duration on ART, ART regimen-line and class of ARV used. All completed data collection tools as well as all laboratory and radiological results were retrieved and duly entered into Statistical Package for Social Sciences (SPSS) software version 21.0 for storage and analysis (Armonk, NY: IBM Corp).

History of smoking was classified as current smokers: those who have smoked cumulatively in their lifetime 100 cigarettes or more up to a period less than one year preceding the study, previous smokers:

those who have smoked cumulatively in their lifetime 100 cigarettes or more but stopped smoking more than one year preceding the study, while non-smokers are those who had smoked cumulatively less than 100 cigarettes in their lifetime or never smoked (43). Systolic blood pressure was classified as normal if <140 mmHg and elevated if ≥ 140 mmHg, diastolic blood pressure was classified as normal if <90 mmHg and elevated if ≥ 90 mmHg (44). ARV regimen was classified based on regimen-line into first- or second-line regimen. Regimen was further classified based on its Nucleoside Reverse Transcriptase Inhibitor (NRTI) backbone or the presence of a Non-Nucleoside Reverse Transcriptase Inhibitor (NNRTI), a PI or an integrase inhibitor in the regimen. Duration on ART was categorized as <2 years, 2–4 years and ≥5 years time intervals. Body mass index was classified as <18.5 Kg/m^2 (underweight), 18.5–24.99 Kg/m^2 (normal), 25–29.99 Kg/m^2 (overweight) or >30 Kg/m^2 (obese) (45). Normal waist/hip ratio was classified as <=0.9 in males, <=0.85 in females. Baseline CD4 count was categorized into <200 mm^3, 200–349 mm^3, 350–499 mm^3 and ≥ 500 mm^3. Fasting blood sugar was categorized as <7.0 mmol/L or ≥ 7.0 mmol/L (46). Fasting lipid profile was classified as Total cholesterol <200 mg/dl or ≥200 mg/dl; LDL < 130 mg/dl or ≥130 mg/dl; HDL < 50 mg/dl or ≥50 mg/dl in females and <40 mg/dl or ≥40 mg/dl in males (47). Viral load was classified as <50 copies/ml (undetectable viral load), 50–199 copies/ml (virally suppressed), 200–999 copies/ml (low level viremia) and ≥1,000 copies/ml (virally unsuppressed). Carotid intima media thickness was categorized as <0.71 mm (non-atherosclerotic) and ≥0.71 mm (subclinical atherosclerotic).

Bivariate analysis using Chi-square test was used to determine factors associated with subclinical atherosclerosis. Factors with a *p*-value of <=0.2 in the bivariate analysis were included in the multivariate model to have a robust mix of predictors to consider. Two multivariable logistic regression models were fitted to explain on the one hand all possible risk factors for atherosclerosis (Model A), while a second model sought to explain the role of HIV infection and ART on atherosclerosis ((Model B). All statistically significant variables from the bivariate analysis were fitted into the multivariable logistic regression model in a stepwise manner to identify all possible risk factors for atherosclerosis (Model A). A second multivariable logistic regression model excluded all the modifiable traditional risk factors of atherosclerosis such as smoking, diabetes mellitus, dyslipidemias, hypertension, and obesity (Model B). A *p*-value <=0.05 was considered statistically significant for all multivariable analysis.

TABLE 1 Socio-demographic characteristics, habits and associations with subclinical atherosclerosis.

Variables		Subclinical atherosclerosis		*p*-value
	n (%) or mean SD	Yes (%)	No (%)	
Sex				
Female	178 (64.26)	63 (35.39)	115 (64.61)	<0.001
Age	39.44 (10.71)			
Age group (years)				
20–29	99 (35.74)	3 (5.17)	55 (94.83)	<0.001
30–39	178 (64.26)	27 (32.14)	57 (67.86)	
≥40	39.44 (10.71)	90 (66.67)	45 (33.33)	
Educational status				
None	22 (7.94)	8 (36.36)	14 (63.64)	0.072
Primary	44 (15.88)	24 (54.55)	20 (45.45)	
Secondary	118 (42.60)	42 (35.59)	76 (64.41)	
Tertiary	93 (33.57)	46 (49.46)	47 (50.54)	
Marital status				
Single	66 (23.83)	14 (21.21)	52 (78.79)	<0.001
Married	175 (63.18)	85 (48.57)	90 (51.43)	
Previously married	36 (13.00)	21 (58.33)	15 (41.67)	
Employment status				
Employed	233 (84.12)	105 (45.06)	128 (54.94)	0.178
Unemployed	44 (15.88)	15 (34.09)	29 (65.91)	
Alcohol consumption				
Yes	40 (14.44)	11 (27.50)	29 (72.50)	0.029
Smoking status				
Current smokers	12 (4.33)	6 (50.00)	6 (50.00)	0.132
Previous smokers	13 (4.69)	9 (69.23)	4 (30.77)	
Non-smokers	252 (90.97)	105 (41.67)	147 (58.33)	
Overall	**277 (100)**	**120 (43.32)**	**157 (56.68)**	

SD, standard deviation.

Ethical considerations

The study protocol was submitted to the human research and ethics committee of UATH for ethical review and approval.

Results

Sociodemographic characteristics and associations with subclinical atherosclerosis

Table 1 summarizes the socio-demographic characteristics and habits of study participants. Female participants constituted 178 (64.30%) of the 277 participants enrolled into the study. The mean age of the participants was 39.40 ± 10.70 years with 135 (48.70%) being older than 40 years, and more than half (63.20%) being married. Alcohol use was reported among 40 (14.44%) while majority (90.97%) were non- smokers.

A total of 120 (43.30%) study participants 95% CI: (37.45–49.19) had subclinical atherosclerosis. Subclinical atherosclerosis was more prevalent in males than females (57.60% vs. 35.40%; $p < 0.001$). Prevalence of subclinical atherosclerosis increased with age, $p < 0.001$. Prevalence of subclinical atherosclerosis was higher among participants who reported no alcohol use than those who reported alcohol use (46.0% vs. 27.50%; $p = 0.03$).

Clinical characteristics and associations with subclinical atherosclerosis

Table 2 shows clinical characteristics of study participants at enrollment. 45.10% of the study participants were over-weight or obese. About 11.19% had systolic blood pressure >140 mm Hg and diastolic blood pressure >90 mm Hg (15.16%). 32.85%, 41.52% and 30% had total cholesterol, low density lipoprotein and triglycerides of >200 mg/dl, >130 mg/dl and >150 mg/dl respectively at enrollment.

TABLE 2 Clinical parameters and associations with subclinical atherosclerosis.

Variables		Subclinical atherosclerosis		*p*-value
	n (%)	Yes (%)	No (%)	
BMI (kg/m^2)				
Under-weight	14 (5.05)	4 (28.57)	10 (71.43)	0.325
Normal	138 (49.82)	55 (39.86)	83 (60.14)	
Over-weight	75 (27.08)	37 (49.33)	38 (50.67)	
Obese	50 (18.05)	24 (48.00)	26 (52.00)	
Systolic BP (mmHg)				
<140	246 (88.81)	98 (39.84)	148 (60.16)	0.001
≥140	31 (11.19)	22 (70.97)	9 (29.03)	
Diastolic BP (mmHg)				
<90	235 (84.84)	97 (41.28)	138 (58.72)	0.104
≥90	42 (15.16)	23 (54.76)	19 (45.24)	
Fasting blood sugar (mg/dl)				
<7	271 (97.83)	116 (42.80)	155 (57.20)	0.408
≥7	6 (2.17)	4 (66.67)	2 (33.33)	
Total cholesterol (mg/dl)				
<200	186 (67.15)	56 (30.11)	130 (69.89)	<0.001
≥200	91 (32.85)	64 (70.33)	27 (29.67)	
Low density lipoprotein (mg/dl)				
<130	162 (58.48)	56 (34.57)	106 (65.43)	<0.001
≥130	115 (41.52)	64 (55.65)	51 (44.35)	
High density lipoprotein				
Normal	12 (4.33)	6 (50.00)	6 (50.00)	0.768
Abnormal	265 (95.67)	114 (43.02)	151 (56.98)	
Waist/hip circumference ratio				
Normal	216 (77.98)	92 (42.59)	124 (57.41)	0.645
Abnormal	61 (22.02)	28 (45.90)	33 (54.10)	
Triglycerides (mg/dl)				
<150	193 (69.68)	71 (36.79)	122 (63.21)	0.001
≥150	84 (30.32)	49 (58.33)	35 (41.67)	

Prevalence of subclinical atherosclerosis was higher among study participants with systolic blood pressure ≥140 mm Hg than those with systolic blood pressure <140 mm Hg (70.97% vs. 39.84%; $p < 0.001$). Subclinical atherosclerosis was more prevalent in study participants with total cholesterol ≥200 mg/dl than those with total cholesterol <200 mg/dl (70.30% vs. 30.10%; $p < 0.001$). Prevalence of subclinical atherosclerosis was higher among study participants with low density lipoprotein >*130* mg/dl than those with low density lipoprotein <130 mg/dl (55.70% vs. 34.60%; $p < 0.001$). Subclinical atherosclerosis was more prevalent in study participants with triglycerides ≥150 mg/dl than those with triglycerides <150 mg/dl (58.33% vs. 36.79%; $p = 0.001$). Body mass index, diastolic blood pressure, fasting blood sugar, high density lipoprotein, and waist-hip circumference ratio were not associated with subclinical atherosclerosis.

HIV-related variables and associations with subclinical atherosclerosis

Table 3 highlights HIV-related characteristics of study participants. Of the 277 study participants, 101(66.90%) were on first-line regimen, 254 (91.70%) were in WHO stage I at study enrollment. More than half (54.51%) were ART experienced. Of the 151 ART experienced, 108 (71.50%) have been on ART for ≥5 years and 114 (75.50%) had viral load <50 copies/ml at study enrollment.

ART status was associated with subclinical atherosclerosis with 26 (20.60%) of ART naive and 94 (62.30%) of ART experienced patients having subclinical atherosclerosis ($p < 0.001$). Of the 151 ART experienced patients studied, the prevalence of subclinical atherosclerosis increased with increase in the duration of usage ART with a prevalence of 22.20% in those with <2 years usage, 41.20% in those with 2–4 years usage, and 72.20% with ≥5 years usage: $p < 0.001$). 60% of the patients on PI, 47.06% on NNRTI, 38.57% on Integrase inhibitor had subclinical atherosclerosis ($p = 0.017$). There were no significant associations between subclinical atherosclerosis and baseline CD4, WHO staging at ART initiation, WHO staging at study enrollment, current ART regimen-line, and NRTI backbone or viral load.

Risk factors for subclinical atherosclerosis

Table 4 shows crude and adjusted odds ratio of risk factors for subclinical atherosclerosis adjusted for all risk factors (Model A). Male participants had four-fold odds of subclinical atherosclerosis compared to females [AOR = 4.33, 95% CI (1.74–10.76)]. The odds of having subclinical atherosclerosis increased as age increased, with those 30–39 years having AOR = 5.95; 95% CI (1.31- 26.96), and those ≥ 40 years with AOR = 19.51; 95% CI (4.30–88.56), reference: 20–29 years]. Participants with total cholesterol ≥200 mg/dl had almost four-fold odds of subclinical atherosclerosis compared to those with total cholesterol <200 mg/dl [AOR = 3.88; 95% CI (1.47–10.25)]. Odds of having subclinical atherosclerosis was also higher among participants on ART for ≥5 years than ART naïve participants [AOR = 9.05; 95% CI (3.16–25.92)]. No

TABLE 3 HIV-related variables and associations with subclinical atherosclerosis.

Variables		Subclinical atherosclerosis		*p*-value
	n (%) or median (IQR)	Yes (%)	No (%)	
ART status				
ART Naïve	126 (45.49)	26 (20.63)	100 (79.37)	<0.001
ART Experienced	151 (54.51)	94 (62.25)	57 (37.75)	
Median time on ART (IQR) (years)[a]	2.31 (0–10.13)			
Time on ART (years)[a]				
<2 years	9 (5.96)	2 (22.22)	7 (77.78)	<0.001
2–4 years	34 (22.52)	14 (41.18)	20 (58.82)	
≥5 years	108 (71.52) 238 (110- 395)	78 (72.22)	30 (27.78)	
Baseline CD4 (cells/mL)				
<200	107 (38.63)	45 (42.06)	62 (57.94)	0.262
200–349	84 (30.32)	33 (39.29)	51 (60.71)	
350–499	42 (15.16)	24 (57.14)	18 (42.86)	
≥500	44 (15.88)	18 (40.91)	26 (59.09)	
WHO staging at ART initiation				
I	229 (82.67)	96 (41.92)	133 (58.08)	0.116
II	45 (16.25)	24 (53.33)	21 (46.67)	
III/IV	3 (1.08)	0 (0.00)	3 (100.00)	
WHO staging at study enrollment				
I	254 (91.70)	111 (43.70)	143 (56.30)	0.312
II	20 (7.22)	9 (45.00)	11 (55.0)	
III/IV	3 (1.08)	0 (0.00)	3 (100.00)	
Current regimen line				
First- line regimen	101 (66.89)	64 (63.37)	37 (36.63)	0.688
Second-line regimen	50 (33.11)	30 (60.00)	20 (40.00)	
NRTI backbone				
ABC	9 (3.25)	5 (55.56)	4 (44.44)	0.191
TDF	254 (91.70)	106 (41.73)	148 (58.27)	
AZT	14 (5.05)	9 (64.29)	5 (35.71)	
Other drug classes				
NNRTI	17 (6.14)	8 (47.06)	9 (52.94)	0.017
PI	50 (18.05)	30 (60.00)	20 (40.00)	
Integrase inhibitors	210 (75.81)	81 (38.57)	129 (61.43)	
Viral load (copies/ml)[a]				
<50	114 (75.5)	75 (65.79)	39 (34.21)	0.131
50–199	16 (10.60)	7 (43.75)	9 (56.25)	
200–999	6 (3.97)	5 (83.33)	1 (16.67)	
≥1000	15 (9.93)	7 (46.67)	8 (53.33)	

IQR, Interquartile range.
[a]For ART experienced only.

TABLE 4 Crude and adjusted associations of subclinical atherosclerosis and socio-demographics, clinical parameters, and HIV-related characteristics (model A).

Variables	UOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
Sex				
Female	1.00		1.00	
Male	2.48 (1.50–4.10)	<0.001	4.33 (1.74–10.76)	0.002
Age group (years)				
20–29	1.00		1.00	
30–39	8.68 (2.49–30.28)	0.001	5.95 (1.31– 26.96)	0.021
≥40	36.67 (10.87–123.69)	<0.001	19.51 (4.30–88.56)	<0.001
Educational status				
None	1.00		1.00	
Primary	2.10 (0.73–6.01)	0.167	1.92 (0.39–9.41)	0.423
Secondary	0.97 (0.38–2.49)	0.945	1.39 (0.35–5.58)	0.644
Tertiary	1.71 (0.66–4.47)	0.271	2.43 (0.57–10.41)	0.231
Marital status				
Single	1.00		1.00	
Married	3.51 (1.81–6.79)	<0.001	1.24 (0.48–3.18)	0.661
Previously married	5.20 (2.14–12.63)	<0.001	2.30 (0.68–7.81)	0.180
Employment status				
Employed	1.00		1.00	
Unemployed	0.63 (0.32–1.24)	0.180	2.99 (0.94–9.55)	0.064
Smoking status				
Current smokers	1.00		1.00	
Previous smokers	2.25 (0.45–11.52)	0.330	1.55 (0.15–16.62)	0.716
Non-smokers	0.71 (0.22–2.28)	0.569	0.60 (0.11–3.22)	0.555
BMI				
Under-weight	1.00		1.00	
Normal	1.66 (0.49–5.55)	0.413	0.51 (0.10–2.67)	0.429
Over-weight	2.43(0.70–8.45)	0.161	0.70 (0.12–3.99)	0.688
Obese	2.31(0.64–8.35)	0.202	0.54 (0.09–3.30)	0.507
Systolic BP (mm Hg)				
<140	1.00		1.00	
≥140	3.69 (1.63–8.35)	0.002	1.23 (0.30–5.01)	0.770
Diastolic BP (mm Hg)				
<90	1.00		1.00	
≥90	1.72 (0.89–3.33)	0.107	2.20 (0.63–7.66)	0.214
Total cholesterol (mg/dl)				
<200	1.00		1.000	
≥200	5.50 (3.18–9.52)	<0.001	3.88 (1.47–10.25)	<0.001

(*continued*)

TABLE 4 Continued

Variables	UOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
Fasting blood sugar (mg/dl)				
<7	1.00		1.00	
≥7	2.67 (0.48–14.84)	0.261	2.39 (0.31–18.22)	0.402
Low density lipoprotein (mg/dl)				
<130	1.00		1.00	
≥ 130	2.34 (1.46–3.88)	0.001	0.82 (0.34–1.99)	0.657
High density lipoprotein				
Normal	1.00		1.00	
Abnormal	0.75 (0.24–2.40)	0.63	0.39 (0.07–2.29)	0.295
WHO clinical stage at study enrollment				
I	1.00		1.00	
II & above	0.83 (0.35–1.98)	0.67	4.19 (1.11–15.92)	0.035
Time on ART (years)				
Naïve	1.00		1.00	
<=1	1.10 (0.22–5.61)	0.91	1.05 (0.13–8.29)	0.966
2–4	2.69 (1.20–6.04)	0.016	2.69 (0.77–9.39)	0.121
≥5	10.00(5.47–18.27)	<0.001	9.05 (3.16–25.92)	<0.001
NRTI-regimen based				
ABC	1.00		1.00	
TDF	0.57 (0.15–2.18)	0.415	0.58 (0.08–4.25)	0.592
AZT	1.44 (0.26–7.96)	0.676	2.01 (0.18–23.11)	0.575
Other regimen-base				
NNRTI	1.00		1.00	
PI	1.74 (0.58–5.27)	0.324	1.06(0.19–5.78)	0.947
Integrase	0.71 (0.26–1.92)	0.502	1.17 (0.27–5.04)	0.836
Triglycerides (mg/dl)				
<150	1.00		1.00	
≥150	1.01 (1.00–1.02)	0.017	1.00 (0.99–1.01)	0.682
Baseline CD4 count				
<200	1.00		1.00	
200–349	0.89 (0.50–1.60)	0.70	1.12(0.47–2.70)	0.793
350–499	1.84(0.89–3.78)	0.099	1.69 (0.60–4.82)	0.324
≥500	0.95(0.49–1.07)	0.897	1.54 (0.49–4.78)	0.458

UOR, unadjusted odds ratio; AOR, adjusted odds ratio.

significant differences were found with marital status, systolic blood pressure, low density lipoprotein, triglycerides, and type of regimen.

In model B (Table 5) in which modifiable traditional risk factors of subclinical atherosclerosis were excluded, sex, age, WHO clinical stage at study enrollment, and time on ART were found to be risk factors significantly associated with subclinical atherosclerosis. The

TABLE 5 Crude and adjusted associations of subclinical atherosclerosis and socio-demographics, and HIV-related characteristics (model B).

Variables	UOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
Sex				
Female	1.00		1.00	
Male	2.48 (1.50–4.10)	<0.001	3.91 (1.82–8.39)	<0.001
Age group (years)				
20–29	1.00		1.00	
30–39	8.68 (2.49–30.28)	0.001	6.95 (1.69–28.59)	0.007
≥40	36.67 (10.87–123.69)	<0.001	20.97 (5.01–87.69)	<0.001
Educational status				
None	1.00		1.00	
Primary	2.10 (0.73–6.01)	0.167	1.43 (0.35–5.91)	0.621
Secondary	0.97 (0.38–2.49)	0.945	1.02 (0.30–3.53)	0.971
Tertiary	1.71 (0.66–4.47)	0.271	2.19 (0.60–8.06)	0.238
Marital status				
Single	1.00		1.00	
Married	3.51 (1.81–6.79)	<0.001	1.23 (0.51–2.92)	0.646
Previously married	5.20 (2.14–12.63)	<0.001	2.67 (0.84–8.48)	0.095
Employment status				
Employed	1.00		1.00	
Unemployed	0.63 (0.32–1.24)	0.180	2.22 (0.76–6.51)	0.145
WHO clinical stage at study enrollment				
I	1.00		1.00	
II & above	0.83 (0.35–1.98)	0.67	3.93 (1.19–13.04)	0.025
Time on ART (years)				
Naïve	1.00		1.00	
<=1	1.10 (0.22–5.61)	0.91	1.10 (0.17–7.20)	0.923
2–4	2.69 (1.20–6.04)	0.016	3.24 (1.07–9.80)	0.037
≥5	10.00(5.47–18.27)	<0.001	11.43 (4.62–28.29)	<0.001
NRTI-regimen based				
ABC	1.00		1.00	
TDF	0.57 (0.15–2.18)	0.415	0.48 (0.09–2.70)	0.408
AZT	1.44 (0.26–7.96)	0.676	1.87 (0.21–16.33)	0.571
Other groups				
NNRTI	1.00		1.00	
PI	1.74 (0.58–5.27)	0.324	0.92 (0.21–4.15)	0.916
Integrase	0.71 (0.26–1.92)	0.502	1.23 (0.33–4.65)	0.756
Baseline CD4 count				
<200	1.00		1.00	
200–349	0.89 (0.50–1.60)	0.699	1.17(0.53–2.60)	0.696
350–499	1.84(0.89–3.78)	0.099	1.98 (0.71–5.56)	0.194
≥500	0.95(0.49–1.07)	0.897	1.78 (0.64–4.96)	0.271

UOR, unadjusted odds ratio; AOR, adjusted odds ratio.

odds of having subclinical atherosclerosis increased as age increased, with those 30–39 years having AOR = 6.95; 95% CI (1.69- 28.59), and those ≥40 years with AOR = 20.97; 95% CI (5.01–87.69)]. Male participants had almost four-fold increase in the odds of having subclinical atherosclerosis compared to females [AOR = 3.91, 95% CI (1.82–8.39)]. The odds of having subclinical atherosclerosis increased as duration on ART increased with a duration of 2–4 years associated with AOR = 3.24; 95% CI (1.07–9.80), ≥ 5 years duration associated with AOR = 11.43; 95% CI (4.62–28.29), reference: ART naive]. Type of regimen, baseline CD4 count were not associated with subclinical atherosclerosis (**Table 5**).

Discussion

Prevalence of subclinical atherosclerosis

We found an overall prevalence of subclinical atherosclerosis of 43.32% in our study higher than the prevalence of 18% found in the Uganda study. A plausible explanation for the differences in prevalence of subclinical atherosclerosis would be the lower CIMT threshold of ≥0.71 mm used to determine subclinical atherosclerosis in our study compared to ≥0.78 mm in the Uganda study. However, like the Uganda study we found a higher prevalence of subclinical atherosclerosis in men. A systematic review by Abeysuriya et al. identified variations in mean CIMT among healthy persons by sex, age groups and regions, with higher mean CIMT values among males across all regions. Overall mean CIMT was highest in the WHO AFRO (African) region (0.72 mm) and increased with age, with mean CIMT of 0.59 mm, 0.63 mm, 0.76 mm and 0.83 mm in age groups 40–49 years, 50–59 years, 60–69 years and >70 years respectively (48). Our threshold CIMT value is comparable to the mean CIMT reported for the African region and when we consider age differences in mean CIMT, our reference value is higher than thresholds reported for ages 40–59 years. With a mean age of 39.40 ± 10.70 years among our study participants, thus making 68% (mean ± 1SD) of our study participants below 59 years, it presupposes that adopting age specific CIMT threshold would increase our observed prevalence above 68%.

In the bivariate analysis, subclinical atherosclerosis was associated with exposure to ART with a higher prevalence compared to ART naïve patients. This finding is comparable to findings by Sarfo et al. (49), in Ghana, that found a prevalence of 67.60% in patients on ARVs. We found subclinical atherosclerosis to be associated with duration on ART, with participants who had been on ARVs for more than 5 years having a higher prevalence of subclinical atherosclerosis. Maggi et al. (50), in a European Cohort study found 32.20% of HAART- treated patients to have CIMT >1.00 mm. The mechanism of atherosclerosis in HIV positive patients has been linked to immune activation. Evidence suggests that immune activation still persists with the use of ARVs and contributes to accelerated atherosclerosis (51).

In model A, after adjusting for confounders the only significant risk factors identified from our study for subclinical atherosclerosis included male sex, age of 40 years and above, advancing HIV infection (WHO stage II & above at study enrollment) and duration on ART of five years or more. Male participants had four-fold increase in the risk of having subclinical atherosclerosis compared to females similar to the findings of Albuquerque et al. (52) who reported a three-fold increased risk of subclinical atherosclerosis in HIV patients. Studies have shown that men have twice the risk of having coronary heart disease due to atherosclerosis than women. This sex difference has been attributed to a protective effect of female sex hormones, and a deleterious effect of male sex hormones, upon the cardiovascular system. Although the evidence on the harmful effects of testosterone on the heart is limited (53). We found an increased risk of subclinical atherosclerosis with age, similar to the findings of Ssinabuya et al. (27). Increased age has been identified as an independent risk factor for atherosclerosis even when all other factors are controlled (53). Study participants with total cholesterol of 200 mg/dl and above had almost four-fold increase in the odds of presenting subclinical atherosclerosis compared to those with total cholesterol less 200 mg/dl. We also found the odds of having subclinical atherosclerosis to be higher among study participants who were enrolled into care at WHO clinical stage II and above compared to WHO stage I similar to the findings of Desormais et al., who found higher risk of lower extremity arterial disease (LEAD) amongst patients in WHO stage IV compared to stage I using ankle brachial index measurements as an index of subclinical atherosclerosis (54). Similar findings were also reported by Kamdem et al., amongst patients in WHO stages II and IV (55). We found a higher risk of subclinical atherosclerosis among those who have been on ART for five years or above compared to ART naïve participants. Similar findings were reported by Roozen et al. who found the risk of subclinical atherosclerosis to increase with duration on ART (56). Post et al., in their study among male HIV patients amongst men who have sex with men (MSM) found a slightly higher risk of coronary artery stenosis with increasing duration on ART (57). In model B after excluding the modifiable traditional risk factors of subclinical atherosclerosis (including smoking, body mass index, systolic blood pressure, diastolic blood pressure, fasting blood sugar, total cholesterol LDL cholesterol, HDL cholesterol, and triglycerides) male sex, advancing age, advancing HIV infection (WHO stage II & above at study enrollment) and duration on ART ≥5 years were associated risk factors.. These findings suggest that even in the absence of traditional risk factors, advancing HIV infection as well as duration on ART are significant risk factors for development of subclinical atherosclerosis. Gupta et al. (58), had suggested that HIV infection itself together with ART are stronger predictors of atherosclerotic disease than the traditional cardiac risk markers like age, body mass index, diastolic blood pressure, low HDL and history of smoking. Contrary to findings in some older studies (18, 58–61), we found no significant risk differences for subclinical atherosclerosis with systolic blood pressure and diastolic blood pressure, low density lipoprotein, triglycerides and type of regimen. This further supports the notion that HIV infection and ART are stronger predictors of atherosclerotic disease than the traditional risk factors. A large South African study comparing HIV negative patients with HIV positives demonstrated that even with lower levels of traditional risk factors for atherosclerosis among HIV positive patients, there was increased risk of cardiovascular disease among aging population of PLHIV 30 years and above. This study further demonstrated increased risk of CVD with increased duration on ART in the face of limited risk with increased duration of HIV infection, thus suggesting that this risk is largely due to ART (62).

Our study provides better understanding of the prevalence and predictors of subclinical atherosclerosis in HIV positive patients in our environment to inform prevention and management of CVD in PLHIV. However, our study has a few limitations. We employed a cross-sectional study design. A longitudinal or cohort design would have been more appropriate to firmly establish the temporal effect of HIV or ART on the aetiopathogenesis of subclinical atherosclerosis. Another limitation of our study was the lack of longitudinal data on regimen changes (substitutions and switches) as well as duration on specific regimen which would have enabled us to further profile the cardiotoxic effects of specific ARV molecules in the aetiopathogenesis of subclinical atherosclerosis. Furthermore, a lack of data on date of HIV diagnosis for all patients or longitudinal data on viral load assays limits our ability to explore the role of prolonged viraemia in the aetiopathogenesis of CVD. We adopted a cross-sectional design due to funding limitations. The adopted methodology was however sufficient to answer our study questions. Future studies may consider exploring these outstanding questions.

Conclusion

We found a high prevalence of subclinical atherosclerosis amongst ART experienced persons in our study. Associated risk factors for subclinical atherosclerosis include male sex, advancing age, hypercholesterolaemia, advancing HIV disease, and duration on ART. Even in the absence of traditional risk factors for CVD, advancing HIV infection and duration on ART are significant risk factors for subclinical atherosclerosis.

Our study findings strengthen the case for cardiovascular risk screening amongst people living with HIV.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Human Research and Ethics Committee of University of Abuja Teaching Hospital, Gwagwalada. The patients/participants provided their written informed consent to participate in this study.

Author contributions

Study conceptualization: TAA, DBO, VGK and HOK. Data collection tool development: TAA, OA and DBO. Data collection: TAA, VGK and HOK. Project administration: TAA, DBO, VGK and HOK. Data analysis: TB and OA. Writing – original draft: TAA, OA and TB. Writing – review and editing: All authors. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. Currier JS, Taylor A, Boyd F, Dezii CM, Kawabata H, Burtcel B, et al. Coronary heart disease in HIV-infected individuals. *J Acquir Immune Defic Syndr*. (2003) 33(4):506–12. doi: 10.1097/00126334-200308010-00012

2. Thiers BH. Class of antiretroviral drugs and the risk of myocardial infarction. *Yearb Dermatology Dermatologic Surg*. (2008) 2008:172–3. doi: 10.1016/S0093-3619(08)70808-6

3. Klein D, Hurley LB, Quesenberry CP, Sidney S. Do protease inhibitors increase the risk for coronary heart disease in patients with HIV-1 infection? *J Acquir Immune Defic Syndr*. (2002) 30(5):471–7. doi: 10.1097/00126334-200208150-00002

4. Vittecoq D, Escaut L, Chironi G, Teicher E, Monsuez JJ, Andrejak M, et al. Coronary heart disease in HIV-infected patients in the highly active antiretroviral treatment era. *AIDS*. (2003) 17(Suppl. 1):70–6. doi: 10.1097/00002030-200304001-00010

5. UNAIDS. Global Report 2012 with Annexes. MSF Access to Essential Medicines. (2011). p. 1–112. Available from: papers2://publication/uuid/4467B415-2E9B-472A-89EF-B30E692EFE5C

6. Szadkowski L, Tseng A, Walmsley SL, Salit I, Raboud JM. Short communication: effects of age on virologic suppression and CD4 cell response in HIV-positive patients initiating combination antiretroviral therapy. *AIDS Res Hum Retroviruses*. (2012) 28 (12):1579–83. doi: 10.1089/aid.2012.0018

7. Gortmaker SL, Hughes M, Cervia J, Brady M, Johnson GM, Seage GR, et al. Effect of combination therapy including protease inhibitors on mortality among children and adolescents infected with HIV-1. *N Engl J Med*. (2001) 345(21):1522–8. doi: 10.1056/NEJMoa011157

8. Palella FJ Jr, Delaney KM, Moorman AC, Loveless MO, Fuhrer J, Satten GA, et al. Declining morbidity and mortality among patients with advanced human immunodeficiency virus infection. HIV outpatient study investigators. *N Engl J Med*. (1998) 338:853–60. doi: 10.1056/NEJM199803263381301

9. Sterne JAC, Hernán MA, Ledergerber B, Tilling K, Weber R, Sendi P, et al. Long-term effectiveness of potent antiretroviral therapy in preventing AIDS and death: a prospective cohort study. *Lancet*. (2005) 366(9483):378–84. doi: 10.1016/S0140-6736(05)67022-5

10. De' Lorenzo F, Collot-Teixeira S, Boffito M, Feher M, Gazzard B, McGregor JL. Metabolic-inflammatory changes, and accelerated atherosclerosis in HIV patients: rationale for preventative measures. *Curr Med Chem*. (2008) 15:2991–9.doi: 10.2174/092986708786848668

11. Triant VA, Meigs JB, Grinspoon SK. Association of C-reactive protein and HIV infection with acute myocardial infarction. *J Acquir Immune Defic Syndr*. (2009) 51 (3):268–73. doi: 10.1097/QAI.0b013e3181a9992c

12. Ross AC, O'Riordan MA, Storer N, Dogra V, McComsey GA. Heightened inflammation is linked to carotid intima-media thickness and endothelial activation in HIV-infected children. *Atherosclerosis*. (2010) 211(2):492–8. doi: 10.1016/j.atherosclerosis.2010.04.008

13. Ross AC, Rizk N, O'Riordan MA, Dogra V, El-Bejjani D, Storer N, et al. Relationship between inflammatory markers, endothelial activation markers, and carotid intima-Media thickness in HIV-infected patients receiving antiretroviral therapy. *Clin Infect Dis*. (2009) 49(7):1119–27. doi: 10.1086/605578

14. Carr A, Samaras K, Burton S, Law M, Freund J, Chisholm DJ, et al. A syndrome of peripheral lipodystrophy, hyperlipidaemia and insulin resistance in patients receiving HIV protease inhibitors. *Aids*. (1998) 12(7):51–8. doi: 10.1097/00002030-199807000-00003

15. Mulligan K, Grunfeld C, Tai VW, Algren H, Pang M, Chernoff DN, et al. Hyperlipidemia and insulin resistance are induced by protease inhibitors independent of changes in body composition in patients with HIV infection. *J Acquir Immune Defic Syndr*. (2000) 23:35–43. doi: 10.1097/00126334-200001010-00005

16. Passalaris JD, Sepkowitz KA, Glesby MJ. Coronary artery disease and human immunodeficiency virus infection. *Clin Infect Dis*. (2000) 31(3):787–97. doi: 10.1086/313995

17. DAD Study Group. Class of antiretroviral drugs and the risk of Myocardial infarction. *N Engl J Med*. (2007) 356:1723–35. doi: 10.1056/NEJMoa062744

18. Carr A, Samaras K, Thorisdottir A, Kaufmann GR, Chisholm DJ, Cooper DA. Diagnosis, prediction, and natural course of HIV-1 protease-inhibitor-associated lipodystrophy, hyperlipidaemia, and diabetes mellitus: acohort study. *Lancet*. (1999) 353(9170):2093–9. doi: 10.1016/S0140-6736(98)08468-2

19. O'Leary DH, Polak JF, Kronmal RA, Manolio TA, Burke GL, Wolfson SK. Carotid-artery intima and media thickness as a risk factor for myocardial infarction and stroke in older adults. *N Engl J Med*. (1999) 340(1):14–22. doi: 10.1056/NEJM199901073400103

20. Bergheanu SC, Bodde MC, Jukema JW. Pathophysiology and treatment of atherosclerosis: current view and future perspective on lipoprotein modification treatment. *Neth Hear J*. (2017) 25(4):231–42. doi: 10.1007/s12471-017-0959-2

21. Rohani M, Jogestrand T, Ekberg M, van der Linden J, Källner G, Jussila R, et al. Interrelation between the extent of atherosclerosis in the thoracic aorta, carotid intima-media thickness and the extent of coronary artery disease. *Atherosclerosis*. (2005) 179(2):311–6. doi: 10.1016/j.atherosclerosis.2004.10.012

22. Kablak-Ziembicka A, Tracz W, Przewlocki T, Pieniazek P, Sokolowski A, Konieczynska M. Association of increased carotid intima-media thickness with the extent of coronary artery disease. *Heart*. (2004) 90(11):1286–90. doi: 10.1136/hrt.2003.025080

23. Bots ML, Grobbee DE, Hofman A, Witteman JCM. Common carotid intima-media thickness and risk of acute myocardial infarction: the role of lumen diameter. *Stroke*. (2005) 36(4):762–7. doi: 10.1161/01.STR.0000158924.71069.94

24. Roman MJ, Naqvi TZ, Gardin JM, Gerhard-Herman M, Jaff M, Mohler E. Clinical application of noninvasive vascular ultrasound in cardiovascular risk stratification: a report from the American society of echocardiography and the society of vascular medicine and biology. *J Am Soc Echocardiogr*. (2006) 19(8):943–54. doi: 10.1016/j.echo.2006.04.020

25. Dogan S, Duivenvoorden R, Grobbee DE, Kastelein JJP, Shear CL, Evans GW, et al. Completeness of carotid intima media thickness measurements depends on body composition: the RADIANCE 1 and 2 trials. *J Atheroscler Thromb*. (2010) 17 (5):526–35. doi: 10.5551/jat.3269

26. Shikuma CM, Ribaudo HJ, Zheng Y, Gulick RM, Meyer WA, Tashima KT, et al. Change in high-sensitivity C-reactive protein levels following initiation of efavirenz-based antiretroviral regimens in HIV-infected individuals. *AIDS Res Hum Retroviruses*. (2011) 27(5):461–8. doi: 10.1089/aid.2010.0154

27. Ssinabulya I, Kayima J, Longenecker C, Luwedde M, Semitala F, Kambugu A, et al. Subclinical atherosclerosis among HIV-infected adults attending HIV/AIDS care at two large ambulatory HIV clinics in Uganda. *PLoS One*. (2014) 9(2):1–9. doi: 10.1371/journal.pone.0089537

28. Parra S, Coll B, Aragonés G, Marsillach J, Beltrán R, Rull A, et al. Nonconcordance between subclinical atherosclerosis and the calculated Framingham risk score in HIV-infected patients: relationships with serum markers of oxidation and inflammation. *HIV Med*. (2010) 11(4):225–31. doi: 10.1111/j.1468-1293.2009.00766.x

29. De Socio GVL, Martinelli C, Ricci E, Orofino G, Valsecchi L, Vitiello P, et al. Relations between cardiovascular risk estimates and subclinical atherosclerosis in naïve HIV patients: results from the HERMES study. *Int J STD AIDS*. (2010) 21(4):267–72. doi: 10.1258/ijsa.2009.009165

30. Kolade-Yunusa HO, Ibinaiye PO, Abdukadir AY, Yunusa T. Comparative evaluation of ultrasound measurement of carotid artery intima media thickness in hypertensive and normotensive adult patients in Jos, Nigeria. *West African J Ultrasound*. (2014) 5(2):63–8.

31. FMOH. National HIV Testing Services Guidelines 2017. (2017).

32. Federal Ministry of Health N. National AIDS and STI's Control Programme, Federal Ministry of Health: National Guidelines for HIV Prevention Treatment and Care (2016). (2016). 123 p. Available from: http://apps.who.int/medicinedocs/documents/s23252en/s23252en.pdf

33. Ochigbo SO. *Rapid advice – recommendations for 1st line ART in Nigeria*. Ist ed. Abuja, Nigeria: FMOH, HIV & AIDS Division (2020) (May 2019). p. 251–4.

34. Wilson Van Voorhis CR, Morgan BL. Understanding power and rules of thumb for determining sample sizes. *Tutor Quant Methods Psychol*. (2007) 3(2):43–50. doi: 10.20982/tqmp.03.2.p043

35. World Health Organization. WHO case definitions of HIV for surveillance and revised clinical staging and immunological classification of HIV-related disease in adults and children [Internet]. World Health. Geneva PP - Geneva: World Health Organization; 2007. p. 52. Available from: https://apps.who.int/iris/handle/10665/43699.

36. Rastogi S, Agrahari S, Ganga S, Hospital R, Singh UP, Verma A. Clinical stages of HIV. *Biolixir*. (2011) I:29–31. doi: 10.31838/hiv21.02.18

37. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the jnc 7 report. *JAMA J Am Med Assoc*. (2003) 289(19):2560–71. doi: 10.1001/jama.289.19.2560

38. Westat Inc. Anthropometry procedures manual. National Health and nutrition examinatory survey (NHANES). (2007). Available from: https://www.cdc.gov/nchs/data/nhanes/nhanes_07_08/manual_an.pdf.

39. World Health Organisation (WHO). WHO | Waist Circumference and Waist–Hip Ratio. Report of a WHO Expert Consultation. Geneva, 8–11 December 2008. (2008). Available from: http://www.who.int.

40. Knopfholz J, Disserol CCD, Pierin AJ, Schirr FL, Streisky L, Takito LL, et al. Validation of the friedewald formula in patients with metabolic syndrome. *Cholesterol*. (2014) 2014:11–3. doi: 10.1155/2014/261878

41. Krishnaveni P, Gowda VMN. Assessing the validity of friedewald's formula and anandraja's formula for serum LDL-cholesterol calculation. *J Clin Diagnostic Res*. (2015) 9(12):BC01–4. doi: 10.7860/JCDR/2015/16850.6870

42. Taylor N, Grabmeier-Pfistershammer K, Egle A, Greil R, Rieger A, Ledergerber B, et al. Cobas ampliprep/cobas TaqMan HIV-1 v2.0 assay: consequences at the cohort level. *PLoS One*. (2013) 8(8):1–4. doi: 10.1371/journal.pone.0074024

43. Nuorti JP, Butler JC, Farley MM, Harrison LH, McGeer A, Kolczak MS, et al. Cigarette smoking and invasive pneumococcal disease. *N Engl J Med*. (2000) 342 (10):681–9. doi: 10.1056/NEJM200003093421002

44. Roger VL, Go AS, Lloyd-Jones DM, Benjamin EJ, Berry JD, Borden WB, et al. Heart disease and stroke statistics—2012 update: a report from the American heart association. *Circulation*. (2013) 125(1):236–45. doi: 10.1161/CIR.0b013e31823ac046

45. WHO. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. WHO Technical Report Series 894. Geneva. (2000).

46. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes care. Vol. 20. United States; (1997).

47. Expert Panel on Detection Evaluation, of High Blood Cholesterol in Adults T. Executive summary of the third report of the national cholesterol education program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III). *JAMA*. (2001) 285(19):2486–97. doi: 10.1001/jama.285.19.2486

48. Abeysuriya V, Perera BPR, Wickremasinghe AR. Regional and demographic variations of carotid artery intima and media thickness (CIMT): a systematic review and meta-analysis. *PLoS ONE*. (2022) 17(7):e0268716. doi: 10.1371/journal.pone.0268716

49. Sarfo FS, Nichols M, Agyei B, Singh A, Ennin E, Nyantakyi AD, et al. Burden of subclinical carotid atherosclerosis and vascular risk factors among people living with HIV in Ghana. *J Neurol Sci*. (2019) 397:103–11. doi: 10.1016/j.jns.2018.12.026

50. Maggi P, Lillo A, Perilli F, Maserati R, Chirianni A, Epifani G, et al. Colour-Doppler ultrasonography of carotid vessels in patients treated with antiretroviral therapy: a comparative study. *AIDS*. (2004) 18(7):1023–8. doi: 10.1097/00002030-200404300-00010

51. Nou E, Lo J, Hadigan C, Grinspoon SK. Pathophysiology and management of cardiovascular disease in HIV-infected patients eric. *Lancet Diabetes Endocrinol*. (2017) 4(7):598–610. doi: 10.1016/S2213-8587(15)00388-5

52. Albuquerque VMG, Zírpoli JC, de Barros Miranda-Filho D, Albuquerque MdF, Montarroyos UR, de Alencar Ximenes RA, et al. Risk factors for subclinical atherosclerosis in HIV-infected patients under and over 40 years: a case-control study. *BMC Infect Dis*. (2013) 13(1):274. doi: 10.1186/1471-2334-13-274

53. Jones RD, Nettleship JE, Kapoor D, Jones HT, Channer KS. Testosterone and atherosclerosis in aging men: purported association and clinical implications. *Am J Cardiovasc Drugs*. (2005) 5(3):141–54. doi: 10.2165/00129784-200505030-00001

54. Desormais I, Harimenshi D, Niyongabo T, Lacroix P, Aboyans V, Preux PM. HIV Clinical stages and lower extremity arterial disease among HIV infected outpatients in Burundi. *Sci Rep*. (2021) 11(1):1–7. doi: 10.1038/s41598-021-87862-z

55. Kamdem F, Mapoure Y, Hamadou B, Souksouna F, Doualla MS, Jingi AM, et al. Prevalence and risk factors of peripheral artery disease in black Africans with HIV infection: a cross-sectional hospital-based study. *Vasc Health Risk Manag*. (2018) 14:401–8. doi: 10.2147/VHRM.S165960

56. Roozen GVT, Vos AG, Tempelman HA, Venter WDF, Grobbee DE, Scheuermaier K, et al. Cardiovascular disease risk and its determinants in people living with HIV across different settings in South Africa. *HIV Med*. (2020) 21(6):386–96. doi: 10.1111/hiv.12831

57. Post WS, Budoff M, Kingsley L, Palella FJ, Witt MD, Li X, et al. Associations between HIV infection and subclinical coronary atherosclerosis. *Ann Intern Med*. (2014) 160(7):458–67. doi: 10.7326/M13-1754

58. Gupta PK, Gupta M, Lal AK, Taneja A, Taneja RS, Rewari BB. Markers of subclinical atherosclerotic disease in HIV-infected individuals. *J Virus Erad*. (2018) 4(1):21–5. doi: 10.1016/S2055-6640(20)30237-5

59. Shor-Posner G, Basit A, Lu Y, Cabrejos C, Chang J, Fletcher M, et al. Hypocholesterolemia is associated with immune dysfunction in early human immunodeficiency virus-1 infection. *Am J Med*. (1993) 94(5):515–9. doi: 10.1016/0002-9343(93)90087-6

60. Riddler SA, Smit E, Cole SR, Li R, Chmiel JS, Dobs A, et al. Impact of HIV infection and HAART on serum lipids in men. *J Am Med Assoc*. (2003) 289(22):2978–82. doi: 10.1001/jama.289.22.2978

61. Nonterah EA, Boua PR, Klipstein-Grobusch K, Asiki G, Micklesfield LK, Agongo G, et al. Classical cardiovascular risk factors and HIV are associated with carotid intima-media thickness in adults from sub-saharan Africa: findings from H3Africa AWI-gen study. *J Am Heart Assoc*. (2019) 8(14):e011506. doi: 10.1161/JAHA.118.011506

62. Vos AG, Barth RE, Klipstein-Grobusch K, Tempelman HA, Devillé WLJ, Dodd C, et al. Cardiovascular disease burden in rural Africa: does hiv and antiretroviral treatment play a role? *J Am Heart Assoc*. (2020) 9(7):1–10. doi: 10.1161/JAHA.119.013466

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The evolution of HIV self-testing and the introduction of digital interventions to improve HIV self-testing

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HIV self-testing (HIVST) complements traditional HIV testing programmes by removing barriers and increasing access to testing for key populations, and digital interventions have been developed for HIVST to improve the testing and linkage to care experience for users. The first HIVST kit was proposed in 1986, but it took 10 years for the home sample collection (HSC) HIVST to become available and another 16 years for rapid diagnostic test HIVST to be approved by the Federal Drug Administration. Since then, studies have shown high usability and performance of HIVST, which led the World Health Organization formally recommending HIVST in 2016, and currently almost 100 countries have incorporated HIVST into their national testing strategy. Despite the popularity, HIVST present challenges around pre-and post-test counselling, as well as the ability to report results and link users to care, and digital interventions for HIVST have been introduced to address these challenges. The first digital intervention for HIVST was introduced in 2014 and showed that digital interventions could be used to distribute HIVST kits, report results and link users to care. Since then, dozens of studies have been conducted, which have validated and expanded on these early findings, but many were pilot studies with small sample sizes and lacked the standardization of indicators required to aggregate data across platforms to prove impact at scale. For digital interventions for HIVST to be championed for scale-up, they must continue to show measurable impact at larger scales, while still maintaining and standardizing data security and integrity.

KEYWORDS
HIV self-screening, digital health, mobile health (mHealth), HIV self-testing (HIVST), HIV, digital intervention

Introduction

Individuals can quickly learn their HIV status, independent of a healthcare facility, by collecting and testing their own specimen (blood drop from finger prick or an oral swab) with a variety of different HIV self-testing (HIVST) kits (1). HIVST can improve traditional HIV counselling and testing programs by removing barriers associated with stigma and time to access traditional testing, while also promoting frequent testing which may lead to earlier diagnosis and treatment of HIV (2). Although these benefits may be well known now (3), it took decades of research and policy shaping for HIVST to reach this state. In 1986, Elliott Millenson first proposed the idea of using home-based HIVST (4) and now, three and a half decades later, more than 10 million HIVST kits are being distributed each year (5).

Progress over the first 25 years was slow due to a lack of knowledge and policies for HIVST (4, 6), however once the first rapid diagnostic test (RDT) HIVST kit became commercially available in 2012 (7), this allowed for research to be conducted into the usability and performance of HIVST, creating a strong body of evidence. This body of evidence now consists of 32 randomly controlled trials (RCTs) and over 150 values and preference studies, which shows high usability, acceptability and feasibility, in a variety of demographics and regions, while maintaining linkage to care rates, especially in key populations. These outcomes have led to the WHO formally recommending HIVST, and nearly 100 countries adopting them into their national HIV strategies (1, 3).

HIVST has become an effective way to complement existing HIV testing strategies, especially for key populations, however they still present a few challenges for users and healthcare systems in general (1). One main challenge is the lack of appropriate pre-test and post-test counselling (8), while another is that the usage of each self-test cannot be verified or tracked, so not all positive cases are appropriately linked to care (9, 10). To address these challenges, digital interventions for HIVST have been introduced in a variety of ways, including apps, websites and messaging platforms (11–13), and there is now a growing body of evidence that supports digital interventions for HIVST (14). This descriptive perspective will present the evolution of HIVST, including the current challenges, then explore how digital interventions for HIVST are beginning to address these challenges.

The evolution of HIVST

Laboratory based HIV testing was first made available in 1985, and in many regions testing was introduced with legislation to protect people that tested positive from accidental disclosure and discrimination (15, 16). This legislation also introduced requirements for pre- and post- test counselling, consent to test and how HIV status could be reported, dictating how an HIV status was documented on medical records (4). While these policies were developed to protect the tester and people living with HIV, requirements like reporting positives by name to confidential registries and the need for face-to-face counselling inadvertently hampered innovative testing approaches like HIVST, as it could not comply with these obligations (15).

At that stage, there was inadequate information surrounding HIVST available to advise policy building, so understandably policies were shaped by the concerns of policy makers, surrounding the legal, ethical and social issues that could have potentially occurred from self-testing (17). Legal concerns for HIVST included the inability for lay-people to correctly conduct the test, leading to false positives or false negatives that could spur litigation, while ethical and social concerns included psychological distress, and downstream effects, that may accompany a positive diagnosis outside a health facility. For example, in 1985, before life-saving ARV treatment, a man committed suicide in San Francisco after learning of his HIV positive status. During the first public hearing on HIVSTs, activists distributed copies of this person's obituary as a cautionary tale (4).

In 1996, with increasing availability of HIV treatment, the United States Food and Drug Administration (FDA) approved the first take-home HIVST kit, the Confide home HIV test by Direct Access Diagnostics (see **Figure 1** for a complete timeline of HIVST evolution). Confide home HIV test was a home sample collection (HSC) test, which required a user to collect their own blood sample, mail it to a laboratory for analysis, then call a toll-free number a week or two later for their results and the appropriate post-test counselling (16). The HSC tests were marketed directly to end-users and during the first year of availability, almost 175,000 HSC tests were conducted, with no reports of suicide associated with the testing (16). Other studies have mentioned the possibility of social harm, but none have presented any evidence of suicide or harm related to self-testing (6, 17, 18).

Although HSC tests broke the home testing barrier, users still had to wait weeks before learning their result, and the HSC tests required blood samples from a finger prick, which proved difficult for some users (16). To address these challenges, a new type of HIV test, the RDT, was developed, which could be conducted with an oral fluid specimen or blood, and the results were revealed in minutes, not weeks (19). In 2003, OraQuick became the first RDT to be waived by the Clinical Laboratory Improvements Amendments Law, which was the first step towards becoming approved for HIVST. The OraQuick waiver did not allow for in-home testing like HSCs, but it did allow for point of care testing at doctors' offices, instead of just traditional laboratory settings (20).

RDTs proved to be easy to use and the short wait times meant that 30%–40% of testers in public facilities were no longer being lost to follow-up before learning their results (19). There were, however, concerns with accuracy, as the Centers for Disease Control and Prevention reported in a Morbidity and Mortality Weekly Report that one testing programme in New York City experienced clusters of false positives, which totaled over 400 from 2005 to 2008, exceeding the specificity confidence interval of the manufacturer (21). The cause of these false positive clusters was not discovered, but it seemed to be an isolated incident, as no large-scale studies reported sensitivity (ability to detect true positives) or specificity (ability to filter out true negatives) values that fell outside the manufacturer's specifications.

The threat of inaccurate results may have delayed the HIVST approval process, but in 2012, the FDA approved OraQuick as the first ever over the counter RDT, joining HSCs as a faster option for HIV home testing (7). Two years after OraQuick's FDA approval, a review of over 300 articles was conducted on self-testing, including 49 on HIVST, and the authors concluded that there was very little evidence of any harm (phycological, social or medical) because of HIVST. This review went on to recommend that HIVST programs should be expanded, and not restricted based on the potential fears of harm that self-testing may cause (17).

After the initial FDA approval, the development of HIVST programmes was slow, and as of July 2015, only two countries were implementing HIVST supported by national policies, but after the WHO released their Guidelines on HIV Self-Testing and Partner Notification in 2016 (1), there was a shift. Programmes like HIV Self-Test AfRica (STAR) were launched to study the use of HIVST in low- and middle-income countries (LMICs), and their findings, as well as findings from other studies, began to show the

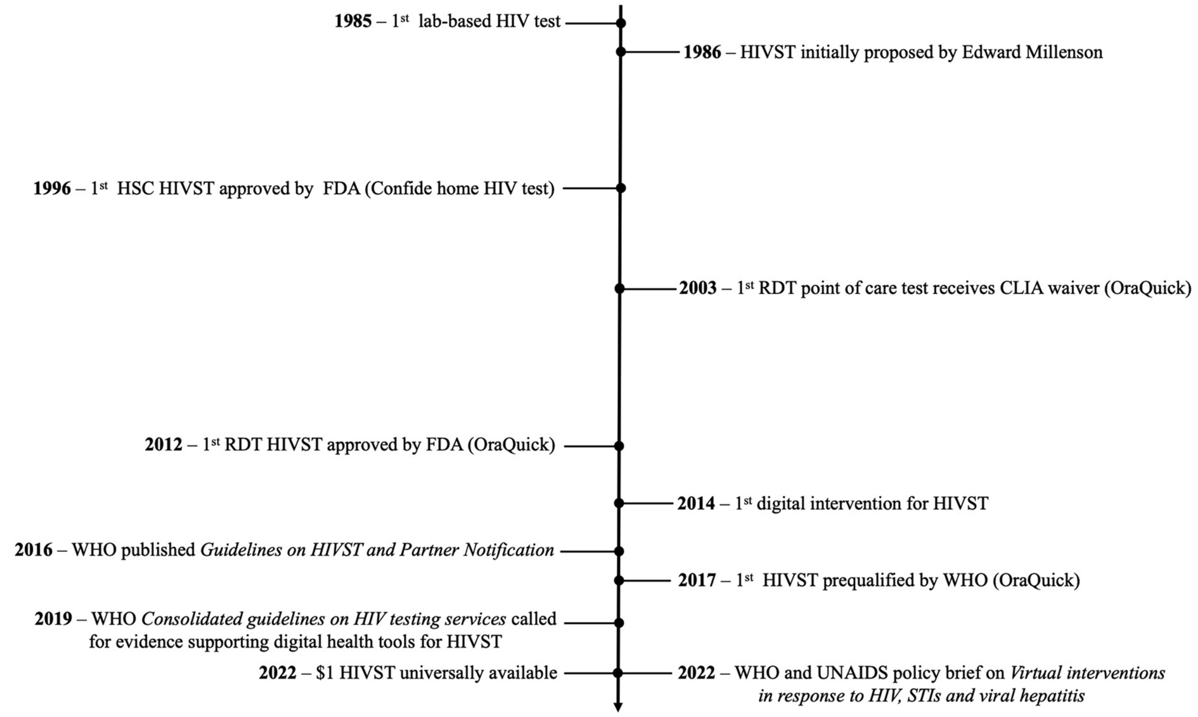

FIGURE 1
Timeline of HIVST and digital interventions for HIVST. FDA, United States Food and Drug Administration; HIV, human immunodeficiency virus; HIVST, HIV self-testing; HSC, home sample collection; STI, sexually transmitted infection; UNAIDS, The Joint United Nations Programme on HIV/AIDS; WHO, World Health Organisation.

true potential of HIVST (22). A usability assessment with seven different HIVST products (Biosure, Atomo 1, Atomo 2, Calypte, OraQuick, Insti and Chembio), and almost 1,500 untrained users was conducted in South Africa. The assessment reported that 96% of the participants thought the tests were easy to use and felt confident using them unassisted (23). These findings were verified a year later by a study of four HIVST products (Biosure, OraQuick, Insti and Chembio), where 97% of the 3,600 users, gave them high usability scores. Furthermore, this study revealed that the sensitivity and specificity of the tests was 98.2% and 99.8%, respectively, surpassing the performance measures attained during FDA approval (24). This study was also conducted with a minimum sample size of 900 users per HIVST product, allowing the results to be used for WHO prequalification (25).

WHO prequalification is a programme that started in the 1980s as a way for UNICEF to determine whether the vaccines they purchased met appropriate quality standards (25, 26). Since then, the programme has expanded to include the prequalification of pharmaceuticals, including antiretrovirals (ARVs) and *in vitro* devices, including HIVST kits (27). For HIVST kits, the prequalification process includes a review of packaging and instructions for use, evidence from studies on usability and clinical performance by untrained users, and a site visit of the manufacturing facilities (25). In 2017, the WHO recognised OraQuick as the first prequalified HIVST kit, and now there are six HIVST kits that have WHO prequalification, including one that is available for only US$1 (5, 28).

Despite the strong body of evidence leading to a formal recommendation by WHO, affordable WHO prequalified products, and supportive national policies in almost 100 countries, challenges with HIVST still remain (3). HIVST can shift testing away from healthcare facilities, but this shift also removes the traditional pre-test and post-test counselling provided by trained healthcare workers or counsellors (8). Furthermore, the shift away from facilities also creates a challenge around the ability to show that HIVST can create a measurable health impact, which is difficult because each individual self-test cannot be appropriately tracked and not all positive cases are linked to care (9, 10). Digital interventions for HIVST have been proposed to improve HIVST programmes by addressing these challenges and in 2019, the *Consolidated guidelines on HIV testing service*s was published by the WHO, which called for evidence supporting the potential for digital health tools to optimise HIVST. Specifically, the guidelines highlighted demand generation, video-based counselling and facilitating linkage to care as areas where evidence supporting digital interventions for HIVST is needed (29).

Digital interventions for HIVST

Digital interventions for HIVST are a type of digital health that incorporates digital technology, in the form of telehealth, apps, social media, messaging platforms or the internet, to complement HIVST by addressing the challenges of traditional HIVST programmes (30). These digital interventions have been used to promote and distribute HIVST kits, deliver video counselling, provide instructions for use, and link self-testers to appropriate care, including preventative services, like preexposure prophylaxis, for negative self-testers and

ARVs for positive self-testers (14). The very first HSC programs for self-testing in the 1990s required users to call a toll-free number for their HIVST results, where they could also access pre-recorded information about their results, a textbook example of telehealth (31). If that same telehealth programme was released today, it would be considered a digital intervention for HIVST, however this terminology did not exist in the 1990s, and the telephones and recordings may very well have still been analog, not digital.

To the authors' knowledge, the first digital intervention for HIVST that was academically evaluated, with findings published in a peer-reviewed journal was in 2014, within 2 years of the FDA approval of OraQuick. The intervention used a social networking app on smartphones, called Grindr, to increase HIVST by promoting a website that distributed free HIVST kits to men who have sex with men (MSM) in Los Angeles. In two months, nearly 12,000 people accessed the website, which led to 334 requests for HIVST kits, two of which tested positive and were linked to care (32). This study showed potential for digital interventions to monitor public health impact by tracking positives and linkage to care. Since then, dozens of studies have been conducted to validate and expand on these early findings (11, 13, 14, 33, 34).

South Africa is one of the leading implementers of HIVST and building off the findings from the usability and performance assessments of HSTAR in sub-Saharan Africa (22–24), there was a series of compounding studies in the same region that illustrated the development of digital interventions for HIVST (11, 13, 33, 34). The first study focused on the usability, acceptability and feasibility of digital interventions for HIVST, and findings confirmed that users found these digital tools highly usable and acceptable (11). The study observed 300 South African users with no prior HIVST experience, while they conducted OraQuick self-tests, assisted by the Aspect smartphone app, a digital intervention designed to improve the testing and reporting experience for HIVST users. The *Aspect* app walked the user through the instructions for use, the collection and testing of their oral fluid specimen, then the reporting of results to a central database by uploading a picture of their self-test result. Of the 300 users, 296 (98.7%) found it easy to use, with 267 (89.0%) users correctly completing all steps and all but one (299/300; 99.7%) stating they would be willing to use the app again (11).

While the *Aspect* study was conducted under the supervision of a healthcare worker in a facility (11), another smartphone app, Ithaka was introduced, which let a similar sample of users from Johannesburg, South Africa self-test and report results at home, independent of a healthcare facility (13). *Ithaka* was a progressive web app for OraQuick, which expanded from just instructions for use, by adding pre- and post- test counselling, before the user self-reported their results. The pilot included 751 users, which led to 295 (39.3%) receiving counselling and 168 (22.4%) self-reported results, including 14 (8.3%) that reported as HIV positive (13). The *Ithaka* app was also adapted from the original home-based configuration, to complement facility-based HIVST as well. In the facility, visitors could self-test in a booth, guided by the *Ithaka* app, which provided digital instructions, followed by audio visual pre- and post- test counselling, as well as the ability to self-report results. The addition of digitally assisted HIVST with *Ithaka* led to a 25% increase in total testing numbers, without compromising the positivity yield (33).

Another South Africa study that paired OraQuick with a digital intervention for HIVST showed that digital interventions for HIVST could also successfully be used to link self-testers to care. Over 3,000 participants from Cape Town were invited to do traditional HIV testing, supervised digital HIVST at the facility, or unsupervised digital HIVST off-site (34). The digital intervention was *HIVSmart!*, an app that guided users through the instructions for use then linked patients to counselling and care; ARVs for positive self-testers and prevention pathways for negative self-testers. The conventional HIV testing (control) arm linked 98.5% of patients to care. The supervised digital HIVST arm was slightly lower with a 95.7% linkage to care rate and the unsupervised digital HIVST arm was slightly higher than the control with a linkage rate of 99.3% (34).

The above studies (11, 13, 33, 34) were presented for their similar methodologies and progressing outcomes, but these findings have also been validated by independent studies in different regions and populations (14). A recent systematic review of digital interventions for HIVST confirmed that digital interventions could be used to link users to care, by aggregating findings from 12 studies, including studies from Asia, America and Europe. Five of the studies used social media or apps to link patients to care at a rate of 80%–100%, which was more effective than the seven web-based platforms, where only 53%–100% of users were linked to care (14).

This review also revealed one of the main challenges with digital interventions for HIVST, which is the lack of standardisation and cohesion across platforms. For example, linkage to care was not standard across all studies, and varied to include a clinic referral, post-test counselling, confirmatory testing, or ART initiation, depending on the study. This led the authors to suggest the need for a digital health framework focused on the diagnostic outcomes of HIV (14). In 2022, at the International AIDS conference in Montreal, the WHO and UNAIDS released a policy brief on *Virtual interventions in response to HIV, sexually transmitted infections and viral hepatitis*, which provides guidance for incorporating digital interventions into traditional programmes, including HIVST. This document champions the use of digital interventions for HIVST, while also attempting to standardise their implementation and indicators (35).

Conclusion

Despite challenges around counselling, reporting self-test results and linkage to care, HIVST has grown in use, especially over the past decade, with over 10 million HIVST kits currently distributed each year. Digital interventions for HIVST have been introduced in a variety of ways, and the research examining HIVST interventions chiefly consists of pilot studies that lacked ability to show impact at scale. This shotgun approach has also led to incompatible datasets across different interventions and regions, impeding data harmonisation and intervention scale-up. For digital interventions to realise universal acceptance, they must begin to show measurable, comparable impact at scale, while also maintaining data security and integrity. Future research needs to focus on large-scale implementation, and explore the need for regulatory approval or prequalification of digital interventions for HIVST, as a way to standardise these interventions beyond generic data privacy policies (36).

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author/s.

Ethics statement

Ethical review and approval was not required for this study in accordance with the local legislation and institutional requirements.

Author contributions

AEF and STLE conceptualized this manuscript. AEF, MM and LS wrote the first draft. All authors wrote and edited the final draft. All authors contributed to the article and approved the submitted version.

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Conflict of interest

AEF, MA and LS work for Aviro Health, a digital health company that develops digital interventions for HIVST.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. World Health Organization (WHO). *Guidelines on HIV self-testing and partner notification: Supplement to consolidated guidelines on HIV testing services.* Geneva: WHO Press (2016).

2. Johnson C, Kennedy C, Fonner V, Siegfried N, Figueroa C, Dalal S, et al. Examining the effects of HIV self-testing compared to standard HIV testing services: a systematic review and meta- analysis. *J Int AIDS Soc.* (2017) 20(1):21594. doi: 10.7448/IAS.20.1.21594

3. Johnson C. *What can be self-tested NOW?* Montreal, Canada: IAS (2022).

4. Wright A, Katz I. Home testing for HIV. *N Engl J Med.* (2006) 354:437–40. doi: 10.1056/NEJMp058302

5. World Health Organization. New US$ 1 price for HIV self-tests. 27 July 2022. https://www.who.int/news/item/27-07-2022-new-1-dollar-price-for-hiv-self-tests (Accessed September 27, 2022).

6. Pai N, Klein M. Are we ready for home-based, self-testing for HIV? *Futur HIV Ther.* (2008) 2(6):515–20. doi: 10.2217/17469600.2.6.515

7. Richter M, Venter WD, Gray A. Enabling HIV self-testing in South Africa. *S Afr J Med.* (2016) 13(4):186–7. doi: 10.7196/sajhivmed.858

8. Stevens DR, Vrana CJ, Dlin RE, Korte JE. A global review of HIV self-testing: themes and implications. *AIDS Behav.* (2018) 22(2):497–512. doi: 10.1007/s10461-017-1707-8

9. Venter F, Majam M, Jankelowitz L, Adams S, Moorehouse M, Carmona S, et al. South African HIV self-testing policy and guidance considerations. *Southern Afr J HIV Med.* (2017) 18(1):775. doi: 10.4102/sajhivmed.v18i1.775

10. Fionet. Mobile diagnostics integrated with cloud information services. *USAID mHealth Compendium* (2017) 2:62–3. [cited 2022 Nov 15]. Available from: http://www.africanstrategies4health.org/uploads/1/3/5/3/13538666/fionet_-_mobile_diagnostics.pdf

11. Gous N, Fischer AE, Rhagnath N, Phatsoane M, Majam M, Lalla-Edward ST. Evaluation of a mobile application to support HIV self-testing in Johannesburg, South Africa. *S Afr J HIV Med.* (2020) 21(1):a1088. doi: 10.4102/sajhivmed. v21i1.1088

12. Venter WDF, Fischer A, Lalla-Edward ST, Coleman J, Lau Chan V, Shubber Z, et al. Improving linkage to and retention in care in newly diagnosed HIV-positive patients using smartphones in South Africa: randomized controlled trial. *JMIR Mhealth Uhealth.* (2019) 7(4):e12652. doi: 10.2196/12652

13. Fischer AE, Phatsoane M, Majam M, Shankland L, Abrahams M, Rhagnath N, et al. Uptake of the Ithaka mobile application in Johannesburg, South Africa, for human immunodeficiency virus self-testing result reporting. *S Afr J HIV Med.* (2021) 22(1):a1197. doi: 10.4102/sajhivmed. v22i1.1197

14. McGuire M, de Waal A, Karellis A, Janssen R, Engel N, Sampath R, et al. HIV self-testing with digital supports as the new paradigm: a systematic review of global evidence (2010-2021). *EClinicalMedicine.* (2021) 39:101059. doi: 10.1016/j.eclinm.2021.101059

15. Bayer R, Stryker J, Smith M. Testing for HIV infection at home. *N Engl J Med.* (1995) 332:1296–9. doi: 10.1056/NEJM199505113321911

16. Branson BM. Home sample collection tests for HIV infection. *JAMA.* (1998) 280 (19):1699–701. doi: 10.1001/jama.280.19.1699

17. Brown AN, Djimeu EW, Cameron DB. A review of the evidence of harm from self-tests. *AIDS Behav.* (2014) 18(Suppl 4(Suppl 4)):S445–9. doi: 10.1007/s10461-014-0831-y

18. Walensky RP, Paltiel AD. Rapid HIV testing at home: does it solve a problem or create one? *Ann Intern Med.* (2006) 145(6):459–62. doi: 10.7326/0003-4819-145-6-200609190-00010

19. Keenan P, Keenan J, Branson B. Rapid HIV testing. *Postgrad Med.* (2005) 117 (3):47–52. doi: 10.3810/pgm.2005.03.1600

20. Branson BM. FDA Approves OraQuick for use in saliva. On March 25, the FDA approved the first rapid test for HIV in oral fluids. *AIDS Clin Care.* (2004) 16(5):39. PMID: 15199863

21. Centers for Disease Control and Prevention (CDC). False-positive oral fluid rapid HIV tests: New York City, 2005–2008. *MMWR.* (2008) 57(24):660–5.

22. Ingold H, Mwerinde O, Ross AL, Leach R, Corbett E, Hatzold K, et al. The self-testing Africa initiative: accelerating global access and scale-up of HIV self-testing. *J Int AIDS Soc.* (2019) 22(S1):e25249. doi: 10.1002/jia2.25249

23. Majam M, Mazzola L, Rhagnath N, Lalla-Edward ST, Mahomed R, Venter WDF, et al. Usability assessment of seven HIV self-test devices conducted with lay-users in Johannesburg, South Africa. *PLoS ONE.* (2020) 15(1):e0227198. doi: 10.1371/journal.pone.0227198

24. Majam M, Fischer AE, Rhagnath N, Msolomba V, Venter WDF, Mazzola L, et al. Performance assessment of four HIV self-test devices in South Africa: a cross-sectional study. *S Afr J Sci.* (2021) 117(1/2):7738. doi: 10.17159/sajs.2021/7738

25. World Health Organization. *Technical specifications series for submission to WHO prequalification–diagnostic assessment: Human immunodeficiency virus (HIV) rapid diagnostic tests for professional use and/or self- testing.* Geneva: World Health Organization (2017).

26. Coyne P. The world health organization prequalification programme—playing an essential role in assuring quality medical products. *Int Health.* (2019) 11(2):79–80. doi: 10.1093/inthealth/ihy095

27. Blaschke TF, Lumpkin M, Hartman D. The world health organization prequalification program and clinical pharmacology in 2030. *Clin Pharmacol Ther*. (2020) 107(1):68–71. doi: 10.1002/cpt.1680

28. World Health Organization. *WHO List of prequalified in vitro diagnostic products*. Geneva: World Health Organization (2022).

29. World Health Organization. *Consolidated guidelines on HIV testing services, 2019*. Geneva: WHO Press (2020).

30. World Health Organization (WHO). *Global strategy on digital health 2020–2025*. Geneva: WHO Press (2021).

31. Frank AP, Wandell MG, Headings MD, Conant MA, Woody GE, Michel C. Anonymous HIV testing using home collection and telemedicine counseling. A multicenter evaluation. *Arch Intern Med*. (1997) 157(3):309–14. doi: 10.1001/archinte.1997.00440240073011

32. Huang E, Marlin RW, Young SD, Medline A, Klausner JD. Using grindr, a smartphone social-networking application, to increase HIV self-testing among Black and Latino men who have sex with men in Los Angeles, 2014. *AIDS Educ Prev*. (2016) 28 (4):341–50. doi: 10.1521/aeap.2016.28.4.341

33. Mshweshwe-Pakela NT, Mabuto T, Shankland L, Fischer A, Tsukudu D, Hoffmann CJ. Digitally supported HIV self- testing increases facility-based HIV testing capacity in Ekurhuleni, South Africa. *S Afr J HIV Med*. (2022) 23(1):a1352. doi: 10.4102/sajhivmed.v23i1.1352

34. Pai N, Esmail A, Saha Chaudhuri P, Oelofse S, Pretorius M, Marathe G, et al. Impact of a personalised, digital, HIV self-testing app-based program on linkages and new infections in the township populations of South Africa. *BMJ Global Health*. (2021) 6:e006032. doi: 10.1136/bmjgh-2021-006032

35. UNAIDS, World Health Organization (WHO). *Virtual interventions in response to HIV, sexually transmitted infections and viral hepatitis*. Geneva: WHO Press (2022).

36. Legislation.gov.uk. *Data Protection Act* 2018. (2018). Available at: https://www.legislation.gov.uk/ukpga/2018/12/part/2 (Accessed October 24, 2022).

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Corrigendum: The evolution of HIV self-testing and the introduction of digital interventions to improve HIV self-testing

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KEYWORDS

HIV self-screening, digital health, mobile health (mHealth), HIV self-testing (HIVST), HIV, digital intervention

A Corrigendum on
The evolution of HIV self-testing and the introduction of digital interventions to improve HIV self-testing

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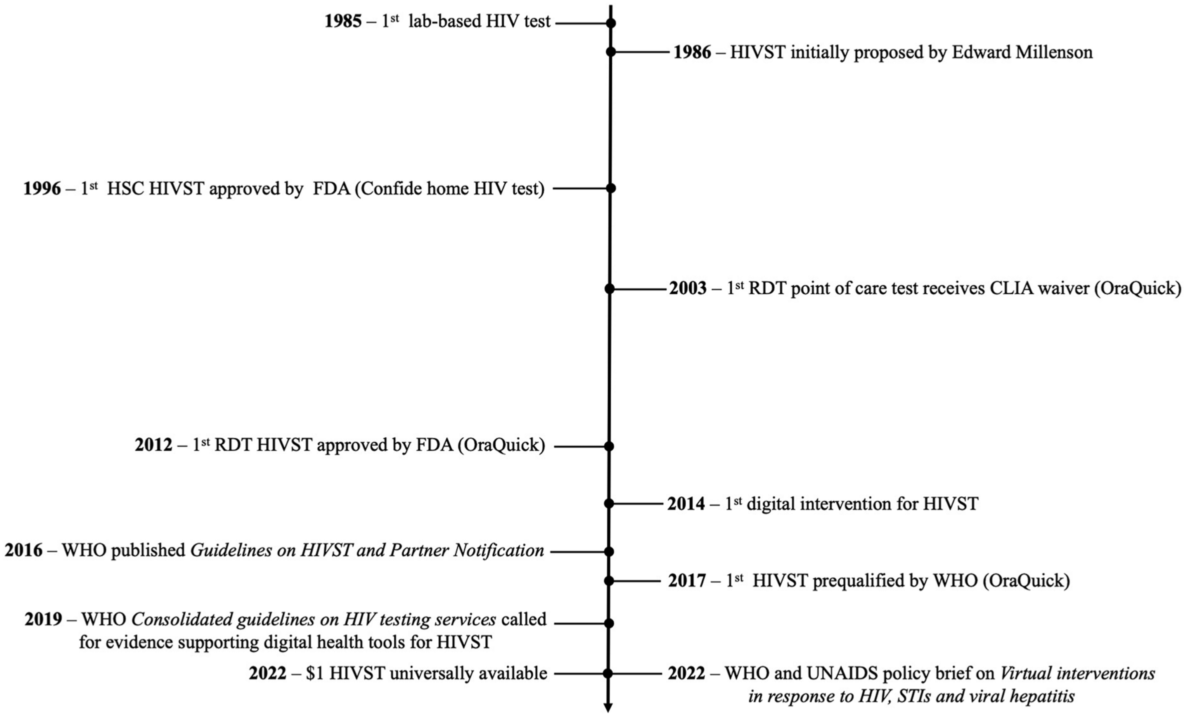
In the published article, there was an error in Figure 1 as published. The third line displays "**1996**—1st HSC HIVST approved by FDA (Home Access HIV)". The correct third line is "**1996**—1st HSC HIVST approved by FDA (Confide home HIV test)". The corrected Figure 1. appears below.



In the published article, there was an error. The first take-home HIVST kit, was "Confide home HIV test by Direct Access Diagnostics", not the "Home Access HIV test system", as originally displayed. A correction has been made to **The evolution of HIVST**, paragraph 3. This sentence previously stated:

"In 1996, with increasing availability of HIV treatment, the United States Food and Drug Administration (FDA) approved the first take- home HIVST kit, the Home Access HIV test system (see Figure 1 for a complete timeline of HIVST evolution). Home Access HIV was a home sample collection (HSC) test, which required a user to collect their own blood sample, mail it to a laboratory for analysis, then call a toll-free number a week or two later for their results and the appropriate post-test counselling (16)."

The corrected sentence appears below:

"In 1996, with increasing availability of HIV treatment, the United States Food and Drug Administration (FDA) approved the first take-home HIVST kit, the Confide home HIV test by Direct Access Diagnostics (see Figure 1 for a complete timeline of HIVST evolution). Confide home HIV test was a home sample collection (HSC) test, which required a user to collect their own blood sample, mail it to a laboratory for analysis, then call a toll-free number a week or two later for their results and the appropriate post-test counselling (16)."

The authors apologize for these errors and state that this does not change the scientific conclusions of the article in any way. The original article has been updated.

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HIV self-test reporting using mHealth platforms: A pilot study in Johannesburg, South Africa

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Background: The main impediment to operational scale-up of HIV self-testing (HIVST) and counselling, is a dearth of information on utilisation, reporting, and linkage to care for HIV-positive individuals. To inform solutions to this issue, this study investigated the utility of self-testers reporting their results using a mobile-health (mHealth) platform, and whether seropositive users linked into care.
Method: Candidates who met the recruitment criteria across multiple sites within inner-city Johannesburg each received an HIVST kit. Using short message service (SMS) reminders (50% standard and 50% behavioural science), participants were prompted to self-report results on provided platforms. On the seventh day, users who did not make contact, were called, and surveyed *via* an interactive voice response system (IVRS). Multivariable regression was used in reporting by age and sex.
Results: Of the 9,505 participants, 2,467 (25.9%) participants answered any survey question, and of those, 1,933 (78.4%) were willing to self-report their HIV status. Men were more likely than women to make an inbound call (10.2% vs. 9.1%, $p = 0.06$) however, women were significantly more likely to self-report their test result (AOR = 1.12, 95%CI = 1.01–1.24, $p = 0.025$). Overall, self-reporting a test result was predicted by being younger and female. In addition, reporting HIV results was associated with age, 25–35 (AOR = 1.58, 95% CI = 1.24–2.02) and above 35 years (AOR = 2.12, 95% CI = 1.61–2.80). Out of 1,933 participants willing to report their HIV status, 314 reported a positive test, indicating a HIV prevalence of 16.2% (95% CI: 14.6%–18.0%) and of those 204 (65.0%) reported inclination to link to care.
Conclusion: While self-reporting HIVST results *via* an IVRS system yielded a higher response rate, behavioural SMSs were ineffective in increasing self-reporting.

KEYWORDS

HIV testing services, HIV self-testing, linkage, HIV care, monitoring and evaluation, short message services, IVRS

1. Introduction

In 2019, South Africa had an estimated 7.5 million people living with HIV (PLHIV), approximately 6.9 million (92%) of whom knew their status. The country faces the highest HIV burden and implements the largest HIV treatment programme globally, yet despite the steady progress towards achieving the UNAIDS 90–90–90 targets, achieving the second 90 (all people diagnosed with HIV will be allowed to start ART treatment) remains problematic. In South Africa, only 5.2 million (70%) of HIV positive people are receiving HIV treatment (1). Further, estimates indicate that there is an HIV incidence (per 1,000 population) of 6.9 in the young adult population between the ages of 15–49 (2, 3). Testing is not being taken up equally, with men in general and adolescent girls and young women, being harder to reach with traditional HIV testing modalities. South Africa employs a multi-pronged HIV prevention approach (3). Despite South Africans being able to access the cutting edge of biomedical prevention and testing services, new infections remain high, and low uptake and coverage of existing HIV testing services pose a significant challenge for universal access to HIV treatment (4). In March 2018, the South African National Department of Health approved and issued guidance on the use of HIV self-tests (HIVSTs) (5).

According to the World Health Organization (WHO), HIVST is defined as the process whereby an individual collects their own specimen (blood or oral fluid), performs HIV testing using an HIV rapid diagnostic test and interprets the result themselves either assisted or unassisted (6). HIVST is not intended to replace facility-based HIV tests but rather serves as the initial step to knowing one's HIV status, and where seropositivity needs a further confirmatory test in the health facility. In July 2017, the OraQuick HIV 1/2 test was approved by WHO as the first pre-qualified HIVST, and in January 2019, the INSTI HIV ½ HIVST was approved (7). Yet, despite the approval of HIVSTs for use in South Africa since 2018, the utilisation rate is (85%), and HIVST users do not utilise the health system fully to obtain a confirmatory test and link to care after receiving a positive HIVST test (8). Linkage to care (prevention services or treatment) is one of the most important aspects of non-facility-based testing. Globally, there is a shortage of available data that demonstrates effective linkage to care for individuals that have self-tested. A systematic review by the WHO has reported on only two randomised controlled trials (RCTs) having examined linkage to care (8). One RCT found that 72% of the male partners of women who received an HIVST kit accessed further testing to confirm their result, even though this could not be directly compared with standard testing. Johnson C, et al. reported lower linkage to care than those diagnosed in the standard group, which was partly attributed to few HIV-positive test results, under-reporting, and possibility that some men knew their HIV-positive status already (8).

Like HIVSTs, mHealth technologies could potentially improve access to public health efforts in underserved communities by making healthcare services easier and more convenient to access (9). mHealth tools can comprise online videos, apps and text messages, depending on the technology available to users. Reviews of interventions implemented globally report strong evidence of text/short message service (SMS) intervention effectiveness for diabetes self-management, weight loss, physical activity, and smoking cessation (10). Within HIV studies, there is strong evidence that SMS messages increase the propensity for HIV positive persons to adhere to treatment (11, 12). Recent studies conducted across the income spectrum report high antiretroviral therapy adherence with the use of mobile phones (standard or smartphone) through interactive voice response calls, and SMS (13). Such phone-based systems offer a low cost and consistent delivery of messages. Patients use the keypad or voice response to choose menu options, respond promptly and answer questions (14).

There is currently no evidence for low- and middle-income countries on whether SMS messages increase linkage to care after an HIV self-test. Evidence from the UK suggests that mHealth interventions to increase HIVST reporting can be enhanced through the inclusion of behavioural insights or "nudges", where small changes in wording led to increased reporting (15). However, there is no evidence on the effectiveness of whether messages based on behavioural nudges can affect HIVST reporting in the South African context. Our study fills these gaps by reporting data from a pilot study of an mHealth communication platform which used SMS and interactive voice response system (IVRS) to enhance HIVST reporting and, if positive, linkage to care. Our primary outcomes report utilization of the healthcare system, reporting of HIV status, and whether these outcomes varied across participant demographics, or whether they received SMS messages based on behavioural nudges.

2. Methods and design

2.1. Setting and recruitment

The study was multi-site and aimed to recruit 12,000 participants from 35 sites in and around the city of Johannesburg. Recruitment sites were heterogenous, and were all densely populated, and included malls, shopping centres, colleges, taxi ranks and informal housing settlements. The fieldwork team consisted of four staff, who presented at each site with a branded canopy, materials advertising HIVST distribution, test kits, and data collection tools. All willing participants were individually approached and provided with information regarding the study. If the participant was interested and met al.l the inclusion criteria, they were consented after which their details were collected using paper-based data collection tools and captured onsite on the Viamo platform. Participants were also provided with an HIVST kit together with information leaflet to contact a hotline or access a website link to report their HIVST result. All staff were comprehensively trained on the study protocols, including requesting informed consent, referral of self-reported HIV positive participants, and how to use the study database.

2.2. Mhealth intervention

On enrolment, participant details were entered into the mHealth system of Viamo Mobile, and participants encouraged to conduct a short survey *via* recorded phone line or website to self-report test use and result. The system encouraged self-reporting through two SMS messages sent at three- and five-days post registration. On the seventh day after distribution, if the participant had not initiated contact with the system, an interactive voice response system (IVRS) called the participant to go through a short survey which included test result. The recorded voice menu options were identical irrespective of whether respondents called in or were called by the system. First, participants were asked if they had used the test and if they were willing to reveal their result. Then, participants were asked how easy the test was to use, how much they would be willing to pay for the test if it had not been provided for free, when they last tested for HIV, when they planned to test next for HIV, and their willingness to pay for the test if it had not been provided free of charge.

2.3. Inclusion and exclusion criteria

Participants were eligible for inclusion if they showed understanding of the written informed consent process, were aged 18 years and older, had access to a cellular phone able to receive SMS messages, and were able to speak and read English and had not tested for HIV in the 3 months prior. Study tools and the consent forms were in English which is a commonly used language in the recruitment areas. Participants were excluded from the study if they were not able and willing to provide informed consent, could not provide a verifiable mobile phone number, had tested in for HIV in the last 3 months and had any condition which would render them unsuitable or unsafe for enrolment, for example pregnancy, being intoxicated or having an acute illness. Participants were not excluded based on race, gender, ethnicity, or sexual orientation.

2.4. Informed consent, enrolment and data collection

Upon enrolment, participants were asked to report their age and gender – no other data were collected to make data collection light-touch and reflect real-world conditions as much as possible. Study staff explained the material included in the screening kit, which included written information on how to report a result. The kit also included a linkage referral card for participants wishing to report to one of a list of named referral clinics in the area for confirmatory testing. All enrolled participants consented to be contacted by the study *via* phone or SMS at a later date. Participant data were collected on paper, and immediately entered into the study database using a computer tablet. Digital data were securely stored on Viamo Mobile servers and reviewed daily by the study team and supervisors for errors. Study tools and consent forms were stored in an access-controlled data room.

2.5. Behavioural wording in SMS messages

Since other HIVST programmes have shown that incorporating SMS messaging increased the reporting of test use and results (16), we deemed it appropriate for participants to receive any SMS message prompts. Evidence from the UK suggested that SMS messages based on behavioural nudges could be effective in increasing HIVST response rates. We adapted this intervention based on the Easy, Attractive, Social and Timely (EAST) framework (17), through discussion with researchers and HIVST experts. Upon enrolment participants were randomly allocated to receive one of two sets of test messages, as shown in **Figure 1**. Participants in the control arm received the same prompt on days three and five. On day three, participants in the intervention arm who had not yet responded, received a message highlighting the cost of the test they received, based on the principle of highlighting friction costs to participants (17, 18). On day five, participants who had not yet responded received a message seeking to enhance the attractiveness of the HIVST. Outcomes were pre-specified in a submission to the American Economic Association Trial Registry (AEARCTR-0002409) as a report of HIVST use through contacting the mHealth system, and HIVST result.

2.6. Data analysis and outcome measurement

Data were downloaded from the Viamo Mobile system to Stata 15 (StataCorp; College Station, United States) where they were reshaped and analysed. We used participant's phone numbers as an identification tool. Based on our experience, we concluded that asking participants to report the number written on their test kit would be ineffective in tracking them through the system, due to a possibility of having duplicate phone numbers in the system, as participants collected more than one kit. We assessed whether duplicates were genuine, and not artefacts such as data entry errors, by looking for different test kit IDs and noting if the place, time, and date of participation was substantively different. Our main analysis omits duplicates and only considers the first time a phone number entered the system, though we conducted sensitivity analyses estimating results using the full dataset and explored reporting by duplicate phone numbers. We use multivariable regression to explore variation in reporting by age and gender, the only participant level characteristics collected.

Outcome measures included the proportion of people who engaged with the mHealth system at different times through SMS messages and voice calls, the proportion of people willing to report their HIV status, and associations with age and gender.

2.7. Ethical review

The study and related study material was reviewed and approved by the Human Research Ethics Committee (HREC) of the University of the Witwatersrand (approval number 171113) and the Observational/Interventions Research Ethics Committee of the London School of Hygiene and Tropical Medicine (reference 14485). Participants were not reimbursed.

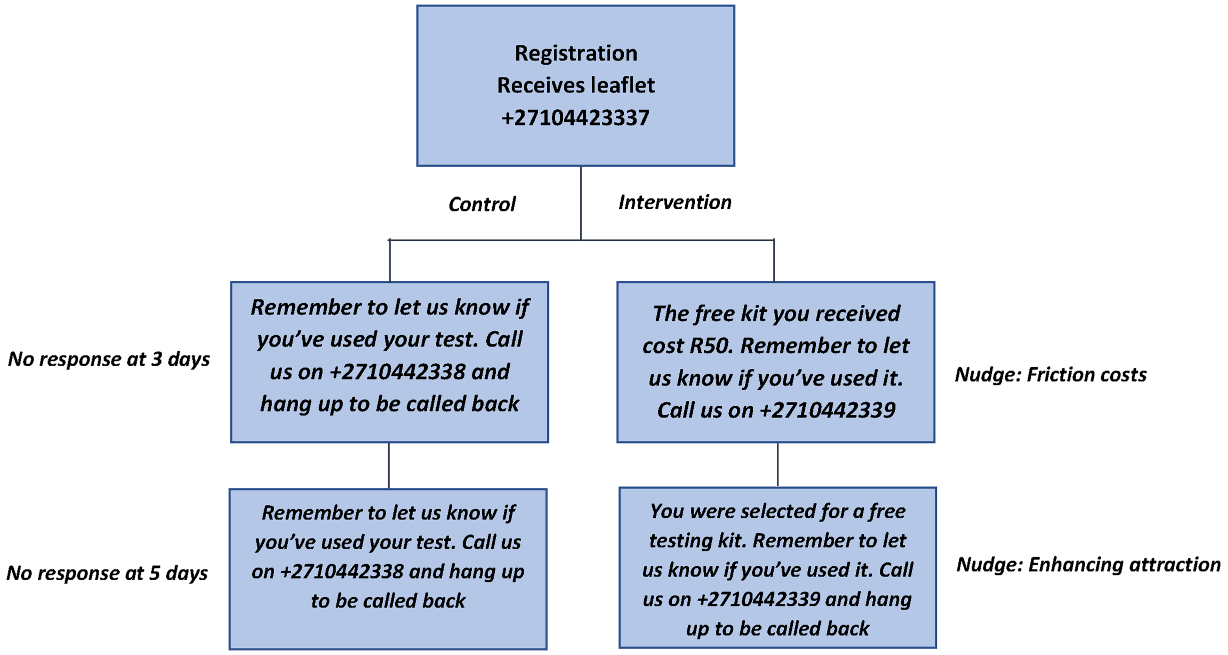

FIGURE 1
Workflow design of behavioural SMS received by participants.

3. Results

In total 10,698 participants registered a phone number with the system and received an HIVST kit. Of those, 9,504 (89%) were unique phone numbers; this figure is used as the denominator for the main analysis. 183 participants (1.9%) called in before being contacted by SMS on day 3. There were slightly more male (5,047, 53%) than female (4,457, 47%) registrations (Table 1). Almost half of the participants (4,501, 47%) were between 25 and 35 years old (Table 1).

3.1. Description of participant interactions with the mHealth system

On day three and day five after registration, participants received an SMS message prompting them to call into the system and complete the survey. This increased self-reporting five-fold compared to unprompted responses before day three (Table 2). Two hundred and thirty seven (237, 2.5%) participants of those who had not called before day three) participants called and completed the survey after receiving the SMS message on day three, and before receiving the second reminder on day five (Figure 2). One hundred and twenty three (123, 1.3%) of those who had not called before day five) called after receiving a second reminder on day five. In total, 1,933 (20.3% of total participants) reported results within seven days (both inbound and outbound), 690 (35.7%) of whom answered any survey question and 612 (31.7%) self-reported their HIV status (Figure 2). Men were slightly more likely than women to have made an inbound call (10.2% vs. 9.1%, $p = 0.06$) but significantly less likely to have reported a test result (19% vs. 22%, $p = 0.01$).

The remaining 8,109 (85.3% of total) of participants received a phone call seven days after enrolment by the same recorded phone survey as accessed by those calling into the system (Table 2). Of these, 1,777 (20.7% of those called) answered the first question of the survey and 1,321 (15.4% of those called) self-reported HIV status. Compared to unprompted and prompted SMS messages, the call out led to 1.9 times as many responses and 2.2 times as many self-reports of HIV status.

3.2. Self-reporting of HIV status

In total, 2,467 (26.0%) participants answered any survey question, and 1,933 (78.4%) of those (20.3% of total) were willing to self-report their HIV status. Women were significantly more likely to self-report their test result (AOR = 1.12, 95%CI = 1.01–1.24, $p = 0.025$). Self-reporting a test result was predicted by being younger and female, though these were not significant predictors of a positive HIVST result. In addition, reporting HIV results increased incrementally with age, 25–35 (AOR = 1.58, 95% CI = 1.24–2.02) and above 35 years (AOR = 2.12, 95% CI = 1.61–2.80). Out of 1,933 self-reporting participants, 314 reported a positive test, indicating a HIV prevalence of 16.2% (95% CI: 14.6%-18.0%). There was indicative evidence ($p = 0.426$) that HIV prevalence was slightly higher among men (16.9%, 95% CI: 14.6–19.4%), than women (15.6%, 95%CI: 13.3–18.0%), although Table 3 shows that neither sex nor age was predictive of reporting an HIV positive test result (Table 3).

3.3. New diagnoses and linkage to care

Out of 314 respondents reporting an HIV positive test, 130 (41.4%) (70 males and 60 females) reported that this was the first positive HIVST that they had taken. Also, of the 314 respondents reporting a HIV positive test, 204 (64.9%) (116 males and 88 females) reported that they had either linked to care or intended to link to care.

3.4. Ease of using the test

Of the 2,467 participants who answered any survey question, 1,592 (64.5%) reported that the HIVST was very easy or easy to use; women were significantly more likely to report this than men ($p = 0.03$).

3.5. Amount willing to pay

Half of the sample were asked to enter the amount willing to pay without prompts for amount categories – the mean amount willing to pay reported by these respondents was ZAR 70.39 (±4.77 USD) (95% CI: 64.3–76.4), and median ZAR 50 (±3.34 USD) (IQR: 10–100). Furthermore, among those who were presented with varying price point options to report the amount willing to pay, the pay category of ZAR 10–50 (±0.68 USD–3.34 USD), being the cheapest option was chosen by 71.0% of respondents. Then 17.2% of respondents were willing to pay ZAR 50–100 (±3.34 USD–6.78 USD), 6.0% ZAR 100–150 (6.78 USD–10.16 USD) and 6.0% ZAR 150+.

3.6. Previous testing behaviour and intention to test again

As shown in Table 4, a relatively high proportion of respondents had tested in the previous 6 months (74.4%), and after using a HIVST the intention to test again in the next three months was also high (77.0%).

3.7. Impact of behavioural SMS wording on responses

There was no evidence of differences in age or gender among participants randomised to receive standard or behavioural SMS messages and of the 9,505 unique phone numbers, 4,637 (48.8%) received behavioural SMS. Overall, the impact of behavioural SMS messages was small, but there was very weak evidence that behavioural SMS led to lower engagement with the mHealth system. Those who received behavioural SMS messages were slightly less likely to answer any survey question (1,175, 25.3%) compared to the control arm (1,291, 27.8%), indicating a difference of −1.2 percentage points (95% CI: 0.5–2.9%, $p = 0.2$). There was no difference in the likelihood of reporting a positive result between intervention and control arms ($p = 0.44$). A secondary analysis, which was not pre-specified and should therefore not be interpreted as causal, found that those who received behavioural SMS messages were slightly less likely to make an inbound call (424, 9.1%) compared to the control arm (503, 10.8%) with a difference of −1.2 percentage points (95% CI: 0–2.4%, $p = 0.05$).

TABLE 1 Demographics.

Participant Demographics ($n = 9,505$)			
Characteristic		Frequency (n)	Percentage (%)
Age group	18–24	2,497	26.27%
	25–35	4,501	47.36%
	36+	2,503	26.34%
	Not answered	3	0.03%
Sex	Female	4,457	46.90%
	Male	5,047	53.10%
	Not answered	0	0.00%

TABLE 2 Self reporting call status (inbound and outbound indicators) for the study participants disaggregated by sex.

Self-reporting Call Status			
Indicators/variables	Sex	Number (n)	Percent (%)
Unique numbers	Male	5,047	53.10
	Female	4,457	46.90
Inbound before day 3 ($n = 183$)	Male	93	50.82
	Female	90	49.18
Inbound day 3 ($n = 237$)	Male	112	47.26
	Female	125	52.74
Outbound day 3 ($n = 4,140$)	Male	2,007	48.48
	Female	2,133	51.52
Inbound day 5 ($n = 123$)	Male	72	58.54
	Female	51	41.46
Outbound day 5 ($n = 4,136$)	Male	2,013	48.67
	Female	2,123	51.33
Outbound day 7 ($n = 8,109$)	Male	4,358	53.74
	Female	3,751	46.26
Inbound and outbound self-reporting (SR) ($n = 1,933$)	Male	976	50.49
	Female	957	49.51
SR HIV results ($n = 612$)	Male	320	52.29
	Female	292	47.71
SR HIV positive results ($n = 314$)	Male	165	52.55
	Female	149	47.45

4. Discussion

The study purpose was to determine if mobile health communication platforms (SMS and voice calls using behavioural science principles would have an impact on self-testers reporting their results and contributing to increased linkage to care.

Overall results showed that 9.8% shared results within 7 days after up to two SMS prompts, and 20.7% of remaining non-responders shared results when they received an automated

TABLE 3 Logistic regression results for self-reporting status and reporting HIV positive result.

Logistic regression results for self-reporting status and reporting HIV positive result												
Variable	Self-reported results (inbound and outbound)				Inbound self-reporting results				Self-reporting HIV positive results (inbound and outbound			
	Unadjusted odds ratio (95% CI)	*p*-value	Adjusted odds ratio (95% CI)	*p*-value	Unadjusted odds ratio (95% CI)	*p*-value	Adjusted odds ratio (95% CI)	*p*-value	Unadjusted odds ratio (95% CI)	*p*-value	Adjusted odds ratio (95% CI)	*p*-value
Age												
25–35 years (vs. 18–24)	0.95 (0.84–1.07)	0.378	0.96 (0.85–1.08)	0.480	1.59 (1.25–2.02)	**<0.001**	1.58 (1.24–2.02)	**<0.001**	0.98 (0.73–1.30)	0.882	0.97 (0.73–1.29)	0.823
Above 35 years (vs. 18–24)	0.81 (0.71–0.94)	**0.004**	0.83 (0.72–0.95)	**0.009**	2.14 (1.63–2.81)	**<0.001**	2.12 (1.61–2.80)	**<0.001**	0.97 (0.70–1.36)	0.878	0.95 (0.68–1.34)	0.784
Gender												
Female (vs. Male)	1.14 (1.03–1.26)	**0.010**	1.12 (1.01–1.24)	**0.025**	0.90 (0.74–1.09)	0.282	0.97 (0.80–1.18)	0.772	0.91 (0.71–1.15)	0.426	0.90 (0.71–1.15)	0.413

TABLE 4 Previous testing behaviour and intention to test again.

Testing Behaviour					
Time of last test (*n* = 1,697)	*N*	%	Anticipated time to next test (*n* = 1,671)	*N*	%
Last 3 months	1,001	59.0%	In 3 months	1,287	77.0%
Last 6 months	261	15.4%	In 6 months	202	12.1%
Last year	203	12.0%	In 1 year	75	4.5%
Last 2 years	61	3.6%	In 2 years	20	1.2%
Don't know	171	10.1%	Don't know	87	5.2%

outbound call. Out of the 314 HIV positive respondents, 65% reported to have had either linked/intend to link to care. Willcox JC, et al. suggest that the effectiveness of text-messaging can be enhanced when coupled with the use of other mediation strategies like links to YouTube videos and webpages (19). Given that in our study participants' face-to-face engagement with the study team ended once their details were recorded and they had received their HIVST, it is possible that some participants did not link to care because they did not completely. For future similar research, it may be advantageous to test whether responses increase if participants could access for example, a video which reiterates the explanations and guidance which they were given on recruitment. Noteworthy too, is that the wording of the SMS message had no impact on response rates. While data on the literacy of the participants and type of language preference were not collected, the impact of using English as the sole medium of communication for this study needs to be considered. In Venables E, et al.'s qualitative study exploring the effectiveness of using SMS communication in viral load mitigation, some patients revealed that receiving messages in English (as opposed to a local language) was problematic (20). Similarly, literacy levels of our study participants needed to be taken into account, since apart from English, participants' first language could well be any one of South Africa's other ten official languages. A study by Sineke T, et al. which focused on HIV knowledge among HIV positive patients in Johannesburg, concluded that HIV knowledge corresponds with English literacy levels (21).

The results indicate that there is a fair degree of acceptability in engaging with text message prompts to report HIV results as well as the intention to link to care. The value of using an mHealth platform like text messages is exemplified in a Ugandan study which found that the high acceptability and feasibility of using mHealth to track HIV positive youth who were lost to follow-up, resulted in the Ministry of Health endorsing mHealth as a strategy to support HIV care (22). Even though the participants of our study did demonstrate health-seeking behaviour, a number of them in fact either did not engage with the text messaging at all or partially engaged. One potential reason for this is that participants were probably sceptical about responding to the contact numbers used for prompting response. This is because the Viamo platform numbers used to prompt the participants were unfamiliar compared to locally used South African numbers. In addition, participants were unsure whether

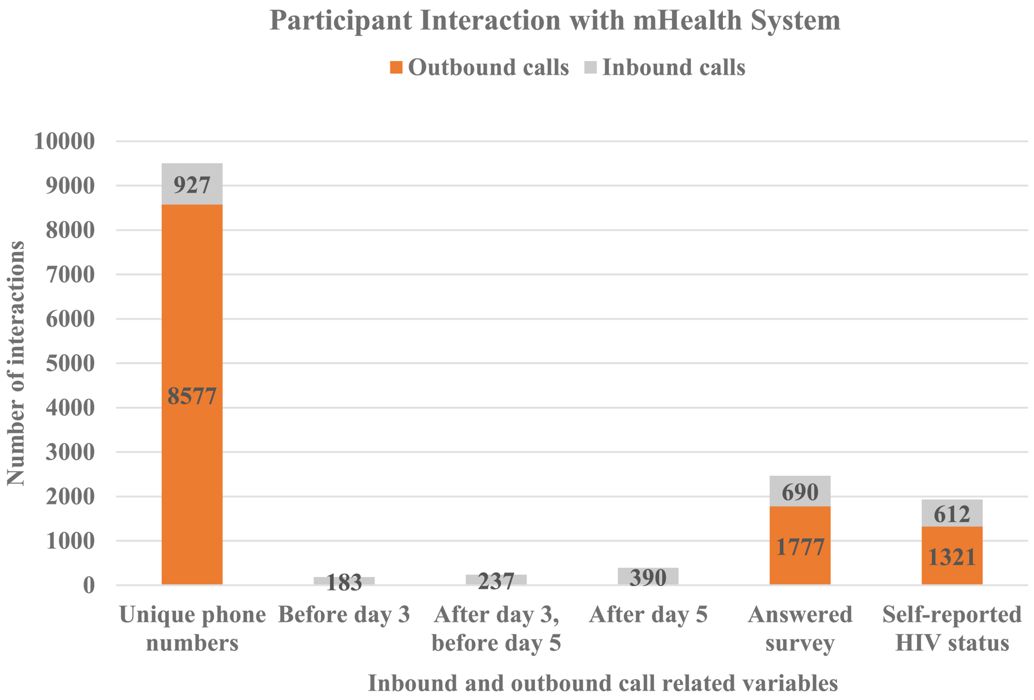

FIGURE 2
Participant survey response.

engaging in text messaging would come with incurred costs. Therefore, participants' hesitancy to use the provided numbers could have negatively impacted participants' willingness to respond.

Our study reported a larger number of participants who had tested positive for HIV responding to calls after seven days, compared to the number of those who tested positive calling in before seven days. This limited and delayed response of HIV positive testers using the mHealth services is similar to the findings in another study of HIV positive patients' behaviour on receiving SMS reminders to report to clinics for information about their viral loads (20). It was concluded that while SMS had the potential to reach large numbers of people quickly, it did not significantly affect the turnaround time for patients reporting to clinics. Furthermore, a concern that was raised in that study was that a reminder message that lacked detailed explanations could cause undue stress to the recipients, negatively impacting on their response time (20). This concern is significant in that it could point to a reason for the post-HIVST reaction time of participants in our investigation. It is possible that increased levels of stress and fear caused by HIV-positive readings and the perceived repercussions thereof, caused delays in reporting results. Other possible barriers to using the mHealth services, could be that in addition to being wary of the costs associated with using their mobile phones, participants also and/or had limited understanding of the expectations post-HIVST. These possibilities were corroborated in the conclusions of a recent similar South African study (23).

While the behavioural SMS messages intended to nudge engagement with the mHealth platform, data showed that they had no impact in doing so, indicating the opposite impact of behavioural messages on reporting that was recorded in a UK study (14). The limited effect documented in our study suggests that more simplistic and direct messaging could potentially yield better engagement in the South African setting. Also, the relatively high response rates from SMS prompts, regardless of the wording, indicate that the impact of sending any SMS message may be much greater than the wording of such messages. A study by Bidargaddi N, et al., found that the context of participants influenced when they were most responsive to prompts – for example, in some contexts, on weekends responsiveness increased within 24 h when prompts were sent around lunch time (24). Given that in South Africa such a range of contexts exists amongst its people, more studies should be conducted to assess the extent to which patterns related to time emerge (if at all) regarding both inbound and outbound responses across different groups, the results of which can inform further similar impact studies.

Unfortunately, technical issues with the mHealth system were experienced during the study such as the system delaying in sending messages in real time once the participant had been registered, therefore affecting user interaction with the platform. Amongst the other reasons, the system used different numbers to prompt the participants response therefore leading to reluctance in answering the call. Apart from potentially willing participants being unable to participate in the study as intended, technical difficulties have wider implications. Greve M, et al., explain that too few pilot mHealth projects in low-resource environments are able to progress to the sustainability stage, and this then hampers the development of healthcare interventions, essentially placing universal health coverage at risk (25). The aforementioned technical complications have also been identified by Mbunge E, et Al. in their review of the utilisation of mHealth in South Africa during the COVID-19 pandemic, and they encourage the revision of mHealth policies as well as political and fiscal investments into the sustainability of mHealth (26).

In their investigation of the design and value of mHealth platforms for HIV care, Marent B, et al. suggest that these platforms are most effectively used by people who already were aware of their HIV positive status (27). If this is indeed the case, further investigation needs to be conducted into why this is so in comparison to people who are unaware of their HIV status. The results thereof ought to be used to inform the development of mHealth programmes that are more feasible for sustained use by first-time testers.

There is clear evidence that SMS reminders and outgoing phone calls were acceptable and resulted in relatively high levels of HIVST result self-reporting. This study adds to the evidence that mHealth systems may have an important role in engaging and communicating with health system users. Nonetheless, an important concern is the financial implications for users of HIVST and mHealth services. Participants who did not receive prompts were willing to pay around ZAR 50–70 for the HIVST, whereas the large majority of those who were prompted selected the cheapest option – ZAR 10–50. This suggests that the cost of HIVST kits, if higher than ZAR 50 could be a deterrent to future uptake of HIVST in South Africa. Furthermore, one cannot out-rule the possibility that some participated in the study because they were given an HIVST for free and may in fact not be able to pay for other HIVST kits. This implies that governmental subsidies may be necessary to scale up and ensure high HIVST uptake.

Healthcare communication through mHealth platforms is increasing, with trends exacerbated by health system changes during the COVID-19 pandemic. This study evaluated a platform using a combination of short message service and voice call prompts to initiate HIV self-reporting and linkage to care around HIVST. For HIV self-reporting and linkage to care to be widespread and efficient, electronic health, also known as eHealth methods, can play a key role in the health system moving forward. Given the ubiquity of mobile phones, Mechael PN, as early as 2009, identified their value to mHealth in boosting communication and access to information (28). Lupton D, takes the idea of mHealth even further, in illustrating how with the inclusion of contemporary digital technology, mhealth has the ability to benefit not only patients, but societies and governments too (29). However, while the opportunities to exploit the mHealth, possibilities in providing healthcare are seemingly endless. There still remains questions around what conditions encourage and create the optimum usage of mHealth programmes and applications, in the self-reporting of HIV status and ensuing healthcare.

4.1. Strengths and weaknesses of the study

One strength of the study was that it targeted young men and women roughly equal in number and recruited a large number of participants using street-based recruitment in urban Gauteng Province; previous studies have struggled to engage men in HIVST distribution and results reporting (30). According to Chikovore's findings, men preferred traditional medicine and also that primary health care settings were not welcoming for them (reference).

A limitation of this study is that the system did not permit sharing of phone as the phone number of the participant was used as a unique identifier. Thus, there is a need to explore more improved mHealth systems that have a multiple-user function that caters for various user identities to engage with the system.

Using English as the sole medium of communication for this study posed a serious limitation as some patients revealed that receiving messages in English was problematic.

This study included a small number of people who responded to the questions and was limited to one study region (Gauteng, South Africa). Therefore, findings from this study may not be generalizable to other settings in South Africa, or to other country settings or larger populations.

5. Conclusion

HIVST empowers individuals to test and know their HIV status privately, safely, and easily. It has been driven to complement, not replace traditional HIV testing services to reach populations that are otherwise not testing. This study demonstrated that HIVST is feasible and acceptable to the target populations with uptake and acceptance of tests being very high.

Reporting results from HIVST distribution programmes remains one of the main barriers to wide-scale implementation and acceptance of this testing modality. Implementers need to weigh up the benefit of HIVST more easily reaching the target population against the downside of not having the patients actionable result immediately available. While self-reporting of results being inherently biased, is not a true reflection of the actual incidence rate, there still is value to be derived from this approach as it provides estimates of incidence and linkage into care.

Self-reporting HIVST results *via* an IVRS system positively impacted the response rate. The automated nature of the IVR system allowed for a consistent follow up across all tests distributed, irrespective of whether the survey was responded to. Patients drop off on IVRS calls as it progressed showed patient reluctance to spend more than a minute following prompts and answering survey questions, and this needs to be taken into consideration in the further development of this self-reporting mechanism. Furthermore, since behavioural SMSs were ineffective in increasing self-reporting, other factors like timing of calls need to be considered.

Overall, IVRS reporting of results in self-testing programmes is not ideal for HIVST programmes to overcome reporting problems. It should be offered as part of a bouquet of options to patients/clients to allow the end user to engage with a reporting tool of their choice, if at all. Further studies are needed to evaluate which self-reporting tools have the highest impact and effectiveness.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study was reviewed and approved by the Human Research Ethics Committee (HREC) of the University of the Witwatersrand (approval number 171113) and the Observational/Interventions Research Ethics Committee of the London School of Hygiene and Tropical Medicine (reference 14485). Participants were not reimbursed. The patients/participants provided their written informed consent to participate in this study.

Author contributions

MM and MQ conceived the idea. MPG and SG wrote the first draft of manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Marinda E, Simbayi L, Zuma K, Zungu N, Moyo S, Kondlo L, et al. Towards achieving the 90–90–90 HIV targets: results from the South African 2017 national HIV survey. *BMC Public Health*. (2020) 20(1):1375. doi: 10.1186/s12889-020-09457-z

2. Simbayi L, Zuma K, Zungu N, Moyo S, Marinda E, Jooste S, et al. *South African National HIV Prevalence, Incidence, Behaviour and Communication Survey, 2017: Towards achieving the UNAIDS 90-90-90 targets*. (2019). Available at: https://www.hsrcpress.ac.za/books/south-african-national-hiv-prevalence-incidence-behaviour-and-communication-survey-2017

3. UNAIDS and AIDSinfo. *Country factsheets: South Africa 2020 HIV and AIDS estimates*. Geneva: Unaids (2021).

4. Forsythe SS, McGreevey W, Whiteside A, Shah M, Cohen J, Hecht R, et al. Twenty years of antiretroviral therapy for people living with hiv: global costs, health achievements, economic benefits. *Health Aff*. (2019) 38(7):1163–72. doi: 10.1377/hlthaff.2018.05391

5. South African National Department of Health. National HIV self screening guidelines 2018. (2018). Available at: https://www.knowledgehub.org.za/system/files/elibdownloads/2021-03/HIVSSBook.pdf

6. World Health Organization. *Guidelines on HIV self-testing and partner notification. Supllement to consolidated guildelines on HIV testing services*. Geneva: World Health Organization (2016).

7. Majam M, Fischer AE, Rhagnath N, Msolomba V, Venter WDF, Mazzola L, et al. Performance assessment of four HIV self-test devices in South Africa: a cross-sectional study. *S Afr J Sci*. (2021) 117(1–2):7738. doi: 10.17159/SAJS.2021/7738

8. Johnson CC, Kennedy C, Fonner V, Siegfried N, Figueroa C, Dalal S, et al. Examining the effects of HIV self-testing compared to standard HIV testing services: a systematic review and meta-analysis. *J Int AIDS Soc*. (2017) 20(1):21594. doi: 10.7448/IAS.20.1.21594

9. Zhao Y, Zhu X, Pérez AE, Zhang W, Shi A, Zhang Z, et al. MHealth approach to promote oral HIV self-testing among men who have sex with men in China: a qualitative description. *BMC Public Health*. (2018) 18(1):1146. doi: 10.1186/s12889-018-6046-9

10. Hall AK, Cole-Lewis H, Bernhardt JM. Mobile text messaging for health: a systematic review of reviews. *Annu Rev Public Health*. (2015) 36:393–415. doi: 10.1146/annurev-publhealth-031914-122855

11. Finitsis DJ, Pellowski JA, Johnson BT. Text message intervention designs to promote adherence to antiretroviral therapy (ART): a meta-analysis of randomized controlled trials. *PLoS One*. (2014) 9(2):e88166. doi: 10.1371/journal.pone.0088166

12. Shet A, De Costa A, Kumarasamy N, Rodrigues R, Rewari BB, Ashorn P, et al. Effect of mobile telephone reminders on treatment outcome in HIV: evidence from a randomised controlled trial in India. *Br Med J*. (2014) 349:g5978. doi: 10.1136/bmj.g5978

13. Amankwaa I, Boateng D, Quansah DY, Akuoko CP, Evans C. Effectiveness of short message services and voice call interventions for antiretroviral therapy adherence and other outcomes: a systematic review and meta-analysis. *PLoS One*. (2018) 13(9):e0204091. doi: 10.1371/journal.pone.0204091

14. Parker MA, Ochalek TA, Rose GL, Badger GJ, Sigmon SC. Feasibility of an interactive voice response system for daily monitoring of illicit opioid use during buprenorphine treatment. *Psychol Addict Behav*. (2018) 32(8):956–60. doi: 10.1037/adb0000413

15. Brown LJ, Tan KS, Guerra LE, Naidoo CJ, Nardone A. Using behavioural insights to increase HIV self-sampling kit returns: a randomized controlled text message trial to improve England's HIV self-sampling service. *HIV Med*. (2018) 19 (9):585–96. doi: 10.1111/hiv.12634

16. Moore HA, Metcalf CA, Cassidy T, Hacking D, Shroufi A, Steele SJ, et al. Investigating the addition of oral HIV self-tests among populations with high testing coverage – do they add value? Lessons from a study in khayelitsha, South Africa. *PLoS One*. (2019) 14(5):e0240146. doi: 10.1371/journal.pone.0215454

17. Service O, Hallsworth M, Halpern D, Algate F, Gallagher R, Nguyen S, et al. *EAST Four simple ways to apply behavioural insights*. London: Nesta (2014).

18. Kigozi J, Jowett S, Lewis M, Barton P, Coast J. Estimating productivity costs using the friction cost approach in practice: a systematic review. *Eur J Heal Econ*. (2016) 17(1):31–44. doi: 10.1007/s10198-014-0652-y

19. Willcox JC, Dobson R, Whittaker R. Old-fashioned technology in the era of "bling": is there a future for text messaging in health care? *J Med Internet Res*. (2019) 21:e16630. doi: 10.2196/16630

20. Venables E, Ndlovu Z, Munyaradzi D, Martínez-Pérez G, Mbofana E, Nyika P, et al. Patient and health-care worker experiences of an HIV viral load intervention using SMS: a qualitative study. *PLoS One*. (2019) 14(4):e0215236. doi: 10.1371/journal.pone.0215236

21. Sineke T, Mokhele I, Langa J, Mngoma B, Onoya D. HIV And ART related knowledge among newly diagnosed patients with HIV under the universal-test-and-treat (UTT) policy in Johannesburg, South Africa. *AIDS Care Psychol Socio-Medical Asp AIDS/HIV*. (2022) 34(5):655–62. doi: 10.1080/09540121.2021.1902927

22. Izudi J, Mugenyi J, Mugabekazi M, Muwanika B, Tumukunde Spector V, Katawera A, et al. Retention of HIV-positive adolescents in care: a quality improvement intervention in mid-western Uganda. *Biomed Res Int*. (2018) 2018:1524016. doi: 10.1155/2018/1524016

23. Fischer AE, Phatsoane M, Majam M, Shankland L, Abrahams M, Rhagnath N, et al. Uptake of the ithaka mobile application in Johannesburg, South Africa, for human immunodeficiency virus self-testing result reporting. *South Afr J HIV Med*. (2021) 22(1):1197. doi: 10.4102/SAJHIVMED.V22I1.1197

24. Bidargaddi N, Almirall D, Murphy S, Nahum-Shani I, Kovalcik M, Pituch T, et al. To prompt or not to prompt? A microrandomized trial of time-varying push notifications to increase proximal engagement with a mobile health app. *JMIR mHealth uHealth*. (2018) 6(11):e10123. doi: 10.2196/10123

25. Greve M, Brendel AB, van Osten N, Kolbe LM. Overcoming the barriers of mobile health that hamper sustainability in low-resource environments. *J Public Heal*. (2022) 30(1):49–62. doi: 10.1007/s10389-021-01536-8

26. Mbunge E, Batani J, Gaobotse G, Muchemwa B. Virtual healthcare services and digital health technologies deployed during coronavirus disease 2019 (COVID-19) pandemic in South Africa: a systematic review. *Global Health J*. (2022) 6:102–113. doi: 10.1016/j.glohj.2022.03.001

27. Marent B, Henwood F, Darking M, Leon A, West B, Lockhart D, et al. Development of an mHealth platform for HIV care: gathering user perspectives through co-design workshops and interviews. *JMIR mHealth uHealth*. (2018) 6(10): e184. doi: 10.2196/mhealth.9856

28. Mechael PN. The case for mHealth in developing countries. Innov technol governance. *Glob*. (2009) 4(1):103–118. doi: 10.1162/itgg.2009.4.1.103

29. Lupton D. M-health and health promotion: the digital cyborg and surveillance society. *Soc Theory Heal*. (2012) 10(3):229–244. doi: 10.1057/sth.2012.6

30. Chikovore J, Gillespie N, McGrath N, Orne-Gliemann J, Zuma T. Men, masculinity, and engagement with treatment as prevention in KwaZulu-natal, South Africa. *AIDS Care Psychol Socio-Medical Asp AIDS/HIV*. (2016) 28:74–82. doi: 10.1080/09540121.2016.1178953

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Addressing coloniality of power to improve HIV care in South Africa and other LMIC

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We describe the appropriateness and potential for effectiveness of three strategic approaches for improving HIV care in South Africa: community-based primary healthcare, local/community-based stakeholder engagement, and community-engaged research. At their core, these approaches are related to overcoming health inequity and inequality resulting from coloniality of power's heterogenous structural processes impacting health care in many low- and middle-income countries (LMIC). We turn to South Africa, a middle-income country, as an example. There the HIV epidemic began in the 1980s and its ending is as elusive as achieving universal healthcare. Despite impressive achievements such as the antiretroviral treatment program (the largest in the world) and the country's outstanding cadre of HIV experts, healthcare workers and leaders, disadvantaged South Africans continue to experience disproportionate rates of HIV transmission. Innovation in global public health must prioritize overcoming the coloniality of power in LMIC, effected through the imposition of development and healthcare models conceived in high-income countries (HIC) and insufficient investment to address social determinants of health. We advocate for a paradigm shift in global health structures and financing to effectively respond to the HIV pandemic in LMIC. We propose ethically responsive, local/community-based stakeholder engagement as a key conceptual approach and strategy to improve HIV care in South Africa and elsewhere. We join in solidarity with local/community-based stakeholders' longstanding efforts and call upon others to change the current status quo characterized by global public health power concentrated in HIC.

KEYWORDS
HIV care, community-based stakeholder engagement, community-engaged research, South Africa, coloniality of power, care integration, LMIC, implementation science

Introduction

The 1978 Global Conference on Primary Health Care (PHC) produced the Alma-Ata Declaration on achieving health for all by the year 2000. Forty years later, the Astana Declaration reaffirmed commitment to this goal, while renewing attention to the persistence of health inequalities and the unfulfilled need to implement the core principles of Alma-Ata. The Astana Declaration also called attention to PHC as critical in achieving health-related targets of the Sustainable Development Goals (SDG), which were adopted in 2015 by the United Nations General Assembly. The SDG include ending the HIV/AIDS epidemic by 2030 (SDG3 Target 3.3) and achieving universal health coverage (UHC) for all (SDG3 Target 3.8) (1).

Alma-Ata's central goal of "health for all" was the product of a global shift in political and social order connected to Western European colonial rule ending globally, especially in Africa. This shift brought to the forefront the devastating impact of former colonial rule and post-colonial relations on the health of oppressed, colonized populations, and the urgent need to address health inequalities produced by colonization. Under colonial rule, major disruptions in traditional community structures left indigenous populations without the economic and social support necessary to confront devastating endemic infectious diseases (e.g., malaria), new epidemics were unleashed from external sources (e.g., 1918 influenza pandemic), and large numbers of displaced individuals and famine contributed to periodic epidemics of local pathogens (e.g., African trypanosomiasis) (2–4). Very limited health services were concentrated in large cities where the minority of local populations resided, and mostly focused on interrupting transmission of infection. The treatment of disease among local indigenous populations was neglected, subsequently stigmatizing them by characterizing them as threats to public health and security (5, 6). These historical factors led to healthcare deserts and social determinants that predisposed further disparities.

The concept of *coloniality of power* was developed by Peruvian sociologist Aníbal Quijano during the latter part of the 20th century (7). It is defined as "a conceptual apparatus to apprehend the racial, political economic, social, epistemological, linguistic and gendered hierarchical orders imposed by European colonialism that transcended "decolonization" and continue to oppress in accordance with the needs of pan-capital (i.e., economic and cultural/symbolic) accumulation" (8). Globally, the 1980s saw international aid and development initiatives dominated by neo-liberal macro-economic and social policies. Structural adjustment programs were implemented which accentuated rather than reduced social inequality and inequity in low- and middle-income countries (LMIC). Austerity measures, aimed at reducing budget deficits through devaluing local currency and cutting public spending, particularly impacted health systems and social care programs, which became default areas for requisite cuts. Neo-liberal approaches brought new forms of oppression and consolidated the coloniality of power in the neo-colonial era. Resulting socioeconomic conditions and structural violence proved favorable to the spread of the human immunodeficiency virus (HIV) in LMIC, particularly in Southern Africa and especially in Botswana, Eswatini, and South Africa.

Leveraging our experience in medical anthropology and biomedicine to address biosocial aspects of the HIV epidemic in South Africa, we describe key HIV care challenges in neo-colonial LMIC; impacts of coloniality of power in South Africa's health system; and three strategic approaches with potential for improving HIV care in South Africa and addressing coloniality of power: community-based PHC (health system level), local/community-based stakeholder engagement (civil society level), and community-engaged research (CEnR) (global health implementation level). Given its prominence in the global health stage and our professional experience in the country, we chose South Africa as an example of HIV public healthcare in post-colonial LMIC. In our discussion and conclusion, we propose coloniality of power as an overarching conceptual framework to advocate for increased critical reflexivity and action to address the coloniality of global health interventions among powerful global health stakeholders/funders. We also advocate for using stakeholder engagement (SE) as a key conceptual strategy for effective and sustainable HIV care improvement in post-colonial contexts.

HIV care in neo-colonial LMIC

LMIC consistently need to address the multiple challenges that impact population health: prioritization of health problems; supply of and access to goods, services, and human resources; and areas of research and investments pursued. Colonialism and globalization have appropriated resources and exploited labor in poor countries, and low wages, economic precarity, and poor living conditions all influence people's vulnerability and capacity to prevent infection and diseases. Inequalities and sustained poverty influence when and where people seek and receive ongoing care and the quality of that care. The continued transmission of infectious diseases and the growing burden of non-communicable diseases (NCDs) in LMIC (9) reflect the inability of countries to address the underlying social and commercial determinants of disease (10, 11), resulting in continued vulnerabilities that place people at risk of different infections, including HIV.

The deepened and sustained health inequalities today make the driving principles of the Alma Ata declaration as relevant as they were in 1978. Wealthier post-colonial middle-income countries, as assessed by gross domestic product, in general have greater income inequality; South Africa is the most unequal country in the world. Marginalized and vulnerable populations, including persons with HIV (PWH), continue to be left behind and seen as the "target" populations of weak PHC efforts. Despite the important global successes of HIV interventions (in South Africa: 45% decrease in HIV incidence between 2010 and 2020, 7-fold increase in the percentage of PWH who are on antiretroviral treatment, and >65% reduction in HIV-associated mortality (12)), poorer, marginalized, and oppressed populations in LMIC (as well as in high income countries) continue to experience disproportionate rates of HIV transmission (13).

Demonstrating a Western technocratic worldview, the approach of higher-income countries to eradicating HIV is "Global North-centric, managerial, data-driven, and biotechnological" (14), often ignoring structural inequities. Global public health funders and technocrats have focused on measurable, discretely identifiable outcomes (e.g., disability-adjusted live years or DALYs) as a measure of impact, which has ultimately driven health investments but has fallen short of more comprehensive health benefits. To realize WHO's aim for UHC as the key catalyst for improving health equity, it is necessary to transition from HIV selective or targeted and vertical approaches to more integrated health system responses (15). In other words, we need to continue to move further away from one-sided technocratic intervention models targeting cost-effective, short-term results, to interventions that support democratic, integrated, long-term approaches within sustainable healthcare systems. The integration of single disease health programs at the PHC level will empower countries to provide holistic healthcare.

Intertwined structural and institutional shortcomings in South African healthcare

South Africa, an upper middle-income country (per World Bank 2022–2023 classification), provides an example of coloniality of power resulting in intertwined structural and institutional shortcomings. Under the apartheid system (1948–1993), which strengthened the racial segregation begun under colonial rule, the South African health system was characterized by racism and geographic disparities, fragmentation, duplication, and disproportioned focus on tertiary care while deprioritizing PHC (16). Challenges in delivering quality care persist in the post-apartheid era despite strong protection provided by the 1996 South African Constitution for the rights of all citizens and residents to access quality healthcare.

Presently South Africa deals with an extraordinary burden of disease and critical health system vulnerabilities. This includes a dual HIV and tuberculosis (TB) epidemic "(about 17% of global burden), high maternal and child mortality (about 1% of global burden), high levels of violence and injuries (about 1.3% of global burden) and increasing NCDs (about 1% of global burden)" (17). Public health system vulnerabilities include its aging and frail infrastructure, a substantial shortage of staff and resources, unequal distribution of resources, management and leadership crisis, negative staff attitudes, long waiting times, unclean facilities, medicine stock-outs, insufficient infection control, compromised safety and security of both staff and patients, pull and push factors, and slow healthcare system restructuring (18, 19). In this context, the health system's capacity to appropriately support and manage multiple health programs (e.g., integrated healthcare) at the PHC level is limited, particularly in marginalized and rural areas (20).

South African health policy has attempted to counter the impact of coloniality of power on the system. The 1996 "Integration of Services Policy" aimed to make PHC services more accessible and improve the efficiency of health service delivery through an integrated care model. The goal of integration remains elusive, however, while the need for equality on access to healthcare continues to be pressing with a 27% unemployment rate and 80% of 55 million South Africans relying on the public sector for healthcare (21). Recently, the National Health Insurance (NHI) initiative was launched to reduce inequalities by improving access and quality of care for all through expanded coverage. It remains unclear whether the NHI initiative will be able to overcome health system challenges and eventually achieve the goal of UHC. Presently, South Africa continues to strive toward services integration given SDG policy (22) and compelling evidence from the experience of integrating TB and HIV services, which has resulted in the reduction in HIV and TB-associated mortality and morbidity (23).

Three strategies to support South Africa's care integration

We propose local/community-based SE, Community-based PHC, and CEnR as complementary strategies for the effective and sustainable integration of health services and improvements in HIV care. Adopted as an implementation strategy by the 1996 Integration of Services Policy, community-based PHC already uses local/community-based SE. The synergy between these two strategies could be furthered by using CEnR to design, deliver, and evaluate health services. This triad can address coloniality of power in healthcare by effectively promoting a democratic, less hierarchical approach to key health interventions such as care integration. Below we define and describe each of these strategies, starting with the one we consider to be indispensable in healthcare services and research: local/community-based SE.

Local/community-based stakeholder engagement

In healthcare SE plays key roles as an *ethical approach to* and a *methodological strategy for* HIV care research and improvement and for care integration. We define stakeholder as any person or group of persons "who is responsible for or affected by health- and healthcare-related decisions that can be informed by research evidence" (24). Stakeholders are diverse, and may include patients, government health officials, local and international health experts and researchers, health activists, community engagement leaders from health non-profit sector, traditional health practitioners, and community health workers.

We understand SE in healthcare as the involvement of people who have a stake in health, those affected by or those who can affect decisions informed by research evidence. SE involves multiple communities and people in different intersecting positions of power, and comprehensive SE can successfully help to leverage local resources and community support of programs while addressing concerns related to agency, needs, and trust of the people receiving healthcare. Health ethicists have also argued that SE is a necessary component of global health and HIV research seeking health equity (25) and that ethical goals of engagement should include a) generating research topics and questions that reflect communities' needs, and b) promoting research translation into tangible benefits to communities (26).

Our approach to SE in this article is localized since effective community engagement (CE) is shaped by local conditions and culture (27, 28). We use "local" when referring to SE to denote stakeholders who are based in the same country (or region in some contexts) where the community of interest is located (i.e., civil society), as opposed to other possible stakeholders who may be outsiders to the country or region. Community-based stakeholders are local and based in the community of interest (i.e., people at the grassroots within communities), while local stakeholders do not need to be grassroot.

Different types of theoretical frameworks or approaches have been used to advance SE, usually falling in two general rationales or "meta-narratives." A *health services* or *utilitarian perspective* understands SE as a tool to achieve more acceptable and appropriate health interventions, while the *social justice perspective* emphasizes empowerment and development of communities (29). In practice, the utilitarian and social justice rationales often merge, providing a balance between the interests of the public health stakeholders and communities.

SE is beneficial to health interventions and possibly necessary for achieving and sustaining health equity (29–31). In the context of LMIC, a 2017 review of systematic reviews on "the effectiveness of community engagement and participation approaches in LMIC" found moderate to limited strength evidence of these approaches being viewed as important in LMIC healthcare settings and playing a role in successful health intervention delivery (32). This review also found that achieving community ownership and empowerment greatly impacts on sustainability of engagement and participation (32). Although the strength of the effectiveness of CE evidence in this review was "moderate to limited," and despite the lack of a more coherent body of evidence about the nature of CE and its contributions to performance of science programs in LMIC (33), CE appears to be decisive in improving performance of some science programs (34).

Interactions between global public health programs and stakeholders include securing access and permission, seeking cooperation and collaboration, fulfilling regulatory and ethical requirements, and shaping research strategies and the translations of their findings into policy or practice (34). However, these interactions can often be "motivated disproportionately by the interests and goals of the scientific programs and less by the need to elicit and understand their implications for stakeholders" (34). Researchers argue that more support is needed from funders, technocrats, and health system leadership to transcend from limited engagement that informs and/or consults with local stakeholders (seen often as tokenism), to a mode of engagement that enables and promotes higher levels of participation (involvement, collaboration, and empowerment levels) (35, 36), with potentially higher effectiveness and sustainability (29).

Community-based primary health care

The community-based PHC model plays a key role in care integration in South Africa. The National Health Act 61 of 2003 formalized local community participation in PHC by mandating the establishment of health committees at all PHC facilities (37). However, this strategy has limitations due to inadequate provision of responsibility and authority and the lack of capacity support to the health committees linked to clinics (38).

The effectiveness of community-based PHC in Africa is tied to political commitment to and inclusion of Community-Oriented Primary Care (COPC) in policy (39). The COPC approach (a variation of Community-based PHC guided by data gathered within the community) was pioneered in 1940s rural South Africa and enabled the strong integration of primary health, community medicine, and CE. Care integration has been key in re-engineering South Africa's UHC and PHC strategies (40), and is perceived as compatible with Community-based PHC.

Integration of HIV, TB, and PHC in South Africa has been welcomed, with comprehensive case management, better client-nurse interactions, and reduced stigma all perceived as benefits of integration by stakeholders, notwithstanding challenges in terms of staff workloads and waiting times (20). One South African study showed that community health workers "managed to easily move from a HIV/TB focus to providing a comprehensive range of services across health and social conditions" (40). Although limited information is available to understand community involvement in priority setting, planning and decision-making in development and implementation of services, stakeholder participation in PHC has emerged as of great importance to realize UHC and the NHI (38).

Community engaged research

CEnR is the umbrella term used for many different participatory approaches and methodologies, covering a spectrum of research approaches driven by the level of community inclusion and engagement, including community-based participatory research (CBPR) – the most cited approach (41).The origins of CEnR in Western academia date back to the 1940s with Kurt Lewin (northern tradition) and later Paulo Freire and Orlando Fals Borda (both representing the southern tradition) (42). CEnR has been recognized as key in all aspects of the process needed for developing and implementing programs and interventions in health (38) and to overcome health disparities (43). Yet, the historical structures and processes of academic health centers, including complexities of review boards operation, accounting practices and indirect funding policies, and tenure and promotion path, are a major barrier toward a translational CEnR agenda (43).

Longstanding partnerships between academia and communities impacted by HIV have paved the way for CEnR in HIV (44). In South Africa, CEnR has been a logical approach given the country's history of anti-apartheid activism and participatory ethos of political change, with many communities embracing participatory principles of collective action and mobilization (45). "Training for Transformation" is an example of a critical pedagogy participatory research methodology developed in the anti-apartheid context (46). There have been a significant number of HIV studies using participatory approaches and methodologies in South Africa in the past decade, addressing issues such as inequality and cultural differences, HIV drug adherence, welfare plans, and reduced HIV incidence (47–50). Nonetheless, barriers to the implementation of CBPR and good participatory practices continue and the extent of participation is highly variable, causing CEnR to be "often partially or incompletely implemented" (44).

Discussion and conclusion

Related healthcare integration efforts in South Africa show some degree of effectiveness and ample acceptance among stakeholders, as well as the importance of broad base SE. Regarding Community-based PHC, a sub-Saharan Africa review found that community healthcare workers are providing a variety of important services to community-based HIV care, despite challenges related to training, resources, and supervision (51). The engagement of local/community-based stakeholders has also been consistently identified as beneficial in health interventions, with a continental-level analysis identifying the need for broad base and multisectoral stakeholder consultation for effective development of human resources for health strategic plans (52).

The future: endemic HIV, integrated healthcare, and epistemic freedom

Community-based health hinges on the input, expertise, and labor of community members. To achieve healthcare system improvement and equitable access to healthcare for PWH and all community members, meaningful, generalized, and sustainable SE, including of community-based stakeholders, is necessary. Biomedical research and implementation science cannot have a fully effective or sustainable impact on clinical outcomes, programmatic development, or public health measures without authentic CE. Too often scientists address concerns that are irrelevant to the community or test solutions that were not developed in partnership with community-based and local stakeholders. These same scientists then find themselves confused as to why so many interventions fail in the real world.

Strong and broad SE is also key for HIV care improvement as the virus and disease transition to endemic status (15). Stakeholder involvement, particularly of community-based members and local health experts, needs to promote higher levels of participation, including involvement, collaboration and empowerment (29) and have the standing of an ethics requirement. This will support challenging the coloniality of power, which persists in global public health interventions and global health education in HIC (53). Increased, sustainable participation can uplift the “epistemic virtue” of local, community-based stakeholders by acknowledging and accepting the value of their knowledges and experiences (e.g., traditional and indigenous health knowledges (18)). In other words, truly inclusive SE would also support Ndlovu-Gatsheni’s (54) call for epistemic freedom in Africa.

Conclusion

To approach healthcare and end the HIV epidemic (SDG3) holistically, we need to move beyond single disease approaches to integrated healthcare and ethically responsive SE, with emphasis on local (non-external) and community-based (grassroots) actors. Despite progress (34), there is still critical need for a paradigm shift toward a horizontal approach in global health structures and financing (e.g., PEPFAR, Global Fund, National Institutes of Health, Gates Foundation) to effectively respond to future endemic HIV, emerging infectious diseases, and the continued high levels of communicable and non-communicable chronic diseases. Health programs that emphasize particular diseases and strategies run a continued risk of failing to reach goals as specific agendas are set aside as new challenges emerge. We see Community-based PHC and CEnR as effective, appropriate, and practical strategies that, in synergy with local/community-based SE, can produce tangible results such as local communities influencing “problem framings, program goals, and other key decisions” (55).

Innovation in global public health must address overcoming the coloniality of power in LMIC effected through the imposition of development and healthcare models conceived in HIC in the interest of pan-capital accumulation. We propose coloniality of power as a conceptual overarching framework and local/community-based SE as both a key *ethical approach to* and a *methodological strategy for* HIV care research and improvement. Some concrete innovation steps are including more leaders from LMIC in central, key decision-making roles in top global health structures, calling funders to fully cover costs and time of CE, and requiring rigorous evidence of appropriate local/community-based SE and CEnR as condition for funding and renewal.

We join in solidarity with community-based and local stakeholders’ efforts, and call upon others to change the current status quo characterized by global public health power concentrated in HIC.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding author.

Author contributions

CO conceived the article and wrote the first draft of the manuscript. LM and VM provided critical review and edited extensively. All authors contributed to the article and approved the submitted version.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frph.2023.1116813/full#supplementary-material.

References

1. United Nations. Transforming our World: The 2030 Agenda for Sustainable Development. United Nations; 2015. Available at: https://sdgs.un.org/sites/default/files/publications/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

2. Tilley H. Medicine, empires, and ethics in colonial Africa. *AMA J Ethics*. (2016) 18(7):743–53. doi: 10.1001/journalofethics.2016.18.7.mhst1-1607

3. Patterson KD, Pyle GF. The diffusion of influenza in sub-saharan Africa during the 1918-1919 pandemic. *Soc Sci Med*. (1983) 17(17):1299–307. doi: 10.1016/0277-9536(83)90022-9

4. Steverding D. The history of African trypanosomiasis. *Parasit Vectors*. (2008) 1(1):3. doi: 10.1186/1756-3305-1-3

5. Anne D. The medical history of South Africa: an overview. *History Compass*. (2008) 6:1194–210. doi: 10.1111/j.1478-0542.2008.00544.x

6. Packard RM. *A history of global health: Interventions into the lives of other peoples*. Baltimore: Johns Hopkins University Press (2016). 414.

7. Quijano A. Colonialidad y modernidad/racionalidad. *Perú Indígena*. (1992) 13 (No. 29):11–20. https://www.lavaca.org/wp-content/uploads/2016/04/quijano.pdf

8. Chigudu S. An ironic guide to colonialism in global health. *Lancet*. (2021) 397(10288):1874–5. doi: 10.1016/S0140-6736(21)01102-8

9. Agan BK, Marconi VC. Noncommunicable diseases: yet another challenge for human immunodeficiency virus treatment and care in sub-saharan Africa. *Clin Infect Dis*. (2019) 71(8):1874–6. doi: 10.1093/cid/ciz1104

10. Guerra G, Borde E, Salgado de Snyder VN. Measuring health inequities in low and middle income countries for the development of observatories on inequities and social determinants of health. *Int J Equity Health*. (2016) 15(1):9. doi: 10.1186/s12939-016-0297-9

11. Miranda JJ, Barrientos-Gutiérrez T, Corvalan C, Hyder AA, Lazo-Porras M, Oni T, et al. Understanding the rise of cardiometabolic diseases in low- and middle-income countries. *Nat Med*. (2019) 25(11):1667–79. doi: 10.1038/s41591-019-0644-7

12. Simelela N, Venter WDF, Pillay Y, Barron P. A political and social history of HIV in South Africa. *Curr HIV/AIDS Rep*. (2015) 12(2):256–61. doi: 10.1007/s11904-015-0259-7

13. UNAIDS. *Inequalities are blocking the end of the AIDS pandemic, say UN*. Geneva: Press Release. (2022). Available at: https://www.unaids.org/en/resources/presscentre/pressreleaseandstatementarchive/2022/november/20221129_dangerous-inequalities

14. Murray DAB. Introduction. In: DAB Murray, editor. *Living with HIV in post-crisis times: beyond the endgame*. Lanham, MD: Lexington Books (2021). p. 1–18.

15. Assefa Y, Gilks CF. Ending the epidemic of HIV/AIDS by 2030: will there be an endgame to HIV, or an endemic HIV requiring an integrated health systems response in many countries? *Int J Infect Dis*. (2020) 100:273–7. doi: 10.1016/j.ijid.2020.09.011

16. Sibiya MN, Gwele NS. A model for the integration of primary health-care services in the province of KwaZulu-natal, South Africa. *J Nurs Manag*. (2013) 21(2):387–95. doi: 10.1111/j.1365-2834.2012.01420.x

17. Malakoane B, Heunis JC, Chikobvu P, Kigozi NG, Kruger WH. Public health system challenges in the free state, South Africa: a situation appraisal to inform health system strengthening. *BMC Health Serv Res*. (2020) 20(1):58. doi: 10.1186/s12913-019-4862-y

18. Ordóñez CE. Coordination of medical pluralism in public HIV health care in South Africa: shifting to an alliance framework with traditional health practitioners. In: DAB Murray, editor. *Living with HIV in post-crisis times: beyond the endgame*. Lanham, MD: Lexington Books; (2021). p. 81–104.

19. Maphumulo WT, Bhengu BR. Challenges of quality improvement in the healthcare of South Africa post-apartheid: a critical review. *Curationis*. (2019) 42(1):1901. doi: 10.4102/curationis.v42i1.1901

20. Lince-Deroche N, Leuner R, Kgowedi S, Moolla A, Madlala S, Manganye P, et al. Voices from the front lines: a qualitative study of integration of HIV, tuberculosis, and primary healthcare services in Johannesburg, South Africa. *PLOS ONE*. (2020) 15(10):e0230849. doi: 10.1371/journal.pone.0230849

21. Sibiya N. Integrated care: a solution for South African healthcare. Science Forum South Africa Magazine, Department of Science, Republic of South Africa and Innovation and Media Torque and Events (Pty) Ltd. [Internet]. Annual 2019 Dec [cited 2023 Mar 6]; (2):47. Available from: https://www.yumpu.com/en/document/read/62953282/sfsa-2019

22. Lê G, Morgan R, Bestall J, Featherstone I, Veale T, Ensor T. Can service integration work for universal health coverage? Evidence from around the globe. *Health Policy*. (2016) 120(4):406–19. doi: 10.1016/j.healthpol.2016.02.007

23. Naidoo K, Gengiah S, Yende-Zuma N, Padayatchi N, Barker P, Nunn A, et al. Addressing challenges in scaling up TB and HIV treatment integration in rural primary healthcare clinics in South Africa (SUTHI): a cluster randomized controlled trial protocol. *Implement Sci*. (2017) 12(1):129. doi: 10.1186/s13012-017-0661-1

24. Magwood O, Riddle A, Petkovic J, Lytvyn L, Khabsa J, Atwere P, et al. PROTOCOL: barriers and facilitators to stakeholder engagement in health guideline development: a qualitative evidence synthesis. *Campbell Systematic Reviews*. (2022) 18(2):e1237. doi: 10.1002/cl2.1237

25. Wilkinson A, Slack C, Crews C, Singh N, Salzwedel J, Wassenaar D. How can research ethics committees help to strengthen stakeholder engagement in health research in South Africa? An evaluation of REC documents. *S Afr J Bioeth Law*. (2021) 14(1):6–10. doi: 10.7196/SAJBL.2021.v14i1.00698

26. Pratt B, de Vries J. Community engagement in global health research that advances health equity. *Bioethics*. (2018) 32(7):454–63. doi: 10.1111/bioe.12465

27. National Institute for Health and Care Research (NIHR) Evidence, Alerts Global Health [Internet]. (UK): NIHR. c2016-2022. Effective community engagement in global health research is shaped by local conditions and culture; 2022 Nov 18 [cited 2023 Mar 6]; Available from: https://evidence.nihr.ac.uk/alert/effective-community-engagement-global-health-research-local-conditions-and-culture/ doi: doi: 10.3310/nihrevidence_54739

28. Polidano K, Parton L, Agampodi SB, Agampodi TC, Haileselassie BH, Lalani JMG, et al. Community engagement in cutaneous leishmaniasis research in Brazil, Ethiopia, and Sri Lanka: a decolonial approach for global health. *Front Public Health*. (2022);10. doi: 10.3389/fpubh.2022.823844

29. Brunton G, Thomas J, O'Mara-Eves A, Jamal F, Oliver S, Kavanagh J. Narratives of community engagement: a systematic review-derived conceptual framework for public health interventions. *BMC Public Health*. (2017) 17(1):944. doi: 10.1186/s12889-017-4958-4

30. Hacker K, Tendulkar SA, Rideout C, Bhuiya N, Trinh-Shevrin C, Savage CP, et al. Community capacity building and sustainability: outcomes of community-based participatory research. *Prog Community Health Partnersh*. (2012) 6(3):349–60. doi: 10.1353/cpr.2012.0048

31. O'Mara-Eves A, Brunton G, Oliver S, Kavanagh J, Jamal F, Thomas J. The effectiveness of community engagement in public health interventions for disadvantaged groups: a meta-analysis. *BMC Public Health*. (2015) 15(1):129. doi: 10.1186/s12889-015-1352-y

32. Pilkington G, Panday S, Khatib M, Kotas E, Hill RA, Simkhada P, et al. The effectiveness of community engagement and participation approaches in low and middle income countries: a review of systematic reviews with particular reference to the countries of south Asia. London: EPPI Centre, Social Science Research Unit, Institute of Education, University of London; (2017).

33. Day S, Blumberg M, Vu T, Zhao Y, Rennie S, Tucker JD. Stakeholder engagement to inform HIV clinical trials: a systematic review of the evidence. *J Int AIDS Soc*. (2018) 21(Suppl 7):e25174. doi: 10.1002/jia2.25174

34. Lavery JV. Building an evidence base for stakeholder engagement. *Science*. (2018) 361(6402):554–6. doi: 10.1126/science.aat8429

35. Organizing Engagement, Models [Internet]. New England (US): Organizing Engagement; c2023. Spectrum of public participation; [date unknown, cited 2023 Mar 6]; Available from: https://organizingengagement.org/models/spectrum-of-public-participation/

36. Vaughn LM, Jacquez F. Participatory research methods—choice points in the research process. *JPRM*. (2020);1(1). doi: 10.35844/001c.13244

37. Haricharan HJ, Stuttaford M, London L. Effective and meaningful participation or limited participation? A study of South African health committee legislation. *Prim Health Care Res Dev*. (2021) 22:e28. doi: 10.1017/S1463423621000323

38. Hove J, D'Ambruoso L, Kahn K, Witter S, van der Merwe M, Mabetha D, et al. Lessons from community participation in primary health care and water resource governance in South Africa: a narrative review. *Glob Health Action*. (2022) 15 (1):2004730. doi: 10.1080/16549716.2021.2004730

39. Mash B, Ray S, Essuman A, Burgueño E. Community-orientated primary care: a scoping review of different models, and their effectiveness and feasibility in sub-saharan Africa. *BMJ Global Health*. (2019) 4(Suppl 8):e001489. doi: 10.1136/bmjgh-2019-001489

40. Thomas LS, Buch E, Pillay Y. An analysis of the services provided by community health workers within an urban district in South Africa: a key contribution towards universal access to care. *Hum Resour Health*. (2021) 19(1):22. doi: 10.1186/s12960-021-00565-4

41. Whitley C. Finding professional meaning in community-engaged work. Footnotes, A magazine of the American sociological association. *Winter*; (2022);50 (1). Available at: https://www.asanet.org/footnotes-article/finding-professional-meaning-community-engaged-work/

42. Macaulay AC. Participatory research: what is the history? Has the purpose changed? *Fam Pract*. (2017) 34(3):256–8. doi: 10.1093/fampra/cmw117

43. Michener L, Cook J, Ahmed SM, Yonas MA, Coyne-Beasley T, Aguilar-Gaxiola S. Aligning the goals of community-engaged research: why and how academic health centers can successfully engage with communities to improve health. *Acad Med*. (2012) 87(3):285. doi: 10.1097/ACM.0b013e3182441680

44. Karris MY, Dubé K, Moore AA. What lessons it might teach us? Community engagement in HIV research. *Curr Opin HIV AIDS*. (2020) 15(2):142. doi: 10.1097/COH.0000000000000605

45. Mosavel M, Simon C, van Stade D, Buchbinder M. Community-based participatory research (CBPR) in South Africa: engaging multiple constituents to shape the research question. *Soc Sci Med*. (2005) 61(12):2577–87. doi: 10.1016/j.socscimed.2005.04.041

46. Hope A, Timmel S, editors. Training for transformation in practice. Vol. 14. Rugby, England: Practical Action Publishing; (2014). 166 pp. ISBN: 978-1-85339-832-2

47. de Wet A, Swartz L, Kagee A, Lesch A, Kafaar Z, Hassan NR, et al. The trouble with difference: challenging and reproducing inequality in a biomedical HIV research community engagement process. *Glob Public Health*. (2020) 15(1):22–30. doi: 10.1080/17441692.2019.1639209

48. Treffry-Goatley A, Lessells RJ, Moletsane R, de Oliveira T, Gaede B. Community engagement with HIV drug adherence in rural South Africa: a transdisciplinary approach. *Med Humanit*. (2018) 44(4):239–46. doi: 10.1136/medhum-2018-011474

49. Beard J, Skalicky A, Nkosi B, Zhuwau T, Cakwe M, Simon J, et al. Challenges of developing a district child welfare plan in South Africa: lessons from a community-engaged HIV/AIDS research project. *Glob Health Promot*. (2020) 27(2):6–16. doi: 10.1177/1757975918774569

50. Lippman SA, Leddy AM, Neilands TB, Ahern J, MacPhail C, Wagner RG, et al. Village community mobilization is associated with reduced HIV incidence in young South African women participating in the HPTN 068 study cohort. *J Int AIDS Soc*. (2018) 21(Suppl 7):e25182. doi: 10.1002/jia2.25182

51. Ngcobo S, Scheepers S, Mbatha N, Grobler E, Rossouw T. Roles, barriers, and recommendations for community health workers providing community-based HIV care in sub-saharan Africa: a review. *AIDS Patient Care STDS*. (2022) 36(4):130–44. doi: 10.1089/apc.2022.0020

52. Nyoni J, Christmals CD, Asamani JA, Illou MMA, Okoroafor S, Nabyonga-Orem J, et al. The process of developing health workforce strategic plans in Africa: a document analysis. *BMJ Global Health*. (2022) 7(Suppl 1):e008418. doi: 10.1136/bmjgh-2021-008418

53. Gichane MW, Wallace DD. Dismantling and reimagining global health education. *Glob Health Action*. (2022) 15(1):2131967. doi: 10.1080/16549716.2022.2131967

54. Ndlovu-Gatsheni SJ. *Epistemic freedom in Africa: deprovincialization and decolonization*. London: Routledge (2018). 255.

55. Delborne J, Kokotovich A, Barnhill-Dilling SK. Engaging community with humility. *Science*. (2018) 362(6414):532–3. doi: 10.1126/science.aav4987

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The South African community pharmacy sector—an untapped reservoir for delivering HIV services

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Differentiated service delivery is recommended to improve the uptake of HIV testing and treatment for people living with HIV. One service delivery option yet to be fully capitalised on is community pharmacies. There are approximately 3,580 registered community pharmacies in South Africa. A total of 1,110 (31%) of these pharmacies are corporate chain pharmacies located in cities and towns, the remainder are individually owned, many of which are in less populated poorer settings. Community pharmacies traditionally play a pivotal role in providing health education to the populations they serve and are the first point of contact for people seeking health services, offering more convenient opening hours and shorter waiting times than public sector clinics or private doctors. As a result, patients regularly seek a variety of sexual and reproductive health services at community pharmacies such as self-testing devices for HIV, treatment for sexually transmitted diseases, and an array of reproductive health services, spanning emergency contraception to fertility advice, often signifying HIV risk. This has presented an opportunity for community pharmacies to provide access to HIV prevention and treatment to ensure the targets for HIV services set by international agencies and local government are achieved. Despite obstacles experienced with the expansion of the community pharmacist's role, exploring the potential of pharmacies to mediate the existing challenges with HIV service delivery has emerged as an important resource. Assessing the South African communities' specific HIV treatment needs and willingness to access HIV services from community pharmacies will benefit from additional research.

KEYWORDS
antiretroviral therapy, pre-exposure prophylaxis, post exposure prophylaxis, PIMART, primary care drug therapy

1. Introduction

Although there has been international commitment to achieving the Joint United Nations Programme on HIV/AIDS (UNAIDS) goals, considerable work needs to be done to ensure the 95-95-95 targets for HIV services are met by the year 2025. By the end of 2021, 85% of people living with HIV (PLHIV) knew their status, of these, 75% were accessing antiretroviral therapy (ART), and 68% of PLHIV were virally suppressed (1). In sub Saharan countries generally, there are various reasons (socio-economic, contextual and behavioural) for the lag in reaching the 2025 targets (2). South Africa in particular has the largest HIV programme in the world with an estimated 74% of PLHIV on ART; however, more than 2 million South Africans who are HIV positive are not on ART (1). Despite the significant gains South Africa has made in providing access to HIV testing and treatment, gender inequality in accessing HIV services, geographical factors, and socio-economic factors could delay the achievement of the 95-95-95 targets by 2025 (3). To galvanise engagement in HIV testing and treatment as well as to reach underserved and hard to reach populations, the authentic experience of HIV susceptible populations and PLHIV needs to be addressed (4). One way of doing this is through differentiated service delivery (DSD).

The World Health Organization advocates DSD to support the cascade of care for PLHIV as well as those who are vulnerable to infection (5). This approach envisions optimising HIV care particularly for patients in low income countries as well as providing a more individualised service to HIV patients (6), in a manner that minimises strain on health systems. In the *Decision Framework for Antiretroviral Therapy Delivery*, the out-of-facility individual model promotes the use of spaces beyond the traditional hospital or clinic facilities. One such alternative space is the community pharmacy (7).

Globally, community pharmacy operations and offerings differ. In South Africa, community pharmacies retail both prescription and over-the-counter medication in addition to providing health advice. Ilardo ML and Speciale A (2020) explain that community pharmacists' services are "relatively under-utilised" and this is largely due to the public perception of them as retailers and their exclusion in healthcare policies. Notwithstanding these factors that undermine the profession, the community pharmacist apart from dispensing medicine can also serve as an educator and facilitate treatment adherence (8). A recent systematic review of studies conducted across the world, indicated that interventions driven by community pharmacists have indeed led to a boost in adherence and patients' ability to manage chronic conditions such as hypertension and asthma (9). Another study which surveyed health professionals in rural Australia also concluded that a large majority (73%) of health professionals advocated for expanded healthcare services to be delivered through community pharmacies. Upon comparing professional groups in this study, doctors were only half as supportive, citing fears that community pharmacists lacked the specific expertise required to provide accurate diagnoses and medical advice, although no evidence was supplied to validate their concerns (10).

Community pharmacies often provide extended services and convenience, when compared to other health facility offerings, especially primary care clinics, with many countries reporting growing patient acceptance of community pharmacies' role in providing care (11). The increasing acceptability of community pharmacies is critical in the South African context, where, despite the advances that South Africa has made in the identification and treatment of HIV, further attainment of treatment and prevention targets are hampered because over-burdened primary clinic facilities are unable to meet patients' healthcare needs (12). Community pharmacies in South Africa can provide routine HIV testing and treatment services to alleviate some of the public health facilities' constraints and service delivery barriers such as extended waiting times, high patient to healthcare worker ratios, and the dependence on healthcare personnel in clinics and hospitals (13). Furthermore, community pharmacies are not stigmatised and are frequented by many of the harder to reach population groups such as men and young women (14, 15).

2. Proliferation of community pharmacies

The ownership of community pharmacies in South Africa was historically restricted to registered pharmacists. However, in 2003 regulations opened the ownership of community pharmacies to lay persons under the direct supervision of a responsible pharmacist, fuelling the emergence of corporate community pharmacy chains, and subsequent expansion in the number of pharmacies (16–18).

According to the 2021 South African Pharmacy Council (SAPC) records, approximately 3,580 community pharmacies are registered in South Africa. These pharmacies have multiple urban and rural locations. The geographical distribution of these community pharmacies is aligned with population occupancy and economic contribution—in other words, there is a greater number of pharmacies in more populous areas and in those which have more robust economies (19–21). This implies that rural areas which are generally poorer and have smaller populations have not seen the same expansion in pharmacies in comparison to urban settings. This trend is also identified by Moodley and Suleman (18), and further illustrated in **Figure 1**, where the total number of community pharmacies is highest in Gauteng, the most populous province (22) and lowest in Northern Cape, the province with the smallest population (22).

Approximately 1,253 (35%) of the registered community pharmacies are located in Gauteng Province. Furthermore, around 1,110 (31%) of community pharmacies are corporate pharmacies and the balance are independently owned. The proportion of corporate versus independent community pharmacies is highest in Gauteng (40% vs. 33%) and Western Cape (21% vs. 11%). The converse is true for the other seven provinces which have a higher proportion of independently owned community pharmacies. An estimated 40% of independent community pharmacies are in rural underserviced communities (23).

The number of community-based pharmacies is steadily increasing in South Africa. In 2020 and 2021 alone 648 new community pharmacies were opened in South Africa and the possibility of increasing healthcare services to the wider population via these pharmacies looks promising. The major corporate chain pharmacies in South Africa currently are Clicks and Dis-Chem pharmacies with 618 and 183 pharmacies respectively nationwide (24, 25). Due to their huge revenues, both Dis-Chem (operating profit of ZAR1.5 billion in 2022) and Clicks (operating profit of ZAR3.3 billion in 2022), have further growth strategies to increase their networks countrywide.

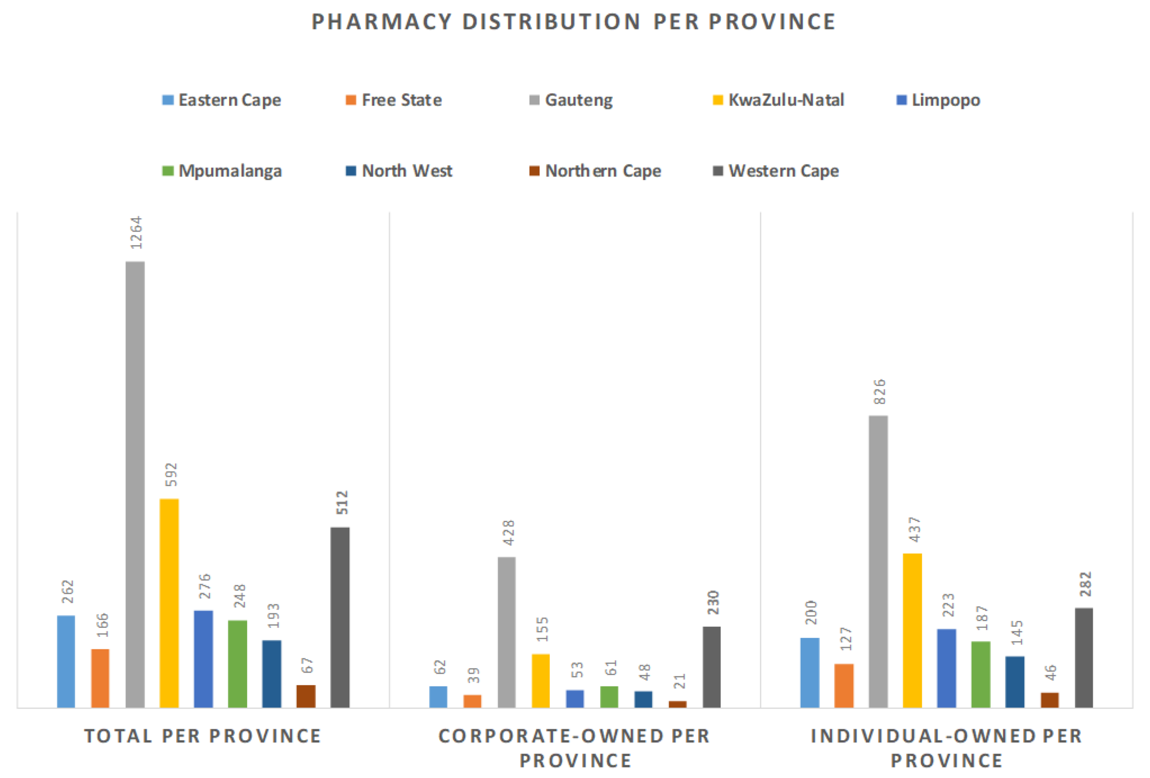

FIGURE 1
Pharmacy distribution per province in South Africa.

Notwithstanding their expansion, one drawback particularly for the growth and sustainability of independent pharmacies is the lack of uniformity regarding co-payment amounts for medically insured customers (26). To prevent the collusion of corporate pharmacies and medical aids in implementing designated service providers (DSPs) which resulted in patients paying heavy co-payments at pharmacies outside the DSPs, the Council for Medical Schemes published regulations which declared these business practices undesirable (27). While, initially, this has tremendously assisted independent pharmacies to continue operating in underserviced areas, the regulations are being held in abeyance until the matter is heard by the appeal committee (23).

3. Expanding the role of the community pharmacist

Gray et al., 2019 claim that the pharmaceutical profession is evolving from primarily dispensing and compounding to a more patient orientated primary healthcare provider role (17). Pharmacists and pharmacy based nurses already perform immunizations and screen for a substantial number of conditions including but not limited to hypertension, diabetes, HIV and cholesterol (15). A survey of a group of South African pharmacists showed that while pharmacists were willing to expand their professional services, this extension of services would need to be accompanied by upskilling (28).

There are some pathways available to pharmacists wishing to upskill and expand their professional services. As per the regulations relating to the scope of practise of pharmacy (29) pharmacists can complete primary care drug therapy (PCDT) supplementary training offered by several tertiary institutions. The training which was first introduced as early as the 1990’s, aims to equip pharmacists with the necessary skills for comprehensive patient management at primary care level. Upon successful completion of the training, a PCDT pharmacist is granted a Section 22A(15) permit by the Director General of Health which will authorise the pharmacist to diagnose, prescribe and administer medicine for selected conditions in line with primary healthcare level standard treatment guidelines and the essential medicine list. Such conditions include management of chronic conditions such as hypertension and diabetes as well as prescription of antiretroviral post exposure prophylaxis (PEP) to health workers. Currently this list does not include the management of ART.

In 2018, pharmacy interest groups, representing the independent pharmacy groups and the corporates, approached the Southern African HIV Clinicians Society (SAHCS), a large well-respected professional group responsible for local treatment guidelines and advocacy, for guidance on how they could support the prescription of antiretroviral medication through pharmacies. SAHCS subsequently developed a Pharmacy Initiated Management of Antiretroviral Therapy (PIMART) short course for pharmacists and pharmacy-based nurses with the guidance of infectious diseases specialists. The PIMART course which was approved by the SAPC in June 2020, allows appropriately trained pharmacists and nurses working within their pharmacies, to prescribe antiretrovirals as pre-exposure and post exposure prophylaxis, and for treatment, according to a set of adapted Department of Health guidelines, with clear referral pathways. Pharmacists and pharmacy based nurses who have completed the course are currently awaiting approval of Section 22A(15) permits by the Director General of Health which will authorise them to initiate and manage patients on ART. The expansion of the role of the community pharmacist in providing access to ART could see an improvement in HIV testing, prevention and treatment in South Africa.

4. Community pharmacies as a potential platform for HIV products and services

Pharmacies in low- and middle-income countries are often the first point of contact with the healthcare system and the most consulted health-care providers (30–33). The increased number of community pharmacies bodes well for South Africa as most of these pharmacies are located in areas easily accessible by the general public such as transport hubs and community shopping centres, potentially increasing access points for HIV service delivery. While there remains an unequal distribution of community pharmacies between rural and urban areas, they remain a very important potential option for providing HIV and sexual health interventions particularly to under serviced communities that have limited access to healthcare.

In the face of health-sector shortcomings and the impact of unanticipated disasters like the COVID-19 pandemic which disrupted public health services such as HIV and tuberculosis testing and reproductive health services (34), exploring the potential of pharmacies to mediate the existing challenges has emerged as an important resource. Data analysed from the public sector indicated a 22% decline in HIV testing, a 26% decline in tuberculosis Gene-Expert tests conducted and a 6% decline in contraceptives prescribed for the period March 2020 to December 2020 (35). The gap in healthcare access was filled in part by people accessing services from pharmacies (34).

In a recent review conducted to evaluate the potential of pharmacy-delivered HIV services in sub-Saharan Africa, there was in increase in uptake of HIV self-tests and in some instances, particularly where people engaged in risky sexual behaviour pre-exposure prophylaxis (PrEP) was sought out more at private pharmacies than at clinics (15). Whilst the reviewers acknowledged that this was early evidence it did suggest that pharmacy-based HIV service delivery models were possible and largely accepted by clients without compromising clinical outcomes (15). Furthermore, during the COVID-19 pandemic, in some Eastern Mediterranean Region countries where clinics were closed, pharmacists played a pivotal role in providing guidance on the management of sexual and reproductive health issues (36).

Assessing the South African communities' specific HIV treatment needs and willingness to access their HIV medication from community pharmacies will benefit from additional research. This was demonstrated by Zhu et al., who in their survey driven investigation found that while patients felt comfortable about pharmacists prescribing PrEP, there were also barriers to be overcome before this practice could be fully rolled out (37). A similar conclusion was also reached in another study which indicated that whilst accessing sexual and reproductive health services at pharmacies was viable especially for at risk groups, integrating sexual and reproductive health services into the traditional pharmacy workflow and policy concerns were other obstacles that needed to be resolved (38).

5. Conclusion

Community pharmacies present a unique opportunity to help South Africa alleviate the burden on public health systems as well as to overcome the challenges in HIV testing and treatment in South Africa. Given the development of community pharmacies across South Africa, these facilities can increase access to HIV treatment particularly in vulnerable and hard to reach groups. In so doing, South Africa could stand a better chance of achieving its 95-95-95 goals as envisioned by UNAIDS.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

TN, FV, SL-E conceptualised the manuscript. TN, NM, SL-E wrote the first draft of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

This study received funding from Ezintsha, a division of the Wits Health Consortium (Pty)Ltd. The Wits Health Consortium (Pty)Ltd was not involved in the study design, collection, analysis, interpretation of data, the writing of this article or the decision to submit it for publication.

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. UNAIDS. UNAIDS data 2022. Geneva: Joint United Nations Programme on HIV/AIDS (2022).

2. Jooste S, Mabaso M, Taylor M, North A, Shean YL, Simbayi LC. Determinants of gender disparities in scaling up the first 90 towards the UNAIDS 90–90–90 targets in South Africa: findings from the 2017 household-based national cross-sectional survey. *AIDS Res Ther*. (2021) 18(1):24. doi: 10.1186/s12981-021-00346-y

3. Kim H, Tanser F, Tomita A, Vandormael A, Cuadros DF. Beyond HIV prevalence: identifying people living with HIV within underserved areas in South Africa. *BMJ Glob Health*. (2021) 6(4):e004089. doi: 10.1136/bmjgh-2020-004089

4. Ehrenkranz P, Rosen S, Boulle A, Eaton JW, Ford N, Fox MP, et al. The revolving door of HIV care: revising the service delivery cascade to achieve the UNAIDS 95-95-95 goals. *PLoS Med*. (2021) 18(5):e1003651. doi: 10.1371/journal.pmed.1003651

5. World Health Organisation. *Updated recommendations on service delivery for the treatment and care of people living with HIV*. Geneva: World Health Organisation (2021).

6. Roy M, Bolton Moore C, Sikazwe I, Holmes CB. A review of differentiated service delivery for HIV treatment: effectiveness, mechanisms, targeting, and scale. *Curr HIV/AIDS Rep*. (2019) 16(4):324–34. doi: 10.1007/s11904-019-00454-5

7. International AIDS Society. Differentiated care for HIV: it's time to deliver differently. Framework for antiretroviral therapy delivery (2016).

8. Ilardo M, Speciale A. The community pharmacist: perceived barriers and patient-centered care communication. *Int J Environ Res Public Health*. (2020) 17:536. doi: 10.3390/ijerph17020536

9. Milosavljevic A, Aspden T, Harrison J. Community pharmacist-led interventions and their impact on patients' medication adherence and other health outcomes: a systematic review. *Int J Pharm Pract*. (2018) 26(5):387–97. doi: 10.1111/ijpp.12462

10. Taylor S, Cairns A, Glass B. Health professional perspectives of expanded practice in rural community pharmacy in Australia. *Int J Pharm Pract*. (2020) 28 (5):458–65. doi: 10.1111/ijpp.12648

11. Agomo C, Udoh A, Kpokiri E, Osuku-Opio J. Community pharmacists' contribution to public health: assessing the global evidence base. *Pharm J*. (2018) 10 (4):1–22. doi: 10.1211/CP.2018.20204556

12. Stime KJ, Garrett N, Sookrajh Y, Dorward J, Dlamini N, Olowolagba A, et al. Clinic flow for STI, HIV, and TB patients in an urban infectious disease clinic offering point-of-care testing services in Durban, South Africa. *BMC Health Serv Res*. (2018) 18(1):363. doi: 10.1186/s12913-018-3154-2

13. Rensburg R. Healthcare in South Africa: how inequity is contributing to inefficiency. The Conversation (2021).

14. Bogart LM, Shazi Z, MacCarthy S, Mendoza-Graf A, Wara NJ, Zionts D, et al. Implementation of South Africa's central chronic medicine dispensing and distribution program for HIV treatment: a qualitative evaluation. *AIDS Behav*. (2022) 26(8):2600–12. doi: 10.1007/s10461-022-03602-y

15. Kuo AP, Roche SD, Mugambi ML, Pintye J, Baeten JM, Bukusi E, et al. The effectiveness, feasibility and acceptability of HIV service delivery at private pharmacies in sub-Saharan Africa: a scoping review. *J Int AIDS Soc*. (2022) 25(10): e26027. doi: 10.1002/jia2.26027

16. National Department of Health. Regulations relating to the ownership and licencing of pharmacies. Pretoria, South Africa: Department of Health Republic of South Africa (2003).

17. Gray A, Osman L, Vawda YA. Chapter 7: Pharmacy practice. In: *Pharmacy law in South Africa a practitioner's handbook*. Johannesburg: Lexis Nexis (2019). p. 105–55.

18. Moodley R, Suleman F. To evaluate the impact of opening up ownership of pharmacies in South Africa. *J Pharm Policy Pract*. (2020) 13(1):28. doi: 10.1186/s40545-020-00232-4

19. Statistics South Africa. Four facts about our provincial economies. In: AFRICA DOSS, editor (2018).

20. Statistics South Africa. Mid-year population estimates 2021. Pretoria, South Africa: Department of Statistics Republic of South Africa (2021).

21. Tew MM, Hatah E, Arif F, Abdul Wahid MA, Makmor-Bakry M, Abdul Maulad KN. Geospatial analysis of distribution of community pharmacies and other health care facilities providing minor ailments services in Malaysia. *J Pharm Policy Pract*. (2021) 14(1):24. doi: 10.1186/s40545-021-00308-9

22. Statistics South Africa. 2020 Mid-year population estimates (2020).

23. ICPA. Discussion on the private community pharmacy sector. Interview with the Independent Community Pharmacy Association (2021).

24. Competition Commission. Notification to approve with conditions the transactions involving Clicks Retailers (Pty) Ltd and the retail pharmacy business carried on by Pick n Pay Retailers (Pty) Ltd. In: Department of Trade IaC, editor. Pretoria, South Africa2022.

25. Dischem Group. South Africa: Dischem group (2022). Available at: https://dischemgroup.com/group-profile/

26. Laing R, Mpanza NM, Bradley H. Reasons why insured consumers co-pay for medicines at retail pharmacies in Pretoria, South Africa. *Afr J Prim Health Care Fam Med*. (2019) 11(1):1–6. doi: 10.4102/ phcfm.v11i1.1878

27. National Department of Health. Declaration of certain practices by medical schemes in selecting designated health care providers and imposing excessive copayments on members as irregular or undesirable practices by the medical schemes, in terms of section 61 of the medical schemes Act no 131 of 1998. (2021).

28. Naidoo V, Suleman F, Bangalee V. Roles and reimbursement of pharmacists as South Africa transitions towards universal health coverage (UHC): an online survey-based study. *PLoS One*. (2021) 16(9):e0257348. doi: 10.1371/journal.pone.0257348

29. South African Pharmacy Council. Primacy care drug therapy pharmacist (PCDT) board notice 102 of 2021. South Africa2021.

30. Miller R, Goodman C. Performance of retail pharmacies in low- and middle-income Asian settings: a systematic review. *Health Policy Plan*. (2016) 31(7):940–53. doi: 10.1093/heapol/czw007

31. Malangu N. The future of community pharmacy practice in South Africa in the light of the proposed new qualification for pharmacists: implications and challenges. *Glob J Health Sci*. (2014) 6(6):226–33. doi: 10.5539/gjhs.v6n6p226

32. Mbilinyi C, Buma D, Ngasa S, Maingu R, Maganda B, Kaali W, et al. Advancing pharmacy practice in Tanzania: a descriptive report of pharmacy education and practice models in 3 institutions. *Inquiry*. (2021) 58:46958021999934. doi: 10.1177/0046958021999934

33. Baker L. The role of pharmacists in travel medicine in South Africa. *Pharmacy*. (2018) 6(3):68–72. doi: 10.3390/pharmacy6030068

34. Lalla-Edward ST, Mosam A, Hove J, Erzse A, Rwafa-Ponela T, Price J, et al. Essential health services delivery in South Africa during COVID-19: community and healthcare worker perspectives. *Front Public Health*. (2022) 10:1–14. doi: 10.3389/fpubh.2022.992481

35. Pillay Y, Pienaar S, Barron P, Zondi T. Impact of COVID-19 on routine primary healthcare services in South Africa2021.

36. El Bizri L, Jarrar LG, Ali WKA, Omar AH. The role of community pharmacists in increasing access and use of self-care interventions for sexual and reproductive health in the eastern Mediterranean region: examples from Egypt, Jordan, Lebanon and Somalia. *Health Res Policy Syst*. (2021) 19(1):49. doi: 10.1186/s12961-021-00695-0

37. Zhu V, Tran D, Banjo O, Onuegbu R, Seung H, Layson-Wolf C. Patient perception of community pharmacists prescribing pre-exposure prophylaxis for HIV prevention. *J Am Pharm Assoc*. (2020) 60(6):781–8.e2. doi: 10.1016/j.japh.2020.03.013

38. Navarrete J, Yuksel N, Schindel TJ, Hughes CA. Sexual and reproductive health services provided by community pharmacists: a scoping review. *BMJ Open*. (2021) 11 (7):e047034. doi: 10.1136/bmjopen-2020-047034

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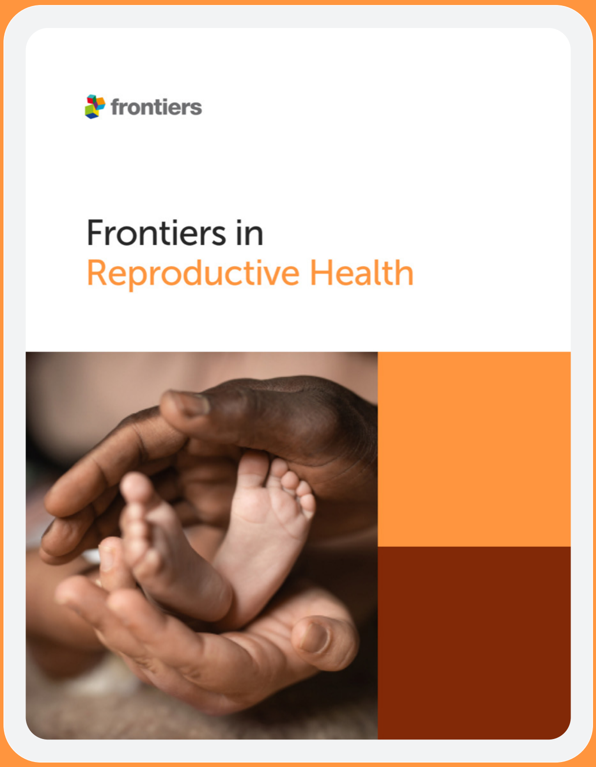
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