HIV self-testing positivity rate and linkage to confirmatory testing and care: a telephone survey in Côte d'Ivoire, Mali and Senegal

Arsène Kouassi Kra[1*], Arlette Simo Fotso[1,2], Nicolas Rouveau[1], Mathieu Maheu-Giroux[3], Marie-Claude Boily[4], Romain Silhol[4], Marc d'Elbée[1,5], Anthony Vautier[6] and Joseph Larmarange[1,2] on behalf of the ATLAS team

[1] Centre Population et Développement (Ceped), Université Paris Cité, Institut de Recherche pour le Développement (IRD), Inserm, France
[2] Institut National d'études Démographiques (Ined), France
[3] Department of Epidemiology and Biostatistics, School of Population and Global Health, McGill University, Montréal, QC, ~~H3A 1A2,~~ Canada
[4] MRC Centre for Global Infectious Disease Analysis, School of Public Health, Imperial College London, London, United Kingdom
[5] National Institute for Health and Medical Research UMR 1219, Research Institute for Sustainable Development EMR 271, Bordeaux Population Health Centre, University of Bordeaux, France
[6] Solidarité Thérapeutique et Initiatives pour la Santé (Solthis), Sénégal

*Corresponding author
Correspondence: arsene.~~krakouassi~~kra.kouassi@ceped.org

ABSTRACT

HIV self-testing (HIVST) empowers individuals ~~by allowing them~~ to decide when and where to test and with whom to share their results. From 2019 to 2022, the ATLAS program distributed ~ 400 000 HIVST kits in Côte d'Ivoire, Mali, and Senegal. It prioritised key populations, including female sex workers and men who have sex with men, and encouraged secondary distribution of HIVST to their partners, peers and clients.

To preserve the confidential nature of HIVST, use of kits and ~~HIVST~~their results were not systematically tracked. ~~Therefore~~Instead, an anonymous phone survey was ~~conducted~~ carried out in two phases during 2021 to estimate HIVST positivity rates (phase 1) and linkage to confirmatory testing ~~and care. This two-step survey involved an initial recruitment phase from March to June 2021 where~~(phase 2). Initially, participants were ~~encouraged~~recruited via leaflets from March to ~~call a free phone number~~June and ~~complete~~completed a sociobehavioural questionnaire. In the second phase (September to October), those with a reactive HIVST result were re-contacted for another questionnaire. Of the 2 615 initial participants, 89.7% reported consistent results between their interpretation and the number of lines on the HIVST (i.e., 1 for negative, 2 for reactive). The HIVST positivity rates ranged between 2.4% and 9.1% depending on calculations.

~~This was followed by a second phase in September and October 2021, where participants who reported a reactive HIVST result were re-contacted to complete a further questionnaire. Of the 2 615 participants recruited during the first phase, 89.7% reported consistent results (2 visible lines and result interpreted as reactive; one line and interpreted as non-reactive; or no/one line~~

~~and interpreted as invalid). HIVST positivity rates varied between 2.4% to 9.1% based on calculation methods (i.e. self-interpreted result or reported number of lines, inclusion or exclusion of don't knows and refusals).~~
The second phase saw 78 out of 126 eligible participants complete the questionnaire. Of the 27 who reported a consistent reactive result in the first phase, 15 (56%, 95%CI: 36 to 74%) underwent confirmatory HIV testing, with 12 (80%) confirmed as HIV-positive, all of whom began antiretroviral treatment.
The confirmation rate of HIVST results was fast, with 53% doing so within a week and 91% within three months of self-testing. Two-thirds (65%) went to a general public facility, and one-third to a facility dedicated to key populations.
The ATLAS HIVST distribution strategy reached people living with HIV in West Africa. Linkage to confirmatory testing remained sub-optimal in these first years of HIVST implementation. However, if confirmed HIV-positive, almost all initiated treatment. HIVST constitutes a relevant complementary tool to existing screening services.
.
Keywords: ~~AIDS,~~ HIV self-testing~~, HIV testing services, diagnosis, knowledge of status, awareness fo status, gay, bisexual, sex work~~, linkage to confirmatory testing and care, phone-based survey, key populations, West Africa.

Introduction

~~Early testing followed by successful linkage to antiretroviral treatment for those diagnosed with HIV can drastically reduce the risk of onward HIV transmission and mortality [1–6]. In 2021, according to the United Nations Program for HIV/AIDS (UNAIDS), 81% of the adult population living with HIV in West and Central Africa knew their status. Only 77% of them were on antiretroviral treatment [7], below the 95-95-95 UNAIDS targets for 2030 [8].~~

Early testing followed by successful linkage to antiretroviral treatment for those diagnosed with HIV can drastically reduce the risk of onward HIV transmission and mortality [1–6]. In 2021, according to the United Nations Program for HIV/AIDS (UNAIDS), 81% of the adult population living with HIV in West and Central Africa knew their status. Only 77% of them were on antiretroviral treatment[7], below the 95-95-95 UNAIDS targets for 2025 [8]. The 95-95-95 targets aim for 95% of people living with HIV to know their status, 95% of those diagnosed to receive treatment, and 95% of those on treatment to achieve viral suppression. Improving diagnosis coverage, especially among vulnerable key populations at high risk of HIV acquisition and transmission, is the necessary first step to achieve this goal.

HIV self-testing (HIVST) is the process by which a person who wants to know their HIV status collects their own sample (oral fluid or blood), performs the test, and then interprets the results themself, often in a private setting [9]. It is an innovative tool that empowers individuals and guarantees the confidentiality of the test [10]. Individuals may decide when and where to test and with whom they want to share their result. ~~It has been shown to be effective in screening populations vulnerable to HIV acquisition and transmission that are often hardly reached through conventional approaches [11–13]. Since 2016, the World Health Organization (WHO) has recommended HIVST as a complementary testing approach [14]~~It's a tool that is widely accepted by various populations, including key populations [11–18]. It has been shown to be effective in screening populations vulnerable to HIV acquisition and transmission that are often hardly reached through conventional approaches [19–21]. The World Health Organization (WHO) has recommended HIVST as a complementary testing approach since 2016 [22].

~~Following the experience gained in Eastern and Southern Africa under the STAR project [15–21], the UNAIDS funding agency sought to stimulate HIVST in West Africa. The ATLAS programme (*AutoTest de dépistage du VIH : Libre d'Accéder à la connaissance de son Statut*) aimed to promote, implement, and expand HIV self-testing in Côte d'Ivoire, Mali, and Senegal. Country national prevalence was comparatively low in West Africa in 2021: 1.9% (1.7%-2.2%) in Côte d'Ivoire, 0.8% (0.6%-1%) in Mali, and 0.3% (0.3%-0.4%) in Senegal according to Unaids[22].~~

~~In the ATLAS project's catchment areas, HIVST was integrated into existing testing policies, programs, and activities. A total of 397 367 HIVST kits were distributed free of charge between July 2019 and February 2022 as part of the national AIDS strategy in these three countries. At the time of ATLAS' implementation, in 2019, only small-scale pilot studies on HIVST had previously been conducted in Senegal and Côte d'Ivoire, and none existed in Mali.~~

The STAR project carried in Eastern and Southern Africa and funded by Unitaid aimed to boost the global market for HIVST . The project unfolded in three phases: Phase 1 ran from September 2015 to August 2017, Phase 2 spanned from August 2017 to July 2020, and Phase 3 took place between January 2020 and July 2021 (https://www.psi.org/fr/project/star/). Following the experience gained in Eastern and Southern Africa under the STAR project [11, 23–28], the Unitaid funding agency sought to stimulate HIVST in West Africa where HIV epidemics differs, are more concentrated, and where key populations (e.g., female sex workers and men who have sex with men) share a disproportionate HIV burden. The ATLAS programme (*AutoTest de dépistage du VIH : Libre d'Accéder à la connaissance de son Statut*) aimed to promote, implement, and expand HIVST in Côte d'Ivoire, Mali, and Senegal [29] where the national HIV prevalence in 2021 were was 1.9% (1.7%-2.2%) , 0.8% (0.6%-1%) , and 0.3% (0.3%-0.4%) respectively [30].

To preserve the anonymity and confidentiality of HIVST and not impede their use, ATLAS decided, in line with WHO recommendations, not to track the use and outcomes of distributed HIVST kits systematically. Such tracking can be logistically challenging and costly and could limit the distribution, redistribution and use of HIVST [31]. Without systematic tracking, it is challenging to obtain information on the users of the HIVST, their results and on linkage to confirmatory testing and treatment, which are crucial indicators to assess program effectiveness and impact. For instance, the positivity rate can reflect the yield of new individuals

diagnosed with HIV and if the testing modality is indeed reaching those in need. Diagnosed individuals must seek confirmatory testing and be linked to care to maximise health benefits and decrease onward transmission

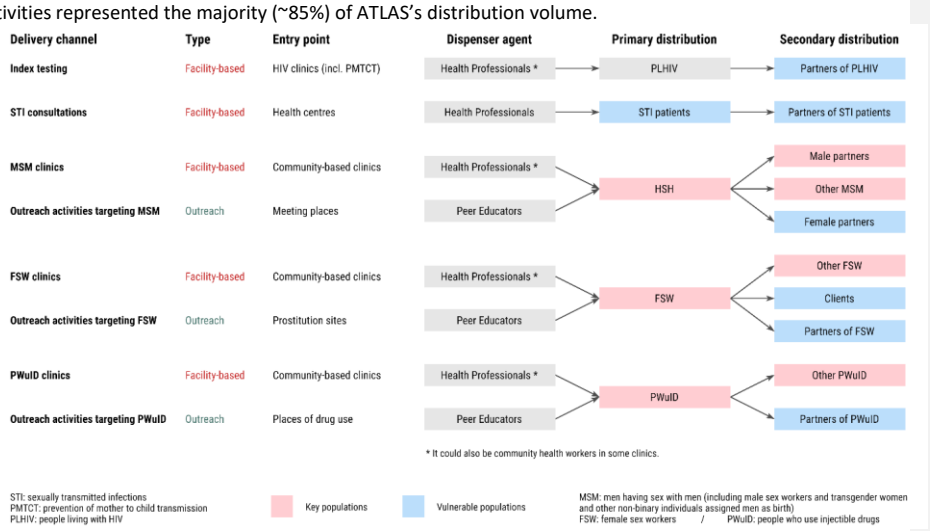
We conducted an innovative survey by setting up an anonymous and free telephone platform in Côte d'Ivoire, Mali and Senegal while preserving anonymity and encouraging voluntary participation. A second phase of the survey was conducted among those with an HIVST reactive result in the first survey. Here we present the HIV test positivity rates from the phase 1 questionnaire and the links with confirmatory tests and care.

Materials and Methods

ATLAS program description

ATLAS HIVST distribution was integrated into existing testing policies, programmes and activities in each country; 397 367 HIVST kits were freely distributed between July 2019 and February 2022 as part of the three countries' national AIDS strategies. At the time of ATLAS's implementation in 2019, only small-scale HIVST pilot programs had been previously conducted in Senegal and Côte d'Ivoire, whereas Mali had no previous experience of HIVST. In Senegal, for instance, the first pilot survey took place between April 2017 and June 2018 [32].

The design of the different delivery channels and the priority populations were developed with country stakeholders~~:~~ including national AIDS programs/councils, international institutions including the WHO, international and national non-governmental organisations involved in local HIV programs, and civil society and community leaders. ATLAS HIVST distribution was organised through eight different operational delivery channels (~~figure~~Figure 1~~)~~), i.e. five ~~were~~ facility-based approaches (delivery of HIVST kits through public or community-based health facilities~~),~~) and three ~~used~~ community-based approaches involving outreach activities engaging female sex workers (FSW), men who have sex with men (MSM), and people who use drugs (PWUD) ~~[23].~~[29]. Peer educators conducted these outreach activities through group activities (e.g. talks, discussion groups, night visits, social events, or parties) and face-to-face activities (e.g. home visits). Outreach activities represented the majority (~85%) of ATLAS's distribution volume.



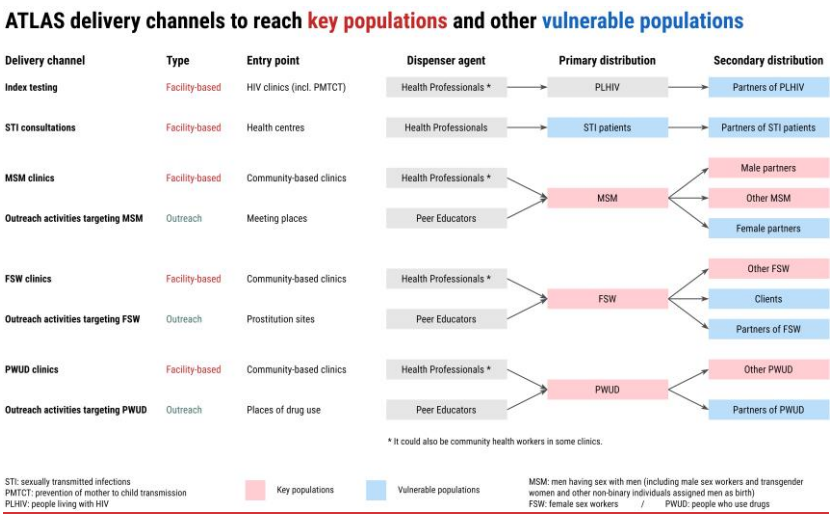


Figure 1. ATLAS delivery channels (adapted from Rouveau et al., 2021, Describing, analysing and understanding the effects of the introduction of HIV self-testing in West Africa through the ATLAS programme in Côte d'Ivoire, Mali and Senegal, BMC Public Health, ~~https://doi.org/10.1186/s12889-021-10212-1)~~https://doi.org/10.1186/s12889-021-10212-1). FSW=female sex workers, MSM=men who have sex with men, PLHIV=people living with HIV PMTCT=prevention of mother-to-child transmission, PWUD=people who use drugs, STI=sexually transmitted infection.

ATLAS activities relied on both primary and secondary distribution. HIVST kits were distributed by peer educators and healthcare professionals to primary contacts for their personal use (primary distribution). With secondary distribution, primary contacts were provided HIVST kits and invited to redistribute them to their peers, partners, and clients. These secondary contacts were often members of key populations that can be more difficult to engage in HIV prevention, along with other peripheral vulnerable populations. This chain-referral distribution of HIVST implies that end-users were not limited to primary contacts.

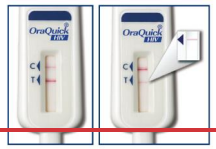
Only oral self-testing (OraQuick HIV Self-Test®) has been distributed through ATLAS. OraSure Technologies, the manufacturer of the OraQuick test, accompanies each HIVST kit with a user manual for result interpretation. OraQuick HIVST results should be interpreted as follow~~:~~. It is reactive if two lines (C & T) are visible~~,~~ (even barely~~)~~, non-reactive if only the C (control) line is visible~~,~~ and invalid if no line is visible or if only the T (test) line is visible.

In addition to the manufacturer's instructions (~~figure~~Figure 2), locally adapted brochures and explanatory videos in French and local languages have been developed to help users perform the test, interpret the result and know what actions should be taken following a non-reactive, a reactive or indeterminate result. They also encouraged people with a reactive HIVST to seek confirmatory HIV testing and care. ~~Free phone lines have been set up in each country, and operators of these lines were trained about HIVST~~Individuals with a non-reactive test were invited to retest after 3 months if still exposed to HIV. Existing toll-free hotlines in each counntry were strengthned and trained on HIVST, to offer information about HIV, prevention, testing, use and interpretation of HIVSTand counseling.

ORAQUICK®
HIV SELF-TEST

INTERPRETING RESULTS Read test results in a well-lit area

HIV POSITIVE RESULT



Two complete lines, even if the line is faint, means you may be HIV POSITIVE and you need to seek additional testing by a trained professional to confirm an HIV diagnosis.

As soon as possible . . .

Visit your nearest HIV Testing Centre or Health Facility

HIV NEGATIVE RESULT

IF READ BEFORE 20 MINUTES, RESULT MAY NOT BE CORRECT

ONE LINE next to the "C" and NO line next to the "T", your result is HIV NEGATIVE.

Seek regular testing. If you may have been exposed to HIV, test again in 3 months.

INVALID RESULT

If there is no line next to the "C" (even when there is a line next to the "T"), the test line or control line are not complete (all the way across the window), or a red background makes it impossible to read the test, the test is not working and should be repeated. **You will need to obtain another test.**

The test did not work properly.

Visit your nearest HIV Testing Centre or Health Facility to test again.

NOT SURE OF RESULT

You do not know your result or you are unsure of your result. Visit your nearest HIV Testing Centre or Health Facility to test again.

DISPOSE

Remove the test stick, put the cap on the test tube, place in the disposal bag provided and throw away all contents in the normal trash.

172
173

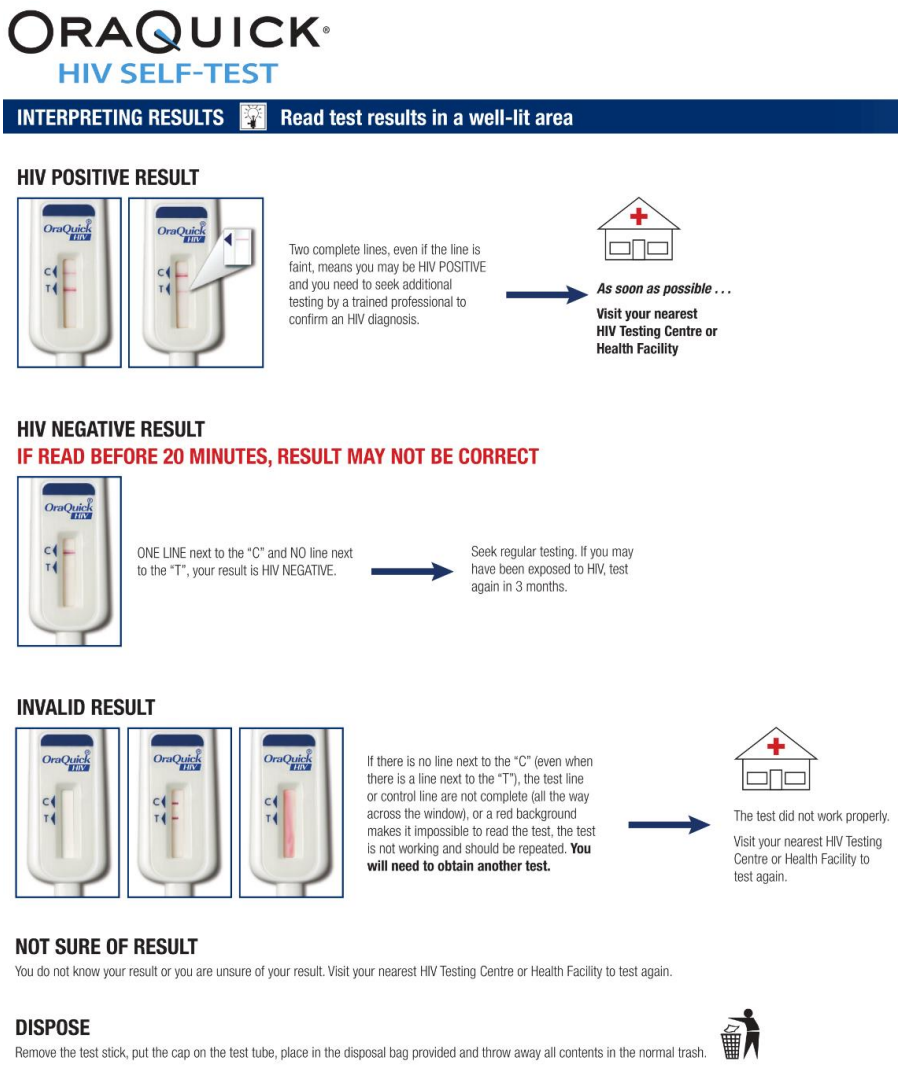


Figure 2. Guidelines for interpreting HIVST result, extracted from the English version of the manufacturer instructions for use (OraQuick HIV Self-Test®)

~~To preserve the anonymity and confidentiality of HIVST and not impede their use, ATLAS has decided, in line with WHO recommendations, not to track the use and outcomes of distributed HIVST kits directly. Such tracking can be logistically challenging and costly and could limit the distribution, redistribution and use of HIVST [24]. Without systematic tracking, it was challenging to obtain information on who was using the HIVST, the results of the tests and the linkage to confirmatory testing and treatment. These are crucial indicators to assess program effectiveness and impact. For instance, the positivity rate can be related to the yield of new individuals diagnosed with HIV and would suggest that the testing modality is indeed reaching those in need.~~

~~Diagnosed individuals must seek confirmatory testing and be linked to care to maximise health benefits and decrease onward transmission.~~

~~We conducted an innovative survey by setting up an anonymous and free telephone platform in Côte d'Ivoire, Mali and Senegal while preserving anonymity and encouraging voluntary participation. This survey among ATLAS HIVST users showed that HIVST secondary distribution was feasible and acceptable. Participants reported that they appreciated the ease of use of HIVST, its discretion and the fact that they are autonomous in carrying out the test. Finally, HIVST appeared as a relevant additional approach for those usually distant from community activities and HIV testing services, and has the potential to reach, beyond key populations, partners, clients, and other groups vulnerable to HIV [25].~~

~~A complementary survey was conducted among those with an HIVST reactive result. Here we report on HIVST's positivity rates and linkage to confirmatory testing and care.~~

~~Materials and Methods~~

~~Sources of data~~

~~The ATLAS program embedded multiple research activities, from qualitative studies to economic analyses, which have been described in detail elsewhere [23, 26–29].~~

~~It~~Study design and data collection

The ATLAS program embedded multiple research activities, from qualitative studies to economic analyses, which have been described in detail elsewhere [17, 29, 33–36].

The program included a voluntary anonymous phone survey. Between mid-March and mid-June 2021, dedicated survey flyers were distributed with the HIVST kits inviting self-test users in each country to call a toll-free number to complete a questionnaire (phase 1). All calls from the three countries, over the same period, were rerouted to a telephone platform located in Abidjan and operated by Ipsos Côte d'Ivoire, which was selected following an international call for tenders.

The questionnaire, which lasted 20 to 30 minutes, collected information on sociodemographic characteristics of HIVST users, testing history, sexual and preventive behaviours, HIVST use and difficulties encountered. ~~Participation in the survey was rewarded with 2~~ Specifically, each participant was asked about the number of lines that appeared when reading the HIVST result and their self-interpretation of it (reactive or non-reactive). A pilot survey was initially conducted without offering financial compensation to the participants.[37] Following the results, we decided to introduce a reward as a token of appreciation for the time participants dedicated to the survey Consequently, completion of the questionnaire was rewarded with 2 000 XOF (≈3.40 USD) of phone communication credit. In order to participate in the survey, participants had to be of legal age to use an HIVST on their own without parental permission (16 years in Côte d'Ivoire, 18 years in Mali, and 15 years in Senegal) and had to have used an HIVST provided to them through the ATLAS project.

As the survey was anonymous, there was a risk that some HIVST users may participate more than once or that individuals who have never used HIVST tried to participate to receive the financial incentive. To limit these risks, several measures were taken: (i) the leaflet distributed with the HIVST kits had a unique 9-digit number generated by the research team that was requested prior to participation in the survey~~;~~, (ii) the same unique number could not be used twice~~;~~, (iii) the financial incentive was only paid out once the questionnaire was fully completed (however individuals could refuse to answer any particular question~~);~~), (iv) the same telephone number could not be used twice to receive the telephone credit. These unique 9-digit numbers were generated non-sequentially and were grouped by country, delivery channel and implementing partner. Thus, any unique number could indirectly identify the delivery channel where the HIVST kit was initially dispensed.

~~In total, 2 615 participants were recruited for phase 1 [25]. During the interviews, each participant was asked about the number of lines that appeared when reading the HIVST result and their self-interpretation of it (reactive or non-reactive). Those who reported two lines or a reactive result were asked for their consent to be called back a few months later to participate in a complementary survey and, if consented, to provide a phone contact.~~

~~Between September 27th and October 22th 2021, eligible participants who agreed to be re-contacted were phoned to complete a 5-minute questionnaire (phase 2) on linkage to confirmatory testing and care.~~

The time when participants received their HIVST kit was not collected. However, as a survey leaflet was mandatory to participate, we could estimate that all participants received their HIVST kit during the survey period (i.e. between mid-March and mid-June 2021).

In total, 2 615 participants were recruited for phase 1[38]. Those who reported two lines or a reactive result (n=126) were asked for their consent to be called back a few months later to participate in a complementary survey and, if consented, to provide a phone contact (n=120). As some individuals may delay their decision to undergo a confirmatory test by several weeks/months after using an HIV self-test, we chose a minimum of 3-month gap between our two surveys to potentially get an estimate of the maximum number of participants who eventually underwent confirmatory testing. From September 27th to October 22nd, 2021, 96 were successfully recontacted and invited to complete a 5-minute questionnaire (phase 2) on linkage to confirmatory testing and care. Among those, 89 accepted to participate in phase 2 and 78 fully completed phase 2 questionnaire.

The interviews were conducted in either French, English, Bambara, or Wolof. On-the-fly translation into other local languages was also available. Compensation of XOF 2 000 (≈3.40 USD) in the form of telephone credit was given to participants who completed the phase 2 questionnaire. Unlike in phase 1, it was not a financial incentive~~:~~ as participants were informed about it only at the end of the interview. Interviews were not audio-recorded. Questionnaires' responses were captured on a computer and stored in a database managed by PAC-CI, an Ivorian research institute with expertise in clinical research.

At the end of the survey, collected telephone numbers (for appointments and rewards) were deleted from the database. All procedures have been described in a publicly available data management plan (https://dmp.opidor.fr/plans/3354/export.pdf). The complete project protocol, including the data management plan (required by the ethics committees), was written in French .

Data analysis

Based on phase 1 participants' self-reports, we distinguished those having reported an HIVST ~~results~~result consistent with both the reported number of visible lines and the reported self-interpretation (2 visible lines and result interpreted as reactive~~;~~, one line and interpreted as non-reactive~~;~~, or no/one line and interpreted as invalid), an inconsistent result, or a partial result (they refused to answer or answered they didn't know to one or both questions).

To estimate HIVST positivity rates, we separately considered the self-interpreted results and the reported number of lines on the HIVST. For each source, we made three hypotheses (low, central, and high) about "*don't know*" and refusals (DK-R). Using self-reported results~~,~~ (respectively the reported number of visible lines), the low hypothesis considered DK-R as non-reactive~~,~~ (as one line), and the high hypothesis as reactive~~,~~ (as two lines), while DK-R were excluded from both the numerator and the denominator in the central hypothesis. ~~Using the reported number of visible lines, the low hypothesis considered DK-R as one line, and the high hypothesis as two lines, while DK-R were excluded from both the numerator and the denominator in the central hypothesis.~~ Positivity rates were stratified by respondents' gender, country, and distribution channel.

We described the selection of eligible participants for phase 2 questionnaires and corresponding participation rates. To assess any participation bias, characteristics of phase 2 participants were compared with individuals eligible for phase 2 but who did not participate and with phase 1 participants not eligible for phase 2.

Among phase 2 eligible participants who completed their questionnaire, linkage to confirmatory testing, the proportion being confirmed HIV positive, and the proportion who initiated treatment ~~initiation~~ were described, stratified by the reported number of lines and self-interpreted HIVST result in phase 1 questionnaire. ~~Confidence intervals (95% confidence interval, 95%CI) were computed using Wilson's method with Yate's continuity correction.~~

We also ~~explored~~describe (i) for those who did not link to confirmatory testing, the main reported reason; and (ii) for those who did link to confirmatory testing, the type of facility ~~was confirmatory testing was performed~~attended for confirmation and the time between HIVST and confirmatory testing.

~~All analyses have been performed using R version 4.2.2 [30]. A dedicated anonymised dataset and the corresponding R script are available on Zenodo (https://doi.org/ 10.5281/zenodo.7986077) to allow replication of the analysis.~~

~~.~~ A dedicated anonymised dataset and the corresponding R script are available on Zenodo (https://doi.org/10.5281/zenodo.8329454) to allow replication of the analysis. All analyses have been

performed using R version 4.3.1 [39]. All the descriptive tables were generated using the *tbl_summary()* function from the *gtsummary* package [40]. Confidence intervals (95% confidence interval, 95%CI) were computed using Wilson's method with Yate's continuity correction (*prop.test()* function).

Ethics

ATLAS research protocol (version 3.0, October 8 2020) has been approved by the WHO Ethical Research Committee (January 12, 2021, reference: ERC 0003181), the National Ethics Committee for Life Sciences and Health of Côte d'Ivoire (November 27, 2020, reference: 191-20/MSHP/CNESVS-km, IRB:000111917), the Ethics Committee of the Faculty of Medicine and Pharmacy of the University of Bamako, Mali (November 16, 2020, reference: 2020/254/CE/FMPOS/FAPH), and the National Ethics Committee for Health Research of Senegal (January 26, 2021, protocol SEN19/32, n°8 MSAS/CNERS/Sec).

The full research protocol was written in French (https://hal.science/ATLAS_ADVIH/hal-04121482v1). The peer-reviewed protocol has been published in English elsewhere [29].

Results

HIVST results

Of the 2 615 participants recruited in phase 1, 2 346 (89.7%) reported a self-interpreted HIVST result consistent with their reported number of visibles lines on the HIVST: 2 292 (88.0%) reported one line ~~and~~ self-interpreted ~~it~~ as non-reactive, 50 (1.9%) two lines ~~and~~self-interpreted as reactive, and 4 (0.2%) ~~none or~~ no/one line self-interpreted as invalid (table 1). In contrast, 48 (1.8%) reported inconsistent answers: 10 (0.4%) one line ~~and~~ self-interpreted ~~it~~ as reactive, 35 (1.3%) two lines ~~and~~self-interpreted as non-reactive/ and 3 (0.1%) no line ~~and~~self-interpreted as non-reactive.

Finally, 221 (8.5%) reported a partial result: 147 (5.6%) reported 0, 1 or 2 lines~~,~~ but did not know how to interpret the result or refused to answer~~;~~, 46 (1.7%) self-interpreted their result~~,~~ but did not know or refused to report the number of lines~~;~~, and 28 (1.1%) did not know or refused to answer to both questions

Table 1. Self-reported HIV self-test (HIVST) result, reported number of lines on the HIVST, and positivity rates according to different hypotheses among participants of the first phase of the survey in Côte d'Ivoire, Mali, and Senegal (2021).

Phase 1 participants	Formula	2615 (100%)
Consistent answer (C)	$C = C_1 + C_2 + C_3$	**2346 (89.7%)**
2 lines / reactive† ~~(C_1)~~	C_1	50 (1.9%)
1 line / non-reactive ~~(C_2)~~	C_2	2 292 (88%)
0-1 line/ invalid ~~(C_3)~~	C_3	4 (0.2%)
Inconsistent answer (I)	$I = I_1 + I_2 + I_3 + I_4 + I_5$	**48 (1.8%)**
1 line / reactive† ~~(I_1)~~	I_1	10 (0.4%)
0 line / reactive† ~~(I_2)~~	I_2	0 (0%)
2 lines/ non-reactive† ~~(I_3)~~	I_3	35 (1.3%)
0 line / non-reactive ~~(I_4)~~	I_4	3 (0.1%)
2 lines/ invalid† ~~(I_5)~~	I_5	0 (0%)
Partial answer (P)	$P = P_1 + P_2 + P_3 + P_4 + P_5 + P_6 + P7$	**221 (8.5%)**
0 line / DK-R ~~(P_1)~~	P_1	1 (<0.1%)
1 line / DK-R ~~(P_2)~~	P_2	117 (4.5%)
2 lines/ DK-R† ~~(P_3)~~	P_3	29 (1.1%)
DK-R / reactive† ~~(P_4)~~	P_4	2 (<0.1%)
DK-R / non-reactive ~~(P_5)~~	P_5	44 (1.7%)
DK-R / invalid ~~(P_6)~~	P_6	0 (0%)
DK-R / DK-R ~~(P_7)~~	P_7	28 (1.1%)
Positivity Rate		
Based on self-interpreted test results		
Low hypothesis (DK-R as not reactive) ~~$(C_1 + I_1 + I_2 + P_4) / n$~~	$(C_1 + I_1 + I_2 + P_4) / n$	62 / 2615 (2.4 %)
Central hypothesis (DK-R excluded)	~~*Central hypothesis (DK-R excluded)*~~ $(C_1 + I_1 + I_2 + P_4) / (C + I + P_4 + P_5 + P_6)$	62 / 2440 (2.5 %)
High hypothesis (DK-R as reactive) ~~$(C_1 + I_1 + I_2 + P_1 + P_2 + P_3 + P_4 + P_7) / n$~~	$(C_1 + I_1 + I_2 + P_1 + P_2 + P_3 + P_4 + P_7) / n$	237 / 2615 (9.1%)
Based on the reported number of lines		
Low hypothesis (DK-R as 1 line) ~~$(C_1 + I_3 + I_5 + P_3) / n$~~	$(C_1 + I_3 + I_5 + P_3) / n$	114 / 2615 (4.4 %)
Central hypothesis mid (DK-R excluded)	~~*Central hypothesis mid (DK-R excluded)*~~ $(C_1 + I_3 + I_5 + P_3) / (C + I + P_1 + P_2 + P_3)$	114 / 2541 (4.5 %)
High hypothesis (DK-R as 2 lines)	~~*High hypothesis (DK-R as 2 lines)*~~ $(C_1 + I_3 + I_5 + P_3, P_4 + P_5 + P_6, P_7) / (C + I + P_1 + P_2 + P_3)$	188 / 2615 (7.2 %)

†: Eligible for phase 2 Survey

~~‡: Eligible for phase 2 Survey~~

DK: don't know. R: refused to answer

HIVST positivity rates

Based on self-interpreted HIVST results, the overall positivity rate was 2.4% when DK-R were considered non-reactive (~~Table 2,~~ low hypothesis~~). By,~~ Figure 3, Table S2). Rate was similar at 2.5% by excluding DK-R from the numerator and the denominator (central hypothesis~~), the positivity rate increased to 2.5%.~~). Considering DK-R as reactive (high hypothesis) increased the positivity rate to 9.1%. Estimates based on the reported number of visible lines on the HIVST were 4.4%, 4.5% and 7.2%, respectively, for the low, central, and high hypotheses. Positivity rates ranged from 1.8% to 9.8% in Côte d'Ivoire, 3.5% to 7.8% in Mali, and 1.2% to 15.0% in Senegal depending on the hypothesis (e.g., low or high; Figure S4, Table ~~2~~S2).

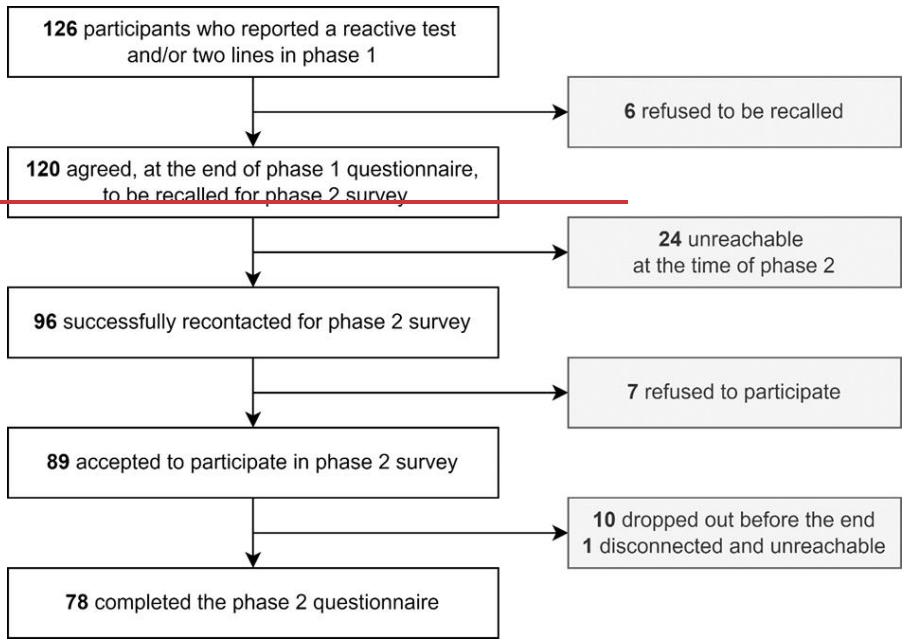
Positivity rates (central hypothesis based on the number of lines) were higher among participants recruited through community-based distribution channels~~:~~. It was 4.8% for men and 4.9% for women in the MSM-based channels, and 4.6% for men and 4.2% for women in the FSW-based channels ~~(central hypothesis based on the number of lines). In~~. Compared to 3.1% for men and 2.9% for women in the other distribution channels (PWUD-based and facility-based~~), positivity rates were slightly lower: 3.1% for men and 2.9% for women.~~).

When analyzing positivity rates by age group (Table S3), for those under 24 years old, the rates ranged from 2.2% to 7.4% based on the reported self-interpreted result and from 3.1% to 5.9% based on the reported number of lines. Among those aged 25 to 34 years old, it fluctuated between 2.7% and 9.5% based on the reported self-interpreted result and from 4.9% to 7.8% based on the reported number of lines. Lastly, for individuals 35 years old or older, the rate layed between 1.8% and 12% based on the reported self-interpreted result and between 4.9% and 9.3% based on the reported number of lines.

Participation in phase 2

During phase 1, 126 individuals reported two lines or self-interpreted their result as reactive~~, thus~~ and were ~~identified as~~therefore eligible for phase 2 (~~table~~Table 1). Among them, 6 ~~had~~ refused to be re-contacted after phase 1 (~~figure 3~~Figure 4). Among the 120 (95%) who agreed to be re-contacted, 24 (20%) were unreachable at the time of the phase 2 survey, and 96 (80%) were successfully re-contacted. Among the latest, 89 (93%) accepted to participate in the phase 2 survey. Ten dropped out before the end of the interview, and 1 disconnected and was unreachable afterwards. As a result, 78 participants completed phase 2 questionnaire. Of the 78 participants, 39 (50%) were from Côte d'Ivoire, 31 (40%) from Mali, and 8 (10%) from Senegal (Table S1). Participation rates were 54% for participants who reported a consistent result (2 lines and reactive), 71.1% for those with an inconsistent result (either 2 lines & non-reactive, or 1 line & reactive), and 65.5% for those reporting a partial result (2 lines & DK-R or DK-R & reactive).

The participants who completed the phase 2 questionnaire had similar sociodemographic characteristics (e.g. country, sex, distribution channel, age group, marital status) compared to those eligible for phase 2, but that did not complete it, and to phase 1 participants not eligible for phase 2 (~~table~~Table S1). For most participants (86%), phase 2 questionnaire was completed between 4 and 6 months after phase 1 questionnaire (~~table~~Table S5).


126 participants who reported a reactive test and/or two lines in phase 1
6 refused to be recalled
120 agreed, at the end of phase 1 questionnaire, to be recalled for phase 2 survey
24 unreachable at the time of phase 2
96 successfully recontacted for phase 2 survey
7 refused to participate
89 accepted to participate in phase 2 survey
10 dropped out before the end
1 disconnected and unreachable
78 completed the phase 2 questionnaire

354

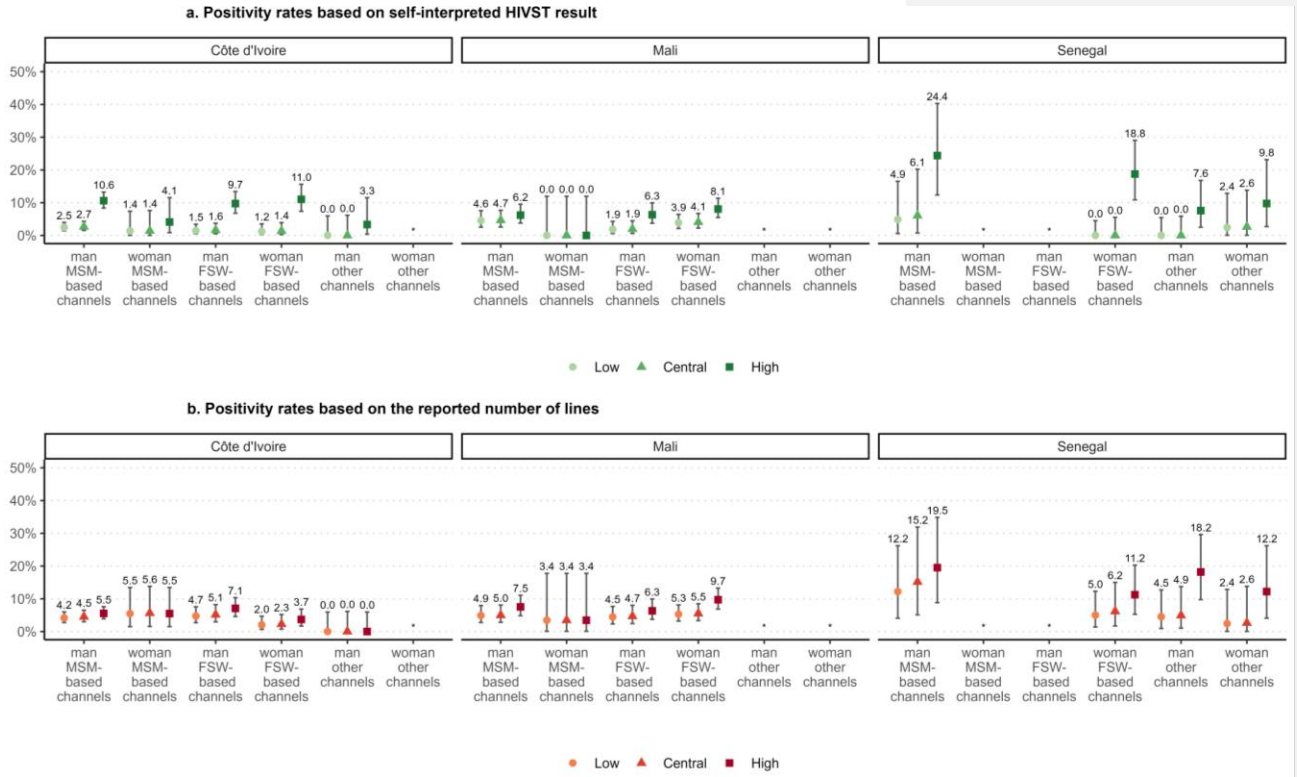


Figure 3. ~~Flow chart of the participant selection process for the 2nd phase of the survey in Côte d'Ivoire, Mali,~~ Positivity rates and ~~Senegal (2021).~~

Table 2. Positivity rates95%CI based on self-interpreted HIVST results or the reported number of visible lines, by distribution channel, gender and country, among participants of the first survey phase in Côte d'Ivoire, Mali, and Senegal (2021).

			MSM based channels		FSW based channels		Others delivery channels		Total
			Man	Woman	Man	Woman	Man	Woman	
Positivity rate based on self-reported HIVST results	Low	Côte d'Ivoire	2.5% (16/650)	1.4% (1/73)	1.5% (5/339)	1.2% (3/245)	0% (0/60)	0% (0/23)	1.8% (25/1 390)
		Mali	4.6% (14/306)	0% (0/29)	1.9% (5/269)	3.9% (14/360)	9.1% (1/11)	0% (0/9)	3.5% (34/984)
		Senegal	4.9% (2/41)	0% (0/1)	0% (0/12)	0% (0/80)	0% (0/66)	2.4% (1/41)	1.2% (3/241)
		Overall	3.2% (32/997)	1.0% (1/103)	1.6% (10/620)	2.5% (17/685)	0.7% (1/137)	1.4% (1/73)	2.4% (62/2 615)
	Central	Côte d'Ivoire	2.7% (16/597)	1.4% (1/71)	1.6% (5/311)	1.4% (3/221)	0% (0/58)	0% (0/21)	2.0% (25/1 279)
		Mali	4.7% (14/301)	0% (0/29)	1.9% (5/257)	4.1% (14/345)	9.1% (1/11)	0% (0/9)	3.6% (34/952)
		Senegal	6.1% (2/33)	0% (0/1)	0% (0/11)	0% (0/65)	0% (0/61)	2.6% (1/38)	1.4% (3/209)
		Overall	3.4% (32/931)	1.0% (1/101)	1.7% (10/579)	2.7% (17/631)	0.8% (1/130)	1.5% (1/68)	2.5% (62/2 440)
	High	Côte d'Ivoire	10.6% (69/650)	4.1% (3/73)	9.7% (33/339)	11% (27/245)	3.3% (2/60)	8.7% (2/23)	9.8% (136/1 390)
		Mali	6.2% (19/306)	0% (0/29)	6.3% (17/269)	8.1% (29/360)	9.1% (1/11)	0% (0/9)	6.7% (66/984)
		Senegal	24.0% (10/41)	0.0% (0/1)	8.3% (1/12)	19.0% (15/80)	7.6% (5/66)	9.8% (4/41)	15.0% (35/241)
		Overall	9.8% (98/997)	2.9% (3/103)	8.2% (51/620)	10.0% (71/685)	5.8% (8/137)	8.2% (6/73)	9.1% (237/2 615)
Positivity rate based on the reported number of visible lines	Low	Côte d'Ivoire	4.2% (27/650)	5.5% (4/73)	4.7% (16/339)	2.0% (5/245)	0% (0/60)	4.3% (1/23)	3.8% (53/1 390)
		Mali	4.9% (15/306)	3.4% (1/29)	4.5% (12/269)	5.3% (19/360)	9.1% (1/11)	0% (0/9)	4.9% (48/984)
		Senegal	12.2% (5/41)	0% (0/1)	0% (0/12)	5.0% (4/80)	4.5% (3/66)	2.4% (1/41)	5.4% (13/241)
		Overall	4.7% (47/997)	4.9% (5/103)	4.5% (28/620)	4.1% (28/685)	2.9% (4/137)	2.7% (2/73)	4.4% (114/2 615)
	Central	Côte d'Ivoire	4.2% (27/641)	5.5% (4/73)	4.8% (16/331)	2.1% (5/241)	0% (0/60)	4.5% (1/22)	3.9% (53/1 368)
		Mali	5.0% (15/298)	3.4% (1/29)	4.5% (12/264)	5.5% (19/344)	9.1% (1/11)	0% (0/9)	5.0% (48/955)
		Senegal	13.2% (5/38)	0% (0/1)	0% (0/10)	5.3% (4/75)	5.3% (3/57)	2.7% (1/37)	6.0% (13/218)
		Overall	4.8% (47/977)	4.9% (5/103)	4.6% (28/605)	4.2% (28/660)	3.1% (4/128)	2.9% (2/68)	4.5% (114/2 541)
	High	Côte d'Ivoire	5.5% (36/650)	5.5% (4/73)	7.1% (24/339)	3.7% (9/245)	0% (0/60)	8.7% (2/23)	5.4% (75/1 390)
		Mali	7.5% (23/306)	3.4% (1/29)	6.3% (17/269)	9.7% (35/360)	9.1% (1/11)	0% (0/9)	7.8% (77/984)
		Senegal	19.5% (8/41)	0% (0/1)	16.7% (2/12)	11.2% (9/80)	18.2% (12/66)	12.2% (5/41)	14.9% (36/241)
		Overall	6.7% (67/997)	4.9% (5/103)	6.9% (43/620)	7.7% (53/685)	9.5% (13/137)	9.6% (7/73)	7.2% (188/2 615)

DK: don't know. R: refusals. FSW: The asterix indicate that there was no participant in that distribution channel. FSW=female sex workersworker, MSM:=men havingwho have sex with men, PR: positivity rate. Shaded cells indicated cells with less than 50 participants. Low hypothesis: DK-R as non-reactive or 1 line. Central hypothesis: DK-R excluded from the numerator and the denominator. High hypothesis: DK-R as reactive or 2 lines.

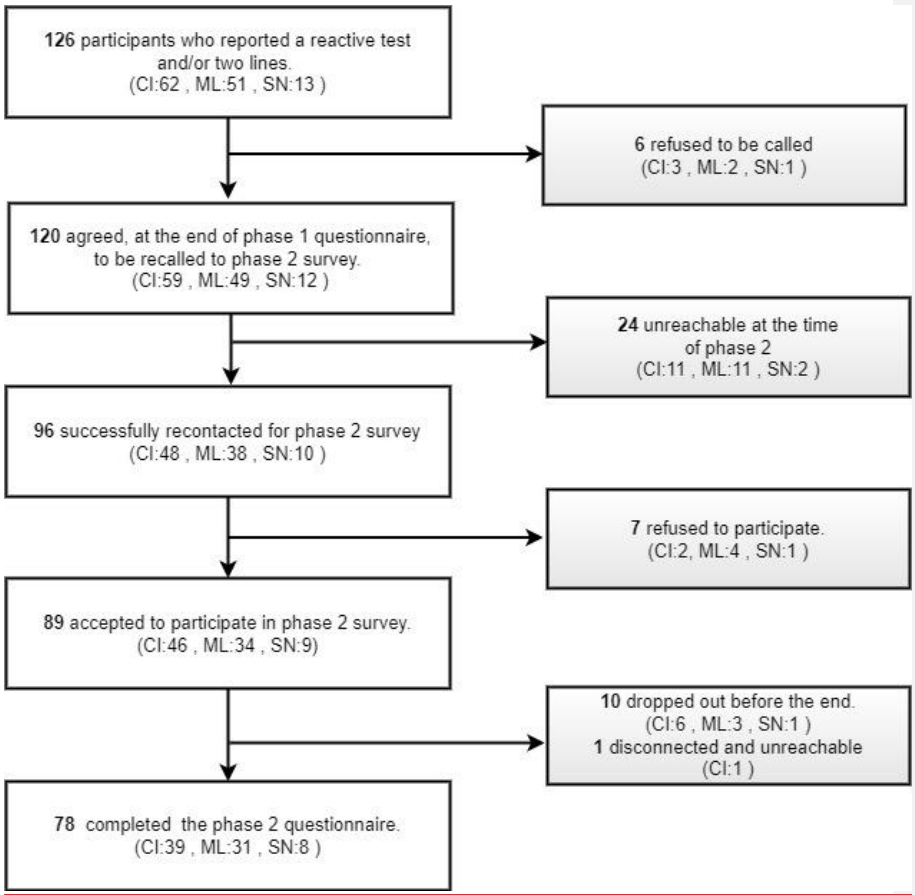


Figure 4:. Flow chart of the participant selection process for the 2nd phase of the survey in Côte d'Ivoire (CI), Mali (ML), and Senegal (SN) (2021).

Linkage to confirmatory testing and care

Overall, 34 of the 78 ~~participants of~~who completed the phase 2 ~~survey~~questionnaire (44%) reported having performed confirmatory testing. Linkage was higher for those who reported 2 lines and correctly self-interpreted their result as reactive~~:~~ (56~~% (~~%, 95%CI: 36-74%), ~~followed by~~than for those who reported two lines but did not know or refused to report their test interpretation ~~with a linkage rate of~~(44~~%~~%, (95%CI: 22-69~~%). Not surprisingly, linkage to confirmatory testing was lower (36%; 95%CI: 19-57%) among~~%) and those who reported 2 lines but incorrectly self-interpreted the result as non-reactive (~~table~~36%, 95%CI: 19-57%) (Table 3). Finally, among the 8 participants who reported none ~~or~~ /one line or did not know how many lines and incorrectly self-interpreted the result as reactive, only 2 linked to confirmatory testing.

The main reason given for not linking to confirmatory testing was that "*their HIVST was non-reactive*" (18/44, 41%, and although 8 of these 18 reported a reactive result in phase 1 questionnaire~~);~~), followed by "*not knowing that a confirmation test was required*" (10/44, 23~~%);~~%), and "*not having time*" (8/44, 18%) (~~table S2~~Table S4).

When participants were linked to confirmatory testing, it was ~~a short time~~usually shortly after performing their HIVST: 53% linked in less than one week and 91% in less than 3 months (~~table S3).~~ Table S5). Most participants (65%) performed their confirmatory testing in a general public facility (health centre, hospital, clinic or maternity~~), and~~) wheras 35% chose a community-based clinic or health centre dedicated to key populations (~~table S4~~Table S6).

Among the 34 that linked to confirmatory testing, 19 (56%, 95%CI: 38-72%) were confirmed HIV-positive, and 18 (95%, 95%CI; 72-100%) initiated antiretroviral treatment. Of the 18 participants who initiated ART, 11 (72%) underwent their confirmation test less than a week after their self-test, 2 (11%) did so between 1 and 2 weeks, 1 (5.6%) between 3 and 4 weeks, 1 (5.6%) waited between 1 and 2 months, and 1 (5.6%) proceeded with the test three months later. Among the 27 who reported a consistent reactive result in the phase 1 questionnaire, 15 (56%, 95%CI: 36-74%) linked to confirmatory test, 12 (80%) were confirmed HIV-positive and all started treatment (100%).

Table 2. Linkage to confirmatory testing, proportion being confirmed HIV positive and treatment initiation, by reported number of lines and self-interpreted HIVST result among eligible participants of the second phase of the survey who completed their questionnaire in Côte d'Ivoire, Mali, and Senegal (2021).

Reported number of lines/ self-interpreted HIVST result	Completed phase 2	Linked to confirmatory testing		Confirmed HIV positive		Initiated ART	
	n	n (%)	95%CI	n (%)	95%CI	n (%)	95%CI
Overall	78	34 (44%)	33% to 55%	19 (56%)	38% to 72%	18 (95%)	72% to 100%
2 lines / reactive	27	15 (56%)	36% to 74%	12 (80%)	51% to 95%	12 (100%)	70% to 100%
1 line / reactive	7	1 (14%)	1% to 58%	0 (0%)	0% to 80%		
2 lines / non-reactive	25	9 (36%)	19% to 57%	3 (33%)	9% to 69%	3 (100%)	31% to 100%
2 lines / DK-R	18	8 (44%)	22% to 69%	4 (50%)	22% to 78%	3 (75%)	22% to 99%
DK-R / reactive	1	1(100%)	5% to 100%	0 (0%)	0% to 95%		

DK: don't know. R: refuse to answer. CI: confidence interval.

Discussion

Our study ~~reveals~~shows that the strategy ~~deployed~~implemented by the ATLAS program, through the secondary distribution of HIVST kits and ~~targeted~~dedicated channels, ~~successfully reached people living with~~achieved HIV ~~in West Africa. However, linkage~~positivity rates ranging from 2.4% to 9.1% based on the reported result, and from 3.8% to 7.2% based on the number of lines reported. The proportion of participants with a reactive HIVST that sought confirmatory ~~HIV~~ testing ~~and access to care remained sub-optimal during these initial years of HIVST implementation. Moreover~~was 44% (95% CI: 33%-55%). Of those who underwent confirmatory testing, 56% (95% CI: 38%-72%) were found to be HIV-positive and, among them, 95% (95% CI: 72%-100%) initiated treatment. Among the participants who confirmed their reactive ~~self-test result~~ HIVST with a traditional facility-based HIV test, ~~a significant proportion quickly proceeded with this confirmation (more than half in less than~~65% did so within a week and ~~the vast majority in less than~~91% within three months~~). Furthermore, if individuals were confirmed HIV-positive, almost all began antiretroviral treatment.~~ .

~~The implementation of a telephone survey, aimed at gathering information from HIVST users while preserving anonymity and without interfering with secondary distribution, has proven to be very useful to evaluate the ATLAS project. However, its high cost makes it difficult to integrate it into national strategies for assessing the impact of HIVST. Nevertheless, other impact evaluation methods, such as data triangulation[26] and modelling, may prove more suitable for routine monitoring of HIVST's impacts.~~

~~In our study, most participants (90%) demonstrated a consistent interpretation between the number of lines reported and the declared result of their HIVST. However, 2% of them reported an inconsistent interpretation of the results. Among them, a small number reported the presence of two visible lines, suggesting potential issues in interpreting the number of visible lines on HIVST kits. In the context of the ATLAS program, the distribution strategy combining primary and secondary approaches has led many HIVST users to perform their HIVST without receiving advice from a healthcare professional or a trained peer educator. Although the HIVST is not designed to require supervision, it is essential to have received information on its use before proceeding with the test. However, the lack of supervision is likely insufficient to explain the inconsistencies observed [31]. Some inconsistencies may result from a misunderstanding of the terms "*reactive*" and "*non reactive*", particularly considering that HIVST was a new tool in our context and that traditional terms used to describe conventional HIV testing are "*positive*" and "*negative*". This possible misunderstanding of the terms is also highlighted by the fact that 8 participants reported a "*reactive*" result in phase 1 questionnaire and then in phase 2 that their test was "*non-reactive*" as the main reason for not linking to confirmatory testing. Specific qualitative interviews or focus groups discussion with HIVST users could help better understand how they perceive different terms.~~

According to our estimates, HIVST positivity rates ~~range~~ranged from 1.8% to 9.8% in Côte d'Ivoire, 3.5% to 7.8% in Mali, and 1.2% to 15.0% in Senegal depending on how missing results (e.g., "*don't know*" and refusals) ~~are classified. It is important to interpret these HIV positivity rates while considering the treatment-adjusted prevalence (i.e., removing those on treatment from the numerator and denominator of HIV prevalence), a more reliable indicator for evaluating the effectiveness of targeted screening programs [32]. In West Africa, the treatment-adjusted prevalence remained relatively low in 2021: 0.6% in Côte d'Ivoire, 0.7% in Mali, and 0.06% in Senegal, according to UNAIDS data (https://aidsinfo.unaids.org/). Our results suggest that the ATLAS HIVST distribution strategy successfully reached people living with HIV. In 2021, the observed HIV positivity rates for conventional HIV testing were 1.4% in Côte d'Ivoire, 2.2% in Mali, and 1.0% in Senegal [33]. These rates were slightly lower to those we identified with HIVST based on our lower (conservative) assumption. Between 2020 and 2021, ATLAS implementing partners collected spontaneous feedback from HIVST users. This unpublished data collection was non-systematic and varied from one partner to another. Among 4 463 documented feedbacks, HIVST was reactive for 188 cases (4.2%), consistent with our estimates based on the reported number of visible lines (4.5%, central hypothesis).~~ were classified. Overall, these results for HIVST positivity are generally higher than the average overall positivity of HIV testing services (excluding HIVST) in West Africa. For instance, in 2020 an estimated 1.9% of all HIV tests performed were found to be positive in the region (95% credible intervals: 1.3 to 2.7%) ~~[33].~~[41]. Further, among 15-24 and 25-34 years old, which constitute more than 80% of our sample, overall

positivity was~~, respectively,~~ 0.9% (0.7 to 1.3%) and 1.6% (1.2 to 2.2~~%).~~%), respectively,. Collectively, these results provide evidence that HIVST is a high-yield testing modality that can address the unmet HIV testing needs of key populations and their partners.

~~Our linkage to confirmatory testing estimates were based on small numbers resulting in large confidence intervals. Nevertheless, the overall proportion was clearly sub-optimal (44%, 95% confidence interval from 33% to 55%). However, this estimate includes some individuals who did not adequately self-interpreted their HIVST result as reactive. When considering only those who reported two lines and self-interpreted their result as reactive, the linkage rate increased to 56% (36% to 74%). This percentage is close to that was observed in a study conducted in Kenya on HIV testing of FSW male partners using HIVST secondary distribution, where 65% of men with a reactive result had a confirmatory test [34]. Linkage to confirmatory testing happened relatively quickly after HIVST use: 53% did it in less than a week and 91% in less than three months. Similar results were observed in a study in the general population in Zambia[35], and a study among MSM in Nigeria [36]. For those who did confirmatory testing and were confirmed HIV positive, initiation of antiretroviral treatment was almost systematic, showing good linkage to care after confirmatory testing, as observed in many HIVST studies in sub-Saharan Africa [37–39].~~

~~Previous analyses of ATLAS data showed that HIVST could reach people not reached by conventional HIV testing approaches [40], particularly partners and clients of key populations and key population members not self-identifying as such [25]. It is consistent with the finding that two-thirds of participants who did confirmatory testing went to a general health facility rather than a community clinic dedicated to key populations. In a study conducted in 2018 in Côte d'Ivoire among MSM, one-third of the participants preferred community based testing, one third expressed no preference, and one third preferred undifferentiated HIV testing services (general population), mentioning the lack of discretion and anonymity of community-based sites and the desire to avoid the gaze of others [41].~~

~~ATLAS' HIVST distribution strategy successfully reached people living with HIV in West Africa, although linkage to confirmatory testing remained sub-optimal in these first years of HIVST implementation.~~

It is important to interpret these HIV positivity rates while considering the treatment-adjusted prevalence (i.e., removing those on treatment from the numerator and denominator of HIV prevalence), a more reliable indicator for evaluating the effectiveness of targeted screening programs [42]. In West Africa, the treatment-adjusted prevalence remained relatively low in 2021: 0.6% in Côte d'Ivoire, 0.7% in Mali, and 0.06% in Senegal, according to UNAIDS data (https://aidsinfo.unaids.org/). Our results suggest that the ATLAS HIVST distribution strategy successfully reached people living with HIV. In 2021, a study based on the UNAIDS-supported *Shiny90* mathematical model [43] estimated, using data from 184 population surveys and reports from national HIV screening programs from 40 sub-Saharan African countries, that the positivity rates for conventional HIV testing were 1.4% in Côte d'Ivoire, 2.2% in Mali, and 1.0% in Senegal. These rates were lower than our estimates for HIVST, even when using our lower (conservative) estimate. These rates are also in lines with those collected by ATLAS implementing partners. Between 2020 and 2021, these ATLAS partners collected spontaneous feedback from HIVST users. This unpublished data collection was non-systematic and varied from one partner to another. Among 4 463 documented feedbacks, HIVST was reactive for 188 cases (4.2%), consistent with our estimates based on the reported number of visible lines (4.5%, central hypothesis).

In our study, most participants (90%) demonstrated a consistent interpretation between the number of lines reported and the reported HIVST result. However, 2% of them inconsistently interpreted the results. Among them, a small number reported the presence of two visible lines, suggesting potential issues in interpreting the number of visible lines on HIVST kits. In the context of the ATLAS program, the distribution strategy combining primary and secondary approaches has led many HIVST users to perform their HIVST without receiving advice from a healthcare professional or a trained peer educator. Although the HIVST is not designed to require supervision, it is essential to have received information on its use before proceeding with the test. A study conducted within the framework of the ATLAS program demonstrated that the manufacturer's instructions alone were insufficient in a multilingual context with low literacy levels. The use of additional aids, such as a demonstration video or a toll-free helpline, proved necessary [44]. Similarly, a study carried out in China in 2018 on the unsupervised use of HIVST among 27 MSM found that only 5 (or 19%) made no errors, and 44% received an invalid test result due to various mistakes made [45]. However, the lack of supervision is likely insufficient to explain the inconsistencies

observed [23]. Some inconsistencies may result from a misunderstanding of the terms "*reactive*" and "*non-reactive*", particularly considering that HIVST was a new tool in our context and that traditional terms used to describe conventional HIV testing are "*positive*" and "*negative*". This possible misunderstanding of the terms is also highlighted by the fact that 8 participants reported a "*reactive*" result in phase 1 questionnaire and then in phase 2 that their test was "*non-reactive*" as the main reason for not linking to confirmatory testing. Specific qualitative interviews or focus groups discussion with HIVST users could help better understand how they perceive different terms.

Our linkage to confirmatory testing estimates were based on small numbers resulting in large confidence intervals. Nevertheless, the overall proportion was clearly sub-optimal (44%, 95% confidence interval from 33% to 55%). However, this estimate includes some individuals who did not adequately self-interpreted their HIVST result as reactive. When considering only those who reported two lines and self-interpreted their result as reactive, the linkage rate increased to 56% (36% to 74%). This percentage is closer to that was observed in a study conducted in Kenya on HIV testing of FSW male partners using HIVST secondary distribution, where 65% of men with a reactive result had a confirmatory test [46]. Linkage to confirmatory testing happened relatively quickly after HIVST use: 53% did it in less than a week and 91% in less than three months. Similar results were observed in a study in the general population in Zambia[47], and a study among MSM in Nigeria [48].

The main reasons given for not linking to confirmatory testing suggest potential misinterpretation of the result or misunderstanding about the need to perform a confirmatory HIV test, highlighting the need to improve messaging around HIVST, in particular when HIV self-testing policies will be scaled-up. For those who did confirmatory testing and were confirmed HIV positive, initiation of antiretroviral treatment was almost systematic, showing good linkage to care after confirmatory testing, as observed in many HIVST studies in sub-Saharan Africa [49–51].

Previous analyses of ATLAS data showed that HIVST could reach people not reached by conventional HIV testing approaches [52], particularly partners and clients of key populations and key population members not self-identifying as such [38]. It is consistent with the finding that two-thirds of participants who did confirmatory testing went to a general health facility rather than a community clinic dedicated to key populations. In a study conducted in 2018 in Côte d'Ivoire among MSM, one-third of the participants preferred community-based testing, one-third expressed no preference, and one-third preferred undifferentiated HIV testing services (general population), mentioning the lack of discretion and anonymity of community-based sites and the desire to avoid the gaze of others [53].

The implementation of a telephone survey, aimed at gathering information from HIVST users while preserving anonymity and without interfering with secondary distribution, has proven to be very useful to evaluate the ATLAS program. However, its high cost makes it difficult to integrate it into national strategies for assessing the impact of HIVST. Nevertheless, other impact evaluation methods, such as data triangulation [35] and modelling [36], may prove more suitable for routine monitoring of HIVST's impacts.

A previous analysis of this survey among ATLAS HIVST users showed that HIVST secondary distribution was feasible and acceptable [38]: participants reported that they appreciated the ease of use of HIVST, its discretion and the fact that they are autonomous in carrying out the test. Finally, HIVST appeared as a relevant additional approach for those usually distant from community activities and HIV testing services, and has the potential to reach, beyond key populations, partners, clients, and other groups vulnerable to HIV.

ATLAS' HIVST distribution strategy successfully reached people living with HIV in West Africa, although linkage to confirmatory testing remained sub-optimal in these first years of HIVST implementation. However, among participants who confirmed their reactive self-test result with a traditional facility-based HIV test, a substantial proportion quickly proceeded with this confirmation (more than half in less than a week and the vast majority in less than three months). Furthermore, if individuals were confirmed HIV-positive, almost all began antiretroviral treatment. We showed that HIVST has the potential to reach more

hidden populations and constitutes a relevant complementary tool to existing screening services. To fully harness the potential of self-tests, messaging around HIVST and its interpretation could be improved.

Appendices

Table S1. Eligibility and participation in phase 2 survey by sociodemographic characteristics, distribution channel, HIV testing history, the reported number of lines and the self-interpreted HIV self-testing (HIVST) result

	~~Overall~~ ~~N= 2 615 (phase 1 participants)~~ Eligible for phase 2 completed the questionnaire N=78	Eligible for phase 2 ~~completed~~ but did not complete the questionnaire N=~~78~~ 42	~~Eligible~~ Not eligible for ~~phase~~ Phase 2 ~~but did not complete the questionnaire~~ N= ~~42~~ = 2 495	~~Not eligible for Phase 2 N = 2495~~ p-value ~~(Chi² test)~~	~~p value (Chi² test)~~ Overall N= 2 615 (phase 1 participants)
Country				0.9	~~0.9~~
Côte ~~d'Ivoire~~d'Ivoire	~~1 390 (53~~39 (50%)	~~39 (50~~20 (48%)	~~20 (48~~1 331 (53%)	~~1 331 (53%)~~	1 390 (53%)
Mali	~~984 (38~~31 (40%)	~~31 (40~~18 (43%)	~~18 (43~~935 (37%)	~~935 (37%)~~	984 (38%)
Senegal	~~241 (9.2~~8 (10%)	~~8 (10~~4 (9.5%)	~~4~~229 (9.5~~2~~%)	~~229 (9.2%)~~	241 (9.2%)
Sex and distribution channel				0.3	~~0.3~~
~~man~~ Man : MSM-based channels	~~997 (38~~35 (45%)	~~35 (45~~14 (33%)	~~14 (33~~948 (38%)	~~948 (38%)~~	997 (38%)
~~woman~~ Woman : MSM-based channels	~~103 (3.9~~5 (6.4%)	~~5 (6.4~~0 (0%)	~~0 (0~~98 (3.9%)	~~98 (3.9%)~~	103 (3.9%)
~~man~~ Man : FSW-based channels	~~620 (24~~22 (28%)	~~22 (28~~10 (24%)	~~10~~588 (24%)	~~588 (24%)~~	620 (24%)
~~woman~~ Woman : FSW-based channels	~~685 (26~~14 (18%)	~~14 (18~~15 (36%)	~~15 (36~~656 (26%)	~~656 (26%)~~	685 (26%)
~~man other based~~ Man: Other delivery channels	~~137 (5.2~~1 (1.3%)	~~1 (1.3~~2 (4.8%)	~~2 (~~134 (5.4~~.8~~%)	~~134 (5.4%)~~	137 (5.2%)
~~woman other based~~ Woman : Other delivery channels	~~73 (2.8~~1 (1.3%)	1 (~~1.3~~2.4%)	~~1~~71 (2.4~~8~~%)	~~71 (2.8%)~~	73 (2.8%)
Age group				0.5	~~0.5~~
15-24 years or ~~younger~~less	~~1 164 (45~~27 (35%)	~~27 (35~~20 (48%)	~~20 (48~~1 117 (45%)	~~1 117 (45%)~~	1 164 (45%)
25-34 years	~~1 063 (41~~38 (49%)	16 (38 ~~(49~~%)	~~16 (38~~1,009 (40%)	~~1 009 (40%)~~	1 063 (41%)
35 years or ~~older~~more	~~388 (15~~13 (17%)	~~13 (17~~6 (14%)	~~6 (14~~369 (15%)	~~369 (15%)~~	388 (15%)
Marital status				0.3	~~0.3~~
single	~~1 761 (67~~54 (69%)	~~54 (69~~28 (67%)	~~28~~1 679 (67%)	~~1 679 (67%)~~	1 761 (67%)
~~living with partner / married~~ divorced / separated / widowed	~~757 (29~~6 (7.7%)	~~18 (23~~2 (4.8%)	~~12 (29~~89 (3.6%)	~~727 (29%)~~	97 (3.7%)
~~divorced / separated / widowed~~ living with partner / married	~~97 (3.7~~18 (23%)	~~6 (7.7~~12 (29%)	~~2 (4.8~~727 (29%)	~~89 (3.6%)~~	757 (29%)
Educational level				0.057	~~0.057~~

none / primary	~~503 (19~~13 (17%)	~~13 (17~~10 (24%)	~~10 (24~~480 (19%)	~~480 (19%)~~	503 (19%)
secondary	~~1 432 (55~~50 (64%)	~~50 (64~~28 (67%)	~~28 (67~~1 354 (54%)	~~1 354 (54%)~~	1 432 (55%)
higher	~~680 (26~~15 (19%)	~~15 (19~~4 (9.5%)	~~4 (9.5~~661 (26%)	~~661 (26%)~~	680 (26%)
First-time ~~testers~~tester				0.3	~~0.3~~
~~yes~~no	~~1 078 (41~~40 (51%)	~~38 (49~~22 (52%)	~~20 (48~~1 475 (59%)	~~1 020 (41%)~~	1 537 (59%)
~~No~~yes	~~1 537 (59~~38 (49%)	~~40 (51~~20 (48%)	~~22 (52~~1 020 (41%)	~~1 475 (59%)~~	1 078 (41%)

	~~Overall~~ ~~N= 2 615~~ ~~(phase 1 participants)~~Eligible for phase 2 completed the questionnaire N=78	Eligible for phase 2 ~~completed~~but did not complete the questionnaire N=~~78~~ 42	~~Eligible~~Not eligible for ~~phase~~ Phase 2 ~~but did not complete the questionnaire~~ -N~~= 42~~ = 2495	~~Not eligible for Phase 2~~ ~~N = 2495~~p-value (Chi² test)	~~p-value (Chi² test)~~Total N= 2 615 (phase 1 participants)
Result and number line				≤0.001	~~<0.001~~
2 lines / reactive	~~50 (1.9~~27 (35%)	~~27 (35~~20 (48%)	~~20 (48~~3 (0.1%)	~~3 (0.1%)~~	50 (1.9%)
1 line / ~~not~~ non-reactive	~~2 292 (88~~0 (0%)	0 (0%)	~~0 (0~~2 292 (92%)	~~2 292 (92%)~~	2 292 (88%)
0-1 line / ~~not reactive~~invalid	~~3 (0.1~~ (0%)	0 (0%)	4 (0-~~(0~~.2%)	~~3 (0.1%)~~	4 (0.2%)
~~2 lines/ not~~1 line / reactive	~~35 (1.3~~7 (9.0%)	~~25 (32~~3 (7.1%)	~~9 (21~~0 (0%)	~~1 (<0.1%)~~	10 (0.4%)
~~1 line /~~ 2 lines / non-reactive	~~10 (0.4~~25 (32%)	~~7 (9.0~~ (21%)	~~3 (7~~1 (<0.1%)	~~0 (0%)~~	35 (1.3%)
0~~-1~~ line~~/ invalid~~ / non-reactive	~~4 (0.2~~ (0%)	0 (0%)	3 (0-~~(0~~.1%)	~~4 (0.2%)~~	3 (0.1%)
~~2 lines~~0 line / DK-R	~~29 (1.1~~0 (0%)	~~18 (23~~0 (0%)	~~9 (21~~1 (<0.1%)	~~2 (<0.1%)~~	1 (<0.1%)
1 line / DK-R	~~117 (4.5~~0 (0%)	0 (0%)	~~0 (0~~117 (4.7%)	~~117 (4.7%)~~	117 (4.5%)
~~0 line~~2 lines / DK-R	~~1 (<0.1~~18 (23%)	~~0 (0~~9 (21%)	2 (<0 ~~(0~~.1%)	~~1 (<0.1%)~~	29 (1.1%)
DK-R / reactive	~~2 (<0.~~1 (1.3%)	1 (~~1.3~~2.4%)	~~1 (2.4~~0 (0%)	~~0 (0%)~~	2 (<0.1%)
DK-R / ~~not reactive~~DK-R	~~44 (1.7~~0 (0%)	0 (0%)	~~0 (0~~28 (1.1%)	~~44 (1.8%)~~	28 (1.1%)
DK-R / ~~DK-R~~non-reactive	~~28 (1.1~~0 (0%)	0 (0%)	~~0 (0~~44 (1.8%)	~~28 (1.1%)~~	44 (1.7%)

FSW: female sex workers, MSM: men having sex with men

Table S2.. Positivity rates based on self-interpreted HIVST results or the reported number of visible lines, by distribution channel, gender and country, among participants of the first survey phase in Côte d'Ivoire, Mali, and Senegal (2021).

			MSM-based channels		FSW-based channels		Others delivery channels		Total
			Man	Woman	Man	Woman	Man	Woman	
Positivity rate based on self-reported HIVST results	Low	Côte d'Ivoire	2.5% (16/650)	1.4% (1/73)	1.5% (5/339)	1.2% (3/245)	0% (0/60)	0% (0/23) †	1.8% (25/1 390)
		Mali	4.6% (14/306)	0% (0/29)	1.9% (5/269)	3.9% (14/360)	9.1% (1/11) †	0% (0/9) †	3.5% (34/984)
		Senegal	4.9% (2/41)	0% (0/1) †	0% (0/12) †	0% (0/80)	0% (0/66)	2.4% (1/41)	1.2% (3/241)
		Overall	3.2% (32/997)	1.0% (1/103)	1.6% (10/620)	2.5% (17/685)	0.7% (1/137)	1.4% (1/73)	2.4% (62/2 615)
	Central	Côte d'Ivoire	2.7% (16/597)	1.4% (1/71)	1.6% (5/311)	1.4% (3/221)	0% (0/58)	0% (0/21) †	2.0% (25/1 279)
		Mali	4.7% (14/301)	0% (0/29)	1.9% (5/257)	4.1% (14/345)	9.1% (1/11) †	0% (0/9) †	3.6% (34/952)
		Senegal	6.1% (2/33)	0% (0/1) †	0% (0/11) †	0% (0/65)	0% (0/61)	2.6% (1/38)	1.4% (3/209)
		Overall	3.4% (32/931)	1.0% (1/101)	1.7% (10/579)	2.7% (17/631)	0.8% (1/130)	1.5% (1/68)	2.5% (62/2 440)
	High	Côte d'Ivoire	10.6% (69/650)	4.1% (3/73)	9.7% (33/339)	11% (27/245)	3.3% (2/60)	8.7% (2/23)	9.8% (136/1 390)
		Mali	6.2% (19/306)	0% (0/29)	6.3% (17/269)	8.1% (29/360)	9.1% (1/11) †	0% (0/9) †	6.7% (66/984)
		Senegal	24.0% (10/41)	0.0% (0/1) †	8.3% (1/12) †	19.0% (15/80)	7.6% (5/66)	9.8% (4/41)	15.0% (35/241)
		Overall	9.8% (98/997)	2.9% (3/103)	8.2% (51/620)	10.0% (71/685)	5.8% (8/137)	8.2% (6/73)	9.1% (237/2 615)
Positivity rate based on the reported number of visible lines	Low	Côte d'Ivoire	4.2% (27/650)	5.5% (4/73)	4.7% (16/339)	2.0% (5/245)	0% (0/60)	4.3% (1/23)	3.8% (53/1 390)
		Mali	4.9% (15/306)	3.4% (1/29)	4.5% (12/269)	5.3% (19/360)	9.1% (1/11) †	0% (0/9) †	4.9% (48/984)
		Senegal	12.2% (5/41)	0% (0/1) †	0% (0/12) †	5.0% (4/80)	4.5% (3/66)	2.4% (1/41)	5.4% (13/241)
		Overall	4.7% (47/997)	4.9% (5/103)	4.5% (28/620)	4.1% (28/685)	2.9% (4/137)	2.7% (2/73)	4.4% (114/2 615)
	Central	Côte d'Ivoire	4.2% (27/641)	5.5% (4/73)	4.8% (16/331)	2.1% (5/241)	0% (0/60)	4.5% (1/22) †	3.9% (53/1 368)
		Mali	5.0% (15/298)	3.4% (1/29)	4.5% (12/264)	5.5% (19/344)	9.1% (1/11) †	0% (0/9) †	5.0% (48/955)
		Senegal	13.2% (5/38)	0% (0/1) †	0% (0/10) †	5.3% (4/75)	5.3% (3/57)	2.7% (1/37)	6.0% (13/218)
		Overall	4.8% (47/977)	4.9% (5/103)	4.6% (28/605)	4.2% (28/660)	3.1% (4/128)	2.9% (2/68)	4.5% (114/2 541)
	High	Côte d'Ivoire	5.5% (36/650)	5.5% (4/73)	7.1% (24/339)	3.7% (9/245)	0% (0/60)	8.7% (2/23) †	5.4% (75/1 390)
		Mali	7.5% (23/306)	3.4% (1/29)	6.3% (17/269)	9.7% (35/360)	9.1% (1/11) †	0% (0/9) †	7.8% (77/984)
		Senegal	19.5% (8/41)	0% (0/1) †	16.7% (2/12) †	11.2% (9/80)	18.2% (12/66)	12.2% (5/41)	14.9% (36/241)
		Overall	6.7% (67/997)	4.9% (5/103)	6.9% (43/620)	7.7% (53/685)	9.5% (13/137)	9.6% (7/73)	7.2% (188/2 615)

DK: don't know. R: refusals. FSW: female sex workers, MSM: men having sex with men, PR: positivity rate.

†: indicated cells with less than 25 participants.

Low hypothesis: DK-R as non-reactive or 1 line. Central hypothesis: DK-R excluded from the numerator and the denominator. High hypothesis: DK-R as reactive or 2 lines.

Table S3. Positivity rates based on self-interpreted HIVST results or the reported number of visible lines, by age group and country, among participants of the first survey phase in Côte d'Ivoire, Mali, and Senegal (2021).

			15-24 years	25-34 years old	35 years or more	Total
Positivity rate based on self-reported HIVST results	Low	Côte d'Ivoire	1.7% (11/645)	2.0% (11/553)	1.6% (3/192)	1.8% (25/1 390)
		Mali	3.3% (15/455)	3.9% (16/415)	2.6% (3/114)	3.5% (34/984)
		Senegal	0.0% (0/64)	2.1% (2/95)	1.2% (1/82)	1.2% (3/241)
		Overall	2.2% (26/1 164)	2.7% (29/1 063)	1.8% (7/388)	2.4% (62/2 615)
	Central	Côte d'Ivoire	1.8% (11/604)	2.2% (11/506)	1.8% (3/169)	2.0% (25/1 279)
		Mali	3.4% (15/439)	4.0% (16/403)	2.7% (3/110)	3.6% (34/952)
		Senegal	0.0% (0/56)	2.4% (2/82)	1.4% (1/71)	1.4% (3/209)
		Overall	2.4% (26/1 099)	2.9% (29/991)	2.0% (7/350)	2.5% (62/2 440)
	High	Côte d'Ivoire	8.1% (52/645)	10.0% (58/553)	14.0% (26/192)	9.8% (136/1 390)
		Mali	6.8% (31/455)	6.7% (28/415)	6.1% (7/114)	6.7% (66/984)
		Senegal	13.0% (8/64)	16.0% (15/95)	15.0% (12/82)	15.0% (35/241)
		Overall	7.8% (91/1 164)	9.5% (101/1 063)	12.0% (45/388)	9.1% (237/2 615)
Positivity rate based on the reported number of visible lines	Low	Côte d'Ivoire	3.1% (20/645)	4.5% (25/553)	4.2% (8/192)	3.8% (53/1 390)
		Mali	4.8% (22/455)	4.8% (20/415)	5.3% (6/114)	4.9% (48/984)
		Senegal	1.6% (1/64)	7.4% (7/95)	6.1% (5/82)	5.4% (13/241)
		Overall	3.7% (43/1 164)	4.9% (52/1 063)	4.9% (19/388)	4.4% (114/2 615)
	Central	Côte d'Ivoire	3.1% (20/637)	4.6% (25/546)	4.3% (8/185)	3.9% (53/1 368)
		Mali	4.9% (22/447)	5.0% (20/401)	5.6% (6/107)	5.0% (48/955)
		Senegal	1.9% (1/54)	8.2% (7/85)	6.3% (5/79)	6.0% (13/218)
		Overall	3.8% (43/1 138)	5.0% (52/1 032)	5.1% (19/371)	4.5% (114/2 541)
	High	Côte d'Ivoire	4.3% (28/645)	5.8% (32/553)	7.8% (15/192)	5.4% (75/1 390)
		Mali	6.6% (30/455)	8.2% (34/415)	11.0% (13/114)	7.8% (77/984)
		Senegal	17.0% (11/64)	18.0% (17/95)	9.8% (8/82)	15.0% (36/241)
		Overall	5.9% (69/1 164)	7.8% (83/1 063)	9.3% (36/388)	7.2% (188/2 615)

Table S4. Main reason for not linking to confirmatory testing among phase 2 participants who did not link to confirmatory testing, by reported number of lines and self-interpreted HIVST result.

	Overall	2 lines / reactive	1 line / reactive	2 lines / non-reactive	2 lines / DK-R
My test was non-reactive	18 (41%)	6 (50%)	2 (33%)	5 (31%)	5 (50%)
I didn't know ~~he~~we should get a confirmatory test	10 (23%)	2 (17%)	2 (33%)	5 (31%)	1 (10%)
I didn't have time	8 (18%)	3 (25%)	0 (0%)	3 (19%)	2 (20%)
I feared that others would know the result	2 (4.5%)	0 (0%)	0 (0%)	1 (6.2%)	1 (10%)
I already knew the result before using HIVST	2 (4.5%)	1 (8.3%)	1 (17%)	0 (0%)	0 (0%)
I had no specific reason	2 (4.5%)	0 (0%)	1 (17%)	1 (6.2%)	0 (0%)
I didn't know where to take the test	1 (2.3%)	0 (0%)	0 (0%)	1 (6.2%)	0 (0%)
The testing site was too far away	1 (2.3%)	0 (0%)	0 (0%)	0 (0%)	1 (10%)
Total	44 (100%)	12 (27.3%)	6 (13.6%)	16 (36.4%)	10 (22.7%)

DK: don't know. R: refuse to answer

Table S5. Time between HIVST and confirmatory testing among phase 2 participants who did link to confirmatory testing, by reported number of lines and self-interpreted HIVST result.

	Overall	2 lines /reactive	1 line /reactive	2 lines /non-reactive	2 lines /DK-R	DK-R / reactive
less than a week	18 (53%)	12 (80%)	0 (0%)	0 (0%)	6 (75%)	0 (0%)
between 1 and 2 weeks	4 (12%)	1 (6.7%)	0 (0%)	2 (22%)	1 (12%)	0 (0%)
between 3 and 4 weeks	2 (5.9%)	1 (6.7%)	0 (0%)	0 (0%)	1 (12%)	0 (0%)
between ~~one~~1 and ~~two~~2 months	7 (21%)	1 (6.7%)	0 (0%)	5 (56%)	0 (0%)	1 (100%)
more than 3 months	3 (8.8%)	0 (0%)	1 (100%)	2 (22%)	0 (0%)	0 (0%)
Total	**34 (100%)**	**15 (44.2%)**	**1 (2.9%)**	**9 (26.5%)**	**8 (23.5%)**	**1 (2.9%)**

DK: don't know. R: refuse to answer

Table S6. Place of confirmatory testing among phase 2 participants who did link to confirmatory testing, by reported number of lines and self-interpreted HIVST result.

	Overall	2 lines /reactive	1 line /reactive	2 lines /non-reactive	2 lines /DK-R	DK-R / reactive
Health Center / Hospital / Clinic / Maternity	12 (35%)	3 (20%)	0 (0%)	6 (67%)	3 (38%)	0 (0%)
Community Clinic / KP-dedicated Health Center	22 (65%)	12 (80%)	1 (100%)	3 (33%)	5 (62%)	1 (100%)
Total	**34 (100%)**	**15 (44.2%)**	**1 (2.9%)**	**9 (26.5%)**	**8 (23.5%)**	**1 (2.9%)**

DK: don't know. R: refuse to answer

Table S7. Time between phase 1 and phase 2 interviews among phase 2 participants who did link to confirmatory testing, by reported number of lines and self-interpreted HIVST result.

	Overall	2 lines /reactive	1 line /reactive	2 lines /non-reactive	2 lines /DK-R	DK-R / reactive
between 4 and 6 months	67 (86%)	24 (89%)	5 (71%)	21 (84%)	17 (94%)	0 (0%)
less than 4 months	8 (10%)	3 (11%)	0 (0%)	4 (16%)	1 (5.6%)	0 (0%)
more than 6 months	3 (3.8%)	0 (0%)	2 (29%)	0 (0%)	0 (0%)	1 (100%)
Total	**34 (100%)**	**15 (44.2%)**	**1 (2.9%)**	**9 (26.5%)**	**8 (23.5%)**	**1 (2.9%)**

DK: don't know. R: refuse to answer

Acknowledgements

We wish to acknowledge the commitment and determination of all the ATLAS ~~project~~program teams, which made this research possible. We would also like to thank the interviewers for their professionalism in collecting this sensitive data. Finally, we are grateful to the participants who were kind enough to give us some of their time by agreeing to take part in the survey.

Data, scripts, code, and supplementary information availability

Data, scripts and code are available online on the Zenodo website. (https://doi.org/10.5281/zenodo.~~7986077);~~8329454).

Conflict of interest disclosure

The authors declare that they comply with the PCI rule of no financial conflicts of interest in relation to the content of the article. They declare no conflict of interest.

Funding

This work was supported by Unitaid (Grant Number: 2018-23 ATLAS) with additional funding from Agence Française pour le Développement (AFD). AKK benefits from an ANRS thesis allowance. MMG's research program is supported by a Canada Research Chair (Tier 2) in Population Health Modeling. The funding bodies were not involved in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript.

MCB and RS acknowledge funding from the MRC Centre for Global Infectious Disease Analysis (reference MR/R015600/1), jointly funded by the UK Medical Research Council (MRC) and the UK Foreign, Commonwealth & Development Office (FCDO), under the MRC/FCDO Concordat agreement and is also part of the EDCTP2 programme supported by the European Union. For the purpose of open access, the author has applied a Creative Commons Attribution (CC BY) license to any Author Accepted Manuscript version arising.

References

1. Das M, Chu PL, Santos G-M, Scheer S, Vittinghoff E, McFarland W, et al. Decreases in Community Viral Load Are Accompanied by Reductions in New HIV Infections in San Francisco. PLoS ONE. 2010;5:e11068.

2. Lima VD, Johnston K, Hogg RS, Levy AR, Harrigan PR, Anema A, et al. Expanded Access to Highly Active Antiretroviral Therapy: A Potentially Powerful Strategy to Curb the Growth of the HIV Epidemic. J Infect Dis. 2008;198:59–67.

3. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Prevention of HIV-1 Infection with Early Antiretroviral Therapy. N Engl J Med. 2011;365:493–505.

4. Quinn TC, Wawer MJ, Sewankambo N, Serwadda D, Li C, Wabwire-Mangen F, et al. Viral Load and Heterosexual Transmission of Human Immunodeficiency Virus Type 1. N Engl J Med. 2000;342:921–9.

5. Hayes RJ, Donnell D, Floyd S, Mandla N, Bwalya J, Sabapathy K, et al. Effect of Universal Testing and Treatment on HIV Incidence — HPTN 071 (PopART). N Engl J Med. 2019;381:207–18.

6. Grinsztejn B, Hosseinipour MC, Ribaudo HJ, Swindells S, Eron J, Chen YQ, et al. Effects of early versus delayed initiation of antiretroviral treatment on clinical outcomes of HIV-1 infection: results from the phase 3 HPTN 052 randomised controlled trial. Lancet Infect Dis. 2014;14:281–90.

7. UNAIDS. ~~REFERENCE~~ UNAIDS ~~DATA~~data 2021~~—~~.Geneva: Joint United Nations Programme on HIV/AIDS;UNAIDS/JC3032E. Geneva; 2021.

8. ~~Unaids. Understanding~~Joint United Nations Programme on HIV/AIDS. Fast-Track~~: accelarating action to end~~ - Ending the AIDS epidemic by ~~2023~~2030. Geneva~~: Unaids; 2015~~; 2014.

9. Johnson C, Baggaley R, Forsythe S, van Rooyen H, Ford N, Napierala Mavedzenge S, et al. Realizing the Potential for HIV Self-Testing. AIDS Behav. 2014;18:391–5.

10. Njau B, Covin C, Lisasi E, Damian D, Mushi D, Boulle A, et al. A systematic review of qualitative evidence on factors enabling and deterring uptake of HIV self-testing in Africa. BMC Public Health. 2019;19:1289.

11. Hector J, Davies M-A, Dekker-Boersema J, Aly MM, Abdalad CCA, Langa EBR, et al. Acceptability and performance of a directly assisted oral HIV self-testing intervention in adolescents in rural Mozambique. PloS One. 2018;13:e0195391.

12. Grésenguet G, Longo J de D, Tonen-Wolyec S, Bouassa R-SM, Belec L. Acceptability and Usability Evaluation of Finger-Stick Whole Blood HIV Self-Test as An HIV Screening Tool Adapted to The General Public in The Central African Republic. Open AIDS J. 2017;11:101–18.

13. Harichund C, Moshabela M, Kunene P, Abdool Karim Q. Acceptability of HIV self-testing among men and women in KwaZulu-Natal, South Africa. AIDS Care. 2019;31:186–92.

14. Kalibala S, Tun W, Cherutich P, Nganga A, Oweya E, Oluoch P. Factors Associated with Acceptability of HIV Self-Testing Among Health Care Workers in Kenya. AIDS Behav. 2014;18:405–14.

15. Kelvin EA, Cheruvillil S, Christian S, Mantell JE, Milford C, Rambally-Greener L, et al. Choice in HIV testing: the acceptability and anticipated use of a self-administered at-home oral HIV test among South Africans. Afr J AIDS Res. 2016;15:99–108.

16. Martínez Pérez G, Steele SJ, Govender I, Arellano G, Mkwamba A, Hadebe M, et al. Supervised oral HIV self-testing is accurate in rural KwaZulu-Natal, South Africa. Trop Med Int Health. 2016;21:759–67.

17. Ky-Zerbo O, Desclaux A, Boye S, Vautier A, Rouveau N, Kouadio BA, et al. Willingness to use and distribute HIV self-test kits to clients and partners: A qualitative analysis of female sex workers' collective opinion and attitude in Côte d'Ivoire, Mali, and Senegal. Womens Health. 2022;18:174550572210922.

18. Kurth AE, Cleland CM, Chhun N, Sidle JE, Were E, Naanyu V, et al. Accuracy and Acceptability of Oral Fluid HIV Self-Testing in a General Adult Population in Kenya. AIDS Behav. 2016;20:870–9.

19. 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;20:21594.

12. word20. World Health Organisazion. WHOOrganization. RECOMMENDS HIV SELFTESTING – EVIDENCE UPDATE AND CONSIDERATIONS FOR SUCCESS. Geneva: Word Health Organization; 2019.

1321. 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.

1422. World Health Organization. Guidelines on HIV self-testing and partner notification: supplement to Consolidated guidelines on HIV testing services. 2016.https://apps.who.int/iris/handle/10665/251655. 2016.

15. Hector J, Davies M-A, Dekker-Boersema J, Aly MM, Abdalad CCA, Langa EBR, et al. Acceptability and performance of a directly assisted oral HIV self-testing intervention in adolescents in rural Mozambique. PLOS ONE. 2018;13:e0195391.

1623. Asiimwe S, Oloya J, Song X, Whalen CC. Accuracy of Un-supervised Versus Provider-Supervised Self-administered HIV Testing in Uganda: A Randomized Implementation Trial. AIDS Behav. 2014;18:2477–84.

1724. Figueroa C, Johnson C, Ford N, Sands A, Dalal S, Meurant R, et al. Reliability of HIV rapid diagnostic tests for self-testing compared with testing by health-care workers: a systematic review and meta-analysis. Lancet HIV. 2018;5:e277–90.

1825. Chanda MM, Ortblad KF, Mwale M, Chongo S, Kanchele C, Kamungoma N, et al. HIV self-testing among female sex workers in Zambia: A cluster randomized controlled trial. PLOS Med. 2017;14:e1002442.

1926. Tonen-Wolyec S, Filali M, Mboup S, Bélec L. HIV self-testing in Africa: stakes and challenges. Médecine Santé Trop. 2018;28:144–9.

2027. Pant Pai N, Behlim T, Abrahams L, Vadnais C, Shivkumar S, Pillay S, et al. Will an Unsupervised Self-Testing Strategy for HIV Work in Health Care Workers of South Africa? A Cross Sectional Pilot Feasibility Study. PLoS ONE. 2013;8:e79772.

2128. Brown AN, Djimeu EW, Cameron DB. A Review of the Evidence of Harm from Self-Tests. AIDS Behav. 2014;18:445–9.

22. UNAIDS. UNAIDS DATA 2022. Geneva: Joint United Nations Programme on HIV/AIDS;UNAIDS/JC3063E. Geneva: Joint United Nations Programme on HIV/AIDS; 2022.

2329. Rouveau N, Ky-Zerbo O, Boye S, Fotso AS, d'Elbée M, Maheu-Giroux M, et al. Describing, analysing and understanding the effects of the introduction of HIV self-testing in West Africa through the ATLAS programme in Côte d'Ivoire, Mali and Senegal. BMC Public Health. 2021;21:181.

24.30. UNAIDS. UNAIDS DATA 2022. Geneva: Joint United Nations Programme on HIV/AIDS;UNAIDS/JC3063E.https://www.unaids.org/sites/default/files/media_asset/data-book-2022_en.pdf. Geneva: Joint United Nations Programme on HIV/AIDS; 2022.

31. World Health Organization. Consolidated guidelines on HIV prevention, testing, treatment, service delivery and monitoring: recommendations for a public health approach. 2021 update. Geneva, Switzerland: World Health Organization; 2021.

25. Kouassi AK, Simo Fotso A, N'Guessan KN, Geoffroy O, Younoussa S, Kanku Kabemba O32. Lyons CE, Coly K, Bowring AL, Liestman B, Diouf D, Wong VJ, et al. Reaching keyUse and peripheral

populations: a phone-based surveyAcceptability of HIV self-test users in West Africa. Durban: poster #PEC004; 2021.

26. Simo Fotso A, Johnson C, Vautier A, Kouamé KB, Diop PM, Silhol R, et al. Routine programmatic data show a positive population-level impact of HIV self-testing: the case of Côte d'Ivoire and implicationsSelf-Testing Among First-Time Testers at Risk for implementation. AIDS. 2022;36:1871–9.

27. Ky-Zerbo O, Desclaux A, Boye S, Vautier A, Rouveau N, Kouadio BA, et al. Willingness to use and distribute HIV self-test kits to clients and partners: a qualitative analysis of female sex workers' collective opinion and attitude in Côte d'Ivoire, Mali, and HIV in Senegal. Women's Health. In pressAIDS Behav. 2019;23:130–41.

2833. Boye S, Bouaré S, Ky-Zerbo O, Rouveau N, Simo Fotso A, d'Elbée M, et al. Challenges of HIV Self-Test Distribution for Index Testing When HIV Status Disclosure Is Low: Preliminary Results of a Qualitative Study in Bamako (Mali) as Part of the ATLAS Project. Front Public Health. 2021;9:653543.

2934. d'Elbée M, Traore MM, Badiane K, Vautier A, Simo Fotso A, Kabemba OK, et al. Costs and Scale-Up Costs of Integrating HIV Self-Testing Into Civil Society Organisation-Led Programmes for Key Populations in Côte d'Ivoire, Senegal, and Mali. Front Public Health. 2021;9:653612.

3035. Simo Fotso A, Johnson C, Vautier A, Kouamé KB, Diop PM, Silhol R, et al. Routine programmatic data show a positive population-level impact of HIV self-testing: the case of Côte d'Ivoire and implications for implementation. AIDS. 2022;36:1871–9.

36. Silhol R, Maheu-Giroux M, Soni N, Fotso AS, Rouveau N, Vautier A, et al. Assessing the potential population-level impacts of HIV self-testing distribution among key populations in Côte d'Ivoire, Mali, and Senegal: a mathematical modelling analysis. preprint. HIV/AIDS; 2023.

37. Simo Fotso A, Kra AK, Maheu-Giroux M, Boye S, d'Elbée M, Ky-zerbo O, et al. Is it possible to recruit HIV self-test users for an anonymous phone-based survey using passive recruitment without financial incentives? Lessons learned from a pilot study in Côte d'Ivoire. Pilot Feasibility Stud. 2022;8:4.

38. Kouassi AK, Fosto AS, N'Guessan NK, Geoffroy O, Younoussa S, Kabemba OK, et al. Reaching key and peripheral populations: a phone-based survey of HIV self-test users in West Africa.Durban: poster #PEC004.https://hal.science/hal-04121478. 2021.

39. R Core Team. R: A Language and Environment for Statistical Computing. 2021.

31. Asiimwe S, Oloya J, Song X, Whalen CC. Accuracy of Un-supervised Versus Provider Supervised Self-administered HIV Testing in Uganda: A Randomized Implementation Trial. AIDS Behav. 2014;18:2477–84.

32. Tippett Barr B, Lowrance D, Case Johnson C, Baggaley RC, Rogers J, Balachandra S, et al. Treatment-adjusted prevalence to assess HIV testing programmes. Bull World Health Organ. 2021;99:874–82.

3340. Sjoberg D D, Whiting K, Curry M, Lavery J A, Larmarange J. Reproducible Summary Tables with the gtsummary Package. R J. 2021;13:570.

41. Giguère K, Eaton JW, Marsh K, Johnson LF, Johnson CC, Ehui E, et al. Trends in knowledge of HIV status and efficiency of HIV testing services in sub-Saharan Africa, 2000–20: a modelling study using survey and HIV testing programme data. Lancet HIV. 2021;8:e284–93.

3442. Tippett Barr B, Lowrance D, Case Johnson C, Baggaley RC, Rogers J, Balachandra S, et al. Treatment-adjusted prevalence to assess HIV testing programmes. Bull World Health Organ. 2021;99:874–82.

43. Maheu-Giroux M, Vesga JF, Diabaté S, Alary M, Baral S, Diouf D, et al. Population-level impact of an accelerated HIV response plan to reach the UNAIDS 90-90-90 target in Côte d'Ivoire: Insights from mathematical modeling. PLOS Med. 2017;14:e1002321.

44. Vautier A. La notice d'utilisation du fabricant suffit-elle dans un contexte multilingue et de faible alphabétisation ? L'exemple de l'autodépistage du VIH en Afrique de l'Ouest. 2020.

45. Wei C, Yan L, Li J, Su X, Lippman S, Yan H. Which user errors matter during HIV self-testing? A qualitative participant observation study of men who have sex with men (MSM) in China. BMC Public Health. 2018;18:1108.

46. Thirumurthy H, Masters SH, Mavedzenge SN, Maman S, Omanga E, Agot K. Promoting male partner HIV testing and safer sexual decision making through secondary distribution of self-tests by HIV-negative female sex workers and women receiving antenatal and post-partum care in Kenya: a cohort study. Lancet HIV. 2016;3:e266–74.

~~35~~47. Chipungu J, Bosomprah S, Zanolini A, Thimurthy H, Chilengi R, Sharma A, et al. Understanding linkage to care with HIV self-test approach in Lusaka, Zambia - A mixed method approach. PLOS ONE. 2017;12:e0187998.

~~36~~48. Tun W, Vu L, Dirisu O, Sekoni A, Shoyemi E, Njab J, et al. Uptake of HIV self-testing and linkage to treatment among men who have sex with men (MSM) in Nigeria: A pilot programme using key opinion leaders to reach MSM. J Int AIDS Soc. 2018;21:e25124.

~~37~~49. Hlongwa M, Hlongwana K, Makhunga S, Choko A, Dzinamarira T, Conserve D, et al. Linkage to HIV care following HIV self-testing among men: systematic review of quantitative and qualitative studies from six countries in sub-Saharan Africa. preprint. In Review; 2022.

~~38~~50. Choko AT, MacPherson P, Webb EL, Willey BA, Feasy H, Sambakunsi R, et al. Uptake, Accuracy, Safety, and Linkage into Care over Two Years of Promoting Annual Self-Testing for HIV in Blantyre, Malawi: A Community-Based Prospective Study. PLOS Med. 2015;12:e1001873.

~~39~~51. Green KE, Vu BN, Phan HT, Tran MH, Ngo HV, Vo SH, et al. From conventional to disruptive: upturning the HIV testing status quo among men who have sex with men in Vietnam. J Int AIDS Soc. 2018;21 Suppl 5:e25127.

~~40~~52. Ky-Zerbo O, Desclaux A, Kouadio AB, Rouveau N, Vautier A, Sow S, et al. Enthusiasm for Introducing and Integrating HIV Self-Testing but Doubts About Users: A Baseline Qualitative Analysis of Key Stakeholders' Attitudes and Perceptions in Côte d'Ivoire, Mali and Senegal. Front Public Health. 2021;9.

~~41~~53. Inghels M, Kouassi AK, Niangoran S, Bekelynck A, Carilon S, Sika L, et al. Preferences and access to community-based HIV testing sites among men who have sex with men (MSM) in Côte d'Ivoire. BMJ Open. 2022;12:e052536.