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

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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 results were not systematically tracked. Therefore, an anonymous phone survey was conducted to estimate HIVST positivity rates and linkage to confirmatory testing and care. This two-step survey involved an initial recruitment phase from March to June 2021 where participants were encouraged via leaflets to call a free phone number and complete a sociobehavioural questionnaire.

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%)

45 underwent confirmatory HIV testing, with 12 (80%) confirmed as HIV-positive, all of whom
46 began antiretroviral treatment.

47 The confirmation rate of HIVST results was fast, with 53% doing so within a week and 91%
48 within three months of self-testing. Two-thirds (65%) went to a general public facility, and one-
49 third to a facility dedicated to key populations.

50 The ATLAS HIVST distribution strategy reached people living with HIV in West Africa. Linkage to
51 confirmatory testing remained sub-optimal in these first years of HIVST implementation.
52 However, if confirmed HIV-positive, almost all initiated treatment. HIVST constitutes a relevant
53 complementary tool to existing screening services.

54

55 **Keywords:** AIDS, HIV self-testing, HIV testing services, diagnosis, knowledge of status, awareness fo
56 status, gay, bisexual, sex work, linkage to confirmatory testing and care, phone-based survey, key
57 populations, West Africa.

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Introduction

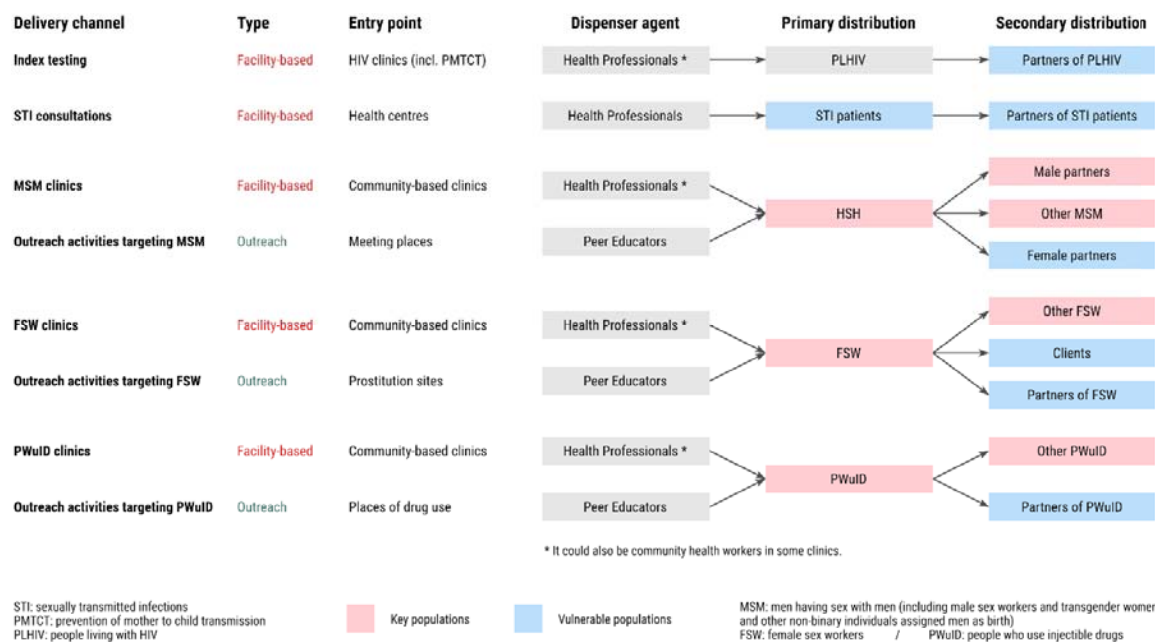
62 Early testing followed by successful linkage to antiretroviral treatment for those diagnosed with HIV can
63 drastically reduce the risk of onward HIV transmission and mortality [1–6]. In 2021, according to the United
64 Nations Program for HIV/AIDS (UNAIDS), 81% of the adult population living with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

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

74 Following the experience gained in Eastern and Southern Africa under the STAR project [15–21], the
75 UNAIDS funding agency sought to stimulate HIVST in West Africa. The ATLAS programme (*AutoTest de*
76 *dépistage du VIH: Libre d'Accéder à la connaissance de son Statut*) aimed to promote, implement, and
77 expand HIV self-testing in Côte d'Ivoire, Mali, and Senegal. Country national prevalence was comparatively
78 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%)
79 in Senegal according to UnAids[22].

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

85 The design of the different delivery channels and the priority populations were developed with country
86 stakeholders: national AIDS programs/councils, international institutions including the WHO, international
87 and national non-governmental organisations involved in local HIV programs, and civil society and
88 community leaders. ATLAS HIVST distribution was organised through eight different operational delivery
89 channels (figure 1): five were facility-based (delivery of HIVST kits through public or community-based health
90 facilities), and three used community-based approaches involving outreach activities engaging female sex
91 workers (FSW), men who have sex with men (MSM), and people who use drugs (PWUD) [23]. Peer educators
92 conducted these outreach activities through group activities (e.g. talks, discussion groups, night visits, social
93 events, or parties) and face-to-face activities (e.g. home visits). Outreach activities represented the majority
94 (~85%) of ATLAS's distribution volume.



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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>)

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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.

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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 should be interpreted as follow: reactive if two lines (C & T) are visible, even barely; non-reactive if only the C (control) line is visible; invalid if no line is visible or if only the T (test) line is visible.

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In addition to the manufacturer's instructions (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.

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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.



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

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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

134 usually distant from community activities and HIV testing services, and has the potential to reach, beyond
135 key populations, partners, clients, and other groups vulnerable to HIV [25].

136 A complementary survey was conducted among those with an HIVST reactive result. Here we report on
137 HIVST's positivity rates and linkage to confirmatory testing and care.
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139 **Materials and Methods**

140 **Sources of data**

141 The ATLAS program embedded multiple research activities, from qualitative studies to economic
142 analyses, which have been described in detail elsewhere [26–30].

143 It included a voluntary phone survey. Between mid-March and mid-June 2021, dedicated survey flyers
144 were distributed with the HIVST kits inviting self-test users in each country to call a toll-free number to
145 complete a questionnaire (phase 1). All calls from the three countries were rerouted to a telephone platform
146 located in Abidjan and operated by Ipsos Côte d'Ivoire, which was selected following an international call for
147 tenders. The questionnaire, which lasted 20 to 30 minutes, collected information on sociodemographic
148 characteristics of HIVST users, testing history, sexual and preventive behaviours, HIVST use and difficulties
149 encountered. Participation in the survey was rewarded with 2 000 XOF (≈3.40 USD) of phone communication
150 credit. In order to participate in the survey, participants had to be of legal age to use an HIVST on their own
151 without parental permission (16 years in Côte d'Ivoire, 18 years in Mali, and 15 years in Senegal) and had to
152 have used an HIVST provided to them through the ATLAS project.

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

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

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

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

176 At the end of the survey, collected telephone numbers (for appointments and rewards) were deleted
177 from the database. All procedures have been described in a publicly available data management plan
178 (<https://dmp.opidor.fr/plans/3354/export.pdf>).

179 **Data analysis**

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

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

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

197 Among phase 2 eligible participants who completed their questionnaire, linkage to confirmatory testing,
198 the proportion being confirmed HIV positive and treatment initiation were described, stratified by the
199 reported number of lines and self-interpreted HIVST result in phase 1 questionnaire. Confidence intervals
200 (95% confidence interval, 95%CI) were computed using Wilson’s method with Yate’s continuity correction.

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

204 All analyses have been performed using R version 4.2.2 [31]. A dedicated anonymised dataset and the
205 corresponding R script are available on Zenodo ([https://doi.org/ 10.5281/zenodo.7986077](https://doi.org/10.5281/zenodo.7986077)) to allow
206 replication of the analysis.

207 . Ethics

208 ATLAS research protocol (version 3.0, October 8 2020) has been approved by the WHO Ethical Research
209 Committee (January 12, 2021, reference: ERC 0003181), the National Ethics Committee for Life Sciences and
210 Health of Côte d’Ivoire (November 27, 2020, reference: 191-20/MSHP/CNESVS-km, IRB:000111917), the
211 Ethics Committee of the Faculty of Medicine and Pharmacy of the University of Bamako, Mali (November 16,
212 2020, reference: 2020/254/CE/FMPOS/FAPH), and the National Ethics Committee for Health Research of
213 Senegal (January 26, 2021, protocol SEN19/32, n°8 MSAS/CNERS/Sec).

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215 Results

216 HIVST results

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

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

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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 | 2615 (100%) |
| <i>Consistent answer (C)</i> | 2346 (89.7%) |
| 2 lines / reactive [†] (C ₁) | 50 (1.9%) |
| 1 line / non-reactive (C ₂) | 2 292 (88%) |
| 0-1 line/ invalid (C ₃) | 4 (0.2%) |
| <i>Inconsistent answer (I)</i> | 48 (1.8%) |
| 1 line / reactive [†] (I ₁) | 10 (0.4%) |
| 0 line / reactive [†] (I ₂) | 0 (0%) |
| 2 lines/ non-reactive [†] (I ₃) | 35 (1.3%) |
| 0 line / non-reactive (I ₄) | 3 (0.1%) |
| 2 lines/ invalid [†] (I ₅) | 0 (0%) |
| <i>Partial answer (P)</i> | 221 (8.5%) |
| 0 line / DK-R (P ₁) | 1 (<0.1%) |
| 1 line / DK-R (P ₂) | 117 (4.5%) |
| 2 lines/ DK-R [†] (P ₃) | 29 (1.1%) |
| DK-R / reactive [†] (P ₄) | 2 (<0.1%) |
| DK-R / non-reactive (P ₅) | 44 (1.7%) |
| DK-R / invalid (P ₆) | 0 (0%) |
| DK-R / DK-R (P ₇) | 28 (1.1%) |
| Positivity Rate | |
| <i>Based on self-interpreted test results</i> | |
| <i>Low hypothesis (DK-R as not reactive)</i> (C ₁ + I ₁ + I ₂ + P ₄) / n | 62 / 2615 (2.4 %) |
| <i>Central hypothesis (DK-R excluded)</i> (C ₁ + I ₁ + I ₂ + P ₄) / (C + I + P ₄ + P ₅ + P ₆) | 62 / 2440 (2.5 %) |
| <i>High hypothesis (DK-R as reactive)</i> (C ₁ + I ₁ + I ₂ + P ₁ + P ₂ + P ₃ + P ₄ + P ₇) / n | 237 / 2615 (9.1%) |
| <i>Based on the reported number of lines</i> | |
| <i>Low hypothesis (DK-R as 1 line)</i> (C ₁ + I ₃ + I ₅ + P ₃) / n | 114 / 2615 (4.4 %) |
| <i>Central hypothesis mid (DK-R excluded)</i> (C ₁ + I ₃ + I ₅ + P ₃) / (C + I + P ₁ + P ₂ + P ₃) | 114 / 2541 (4.5 %) |
| <i>High hypothesis (DK-R as 2 lines)</i> (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 | |
| DK: don't know. R: refused to answer | |

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229 HIVST positivity rates

230 Based on self-interpreted HIVST results, the overall positivity rate was 2.4% when DK-R were considered
231 non-reactive (Table 2, low hypothesis). By excluding DK-R from the numerator and the denominator (central
232 hypothesis), the positivity rate increased to 2.5%. Considering DK-R as reactive (high hypothesis) increased
233 the positivity rate to 9.1%. Estimates based on the reported number of visible lines on the HIVST were 4.4%,
234 4.5% and 7.2%, respectively, for low, central and high hypotheses. Positivity rates ranged from 1.8% to 9.8%
235 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
236 high; Table 2).

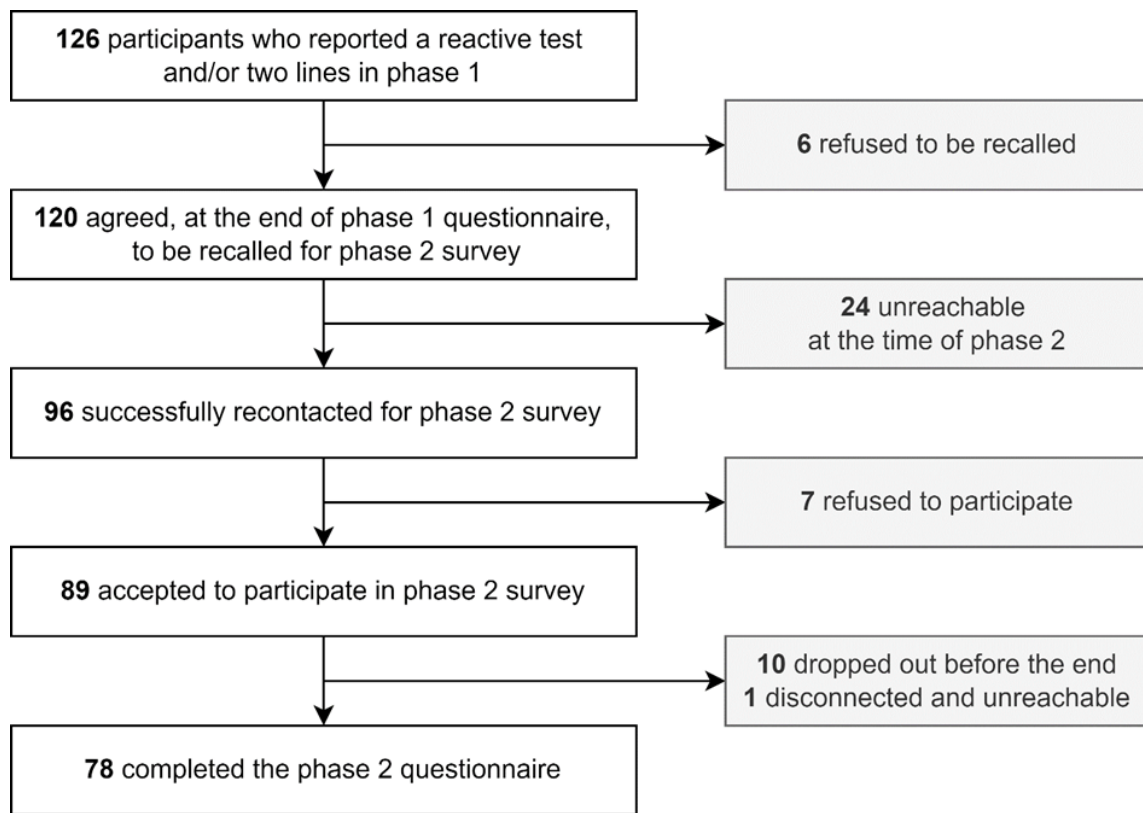
237 Positivity rates were higher among participants recruited through community-based distribution
238 channels: 4.8% for men and 4.9% for women in the MSM-based channels, and 4.6% for men and 4.2% for
239 women in the FSW-based channels (central hypothesis based on the number of lines). In the other
240 distribution channels (PWUD-based and facility-based), positivity rates were slightly lower: 3.1% for men and
241 2.9% for women.

242 **Participation in phase 2**

243 During phase 1, 126 individuals reported two lines or self-interpreted their result as reactive, thus were
244 identified as eligible for phase 2 (table 1). Among them, 6 had refused to be re-contacted after phase 1
245 (figure 3). Among the 120 (95%) who agreed to be re-contacted, 24 (20%) were unreachable at the time of
246 the phase 2 survey, and 96 (80%) were successfully re-contacted. Among the latest, 89 (93%) accepted to
247 participate in the phase 2 survey. Ten dropped out before the end of the interview, and 1 disconnected and
248 was unreachable afterwards. As a result, 78 participants completed phase 2 questionnaire.

249 The participants who completed the phase 2 questionnaire had similar sociodemographic characteristics
250 (e.g. country, sex, distribution channel, age group, marital status) compared to those eligible for phase 2, but
251 that did not complete it, and to phase 1 participants not eligible for phase 2 (table S1). For most participants
252 (86%), phase 2 questionnaire was completed between 4 and 6 months after phase 1 questionnaire (table S5).

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

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Table 2. 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. 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.

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265 **Linkage to confirmatory testing and care**

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

274 The main reason given for not linking to confirmatory testing was that “their HIVST was non-reactive”
275 (18/44, 41%, and although 8 of these 18 reported a reactive result in phase 1 questionnaire); followed by
276 “not knowing that a confirmation test was required” (10/44, 23%); and “not having time” (8/44, 18%)
277 (table S2).

278 When participants were linked to confirmatory testing, it was a short time after performing their
279 HIVST: 53% linked in less than one week and 91% in less than 3 months (table S3).

280 Most participants (65%) performed their confirmatory testing in a general public facility (health
281 centre, hospital, clinic or maternity), and 35% chose a community-based clinic or health centre dedicated
282 to key populations (table S4).

283 Among the 34 linked to confirmatory testing, 19 (56%, 95%CI: 38-72%) were confirmed HIV-positive,
284 and 18 (95%, 95%CI: 72-100%) initiated antiretroviral treatment. Among the 27 who reported a
285 consistent reactive result in the phase 1 questionnaire, 15 (56%, 95%CI: 36-74%) linked to confirmatory
286 test, 12 (80%) were confirmed HIV-positive and all started treatment (100%).

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Table 3. 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 n | Linked to confirmatory testing | | Confirmed HIV positive | | Initiated ART | |
|--|---------------------------|--------------------------------|------------|------------------------|------------|---------------|-------------|
| | | 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.

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Discussion

294 Our study reveals that the strategy deployed by the ATLAS program, through secondary distribution
295 of HIVST and targeted channels, successfully reached people living with HIV in West Africa. However,
296 linkage to confirmatory HIV testing and access to care remained sub-optimal during these initial years of
297 HIVST implementation. Moreover, among participants who confirmed their reactive self-test result with a
298 traditional facility-based HIV test, a significant proportion quickly proceeded with this confirmation (more
299 than half in less than a week and the vast majority in less than three months). Furthermore, if individuals
300 were confirmed HIV-positive, almost all began antiretroviral treatment.

301 The implementation of a telephone survey, aimed at gathering information from HIVST users while
302 preserving anonymity and without interfering with secondary distribution, has proven to be very useful
303 to evaluate the ATLAS project. However, its high cost makes it difficult to integrate it into national
304 strategies for assessing the impact of HIVST. Nevertheless, other impact evaluation methods, such as
305 data triangulation[27] and modelling, may prove more suitable for routine monitoring of HIVST's impacts.

306 In our study, most participants (90%) demonstrated a consistent interpretation between the number
307 of lines reported and the declared result of their HIVST. However, 2% of them reported an inconsistent
308 interpretation of the results. Among them, a small number reported the presence of two visible lines,
309 suggesting potential issues in interpreting the number of visible lines on HIVST kits. In the context of the
310 ATLAS program, the distribution strategy combining primary and secondary approaches has led many
311 HIVST users to perform their HIVST without receiving advice from a healthcare professional or a trained
312 peer educator. Although the HIVST is not designed to require supervision, it is essential to have received
313 information on its use before proceeding with the test. However, the lack of supervision is likely
314 insufficient to explain the inconsistencies observed [32]. Some inconsistencies may result from a
315 misunderstanding of the terms "*reactive*" and "*non-reactive*", particularly considering that HIVST was a
316 new tool in our context and that traditional terms used to describe conventional HIV testing are
317 "*positive*" and "*negative*". This possible misunderstanding of the terms is also highlighted by the fact that
318 8 participants reported a "*reactive*" result in phase 1 questionnaire and then in phase 2 that their test
319 was "*non-reactive*" as the main reason for not linking to confirmatory testing. Specific qualitative
320 interviews or focus groups discussion with HIVST users could help better understand how they perceive
321 different terms.

322 According to our estimates, HIVST positivity rates range from 1.8% to 9.8% in Côte d'Ivoire, 3.5% to
323 7.8% in Mali, and 1.2% to 15.0% in Senegal depending on how missing results (e.g., "*don't know*" and
324 refusals) are classified. It is important to interpret these HIV positivity rates while considering the
325 treatment-adjusted prevalence (i.e., removing those on treatment from the numerator and denominator
326 of HIV prevalence), a more reliable indicator for evaluating the effectiveness of targeted screening
327 programs [33]. In West Africa, the treatment-adjusted prevalence remained relatively low in 2021: 0.6%
328 in Côte d'Ivoire, 0.7% in Mali, and 0.06% in Senegal, according to UNAIDS data
329 (<https://aidsinfo.unaids.org/>). Our results suggest that the ATLAS HIVST distribution strategy successfully
330 reached people living with HIV. In 2021, the observed HIV positivity rates for conventional HIV testing
331 were 1.4% in Côte d'Ivoire, 2.2% in Mali, and 1.0% in Senegal [34]. These rates were slightly lower to
332 those we identified with HIVST based on our lower (conservative) assumption. Between 2020 and 2021,
333 ATLAS implementing partners collected spontaneous feedback from HIVST users. This unpublished data
334 collection was non-systematic and varied from one partner to another. Among 4 463 documented
335 feedbacks, HIVST was reactive for 188 cases (4.2%), consistent with our estimates based on the reported
336 number of visible lines (4.5%, central hypothesis).

337 Overall, these results for HIVST positivity are generally higher than the average overall positivity of
338 HIV testing services (excluding HIVST) in West Africa. For instance, in 2020 an estimated 1.9% of all HIV
339 tests performed were found to be positive in the region (95% credible intervals: 1.3 to 2.7%) [34].
340 Further, among 15-24 and 25-34 years old, which constitute more than 80% of our sample, overall
341 positivity was, respectively, 0.9% (0.7 to 1.3%) and 1.6% (1.2 to 2.2%). Collectively, these results provide
342 evidence that HIVST is a high-yield testing modality that can address the unmet HIV testing needs of key
343 populations and their partners.

344 Our linkage to confirmatory testing estimates were based on small numbers resulting in large
345 confidence intervals. Nevertheless, the overall proportion was clearly sub-optimal (44%, 95% confidence

346 interval from 33% to 55%). However, this estimate includes some individuals who did not adequately self-
347 interpreted their HIVST result as reactive. When considering only those who reported two lines and self-
348 interpreted their result as reactive, the linkage rate increased to 56% (36% to 74%). This percentage is
349 close to that was observed in a study conducted in Kenya on HIV testing of FSW male partners using
350 HIVST secondary distribution, where 65% of men with a reactive result had a confirmatory test [35].
351 Linkage to confirmatory testing happened relatively quickly after HIVST use: 53% did it in less than a week
352 and 91% in less than three months. Similar results were observed in a study in the general population in
353 Zambia[36], and a study among MSM in Nigeria [37]. For those who did confirmatory testing and were
354 confirmed HIV positive, initiation of antiretroviral treatment was almost systematic, showing good
355 linkage to care after confirmatory testing, as observed in many HIVST studies in sub-Saharan Africa [38–
356 40].

357 Previous analyses of ATLAS data showed that HIVST could reach people not reached by conventional
358 HIV testing approaches [41], particularly partners and clients of key populations and key population
359 members not self-identifying as such [25]. It is consistent with the finding that two-thirds of participants
360 who did confirmatory testing went to a general health facility rather than a community clinic dedicated to
361 key populations. In a study conducted in 2018 in Côte d'Ivoire among MSM, one-third of the participants
362 preferred community-based testing, one-third expressed no preference, and one-third preferred
363 undifferentiated HIV testing services (general population), mentioning the lack of discretion and
364 anonymity of community-based sites and the desire to avoid the gaze of others [42].

365 ATLAS' HIVST distribution strategy successfully reached people living with HIV in West Africa,
366 although linkage to confirmatory testing remained sub-optimal in these first years of HIVST
367 implementation. We showed that HIVST has the potential to reach more hidden populations and
368 constitutes a relevant complementary tool to existing screening services. To fully harness the potential of
369 self-tests, messaging around HIVST and its interpretation could be improved.
370

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 but did not complete the questionnaire N= 42 | Not eligible for Phase 2 N = 2495 | p-value (Chi ² test) |
|-------------------------------------|---|---|---|---|------------------------------------|
| Country | | | | | 0.9 |
| Côte d'Ivoire | 1 390 (53%) | 39 (50%) | 20 (48%) | 1 331 (53%) | |
| Mali | 984 (38%) | 31 (40%) | 18 (43%) | 935 (37%) | |
| Senegal | 241 (9.2%) | 8 (10%) | 4 (9.5%) | 229 (9.2%) | |
| Sex and distribution channel | | | | | 0.3 |
| man MSM-based channels | 997 (38%) | 35 (45%) | 14 (33%) | 948 (38%) | |
| woman MSM-based channels | 103 (3.9%) | 5 (6.4%) | 0 (0%) | 98 (3.9%) | |
| man FSW-based channels | 620 (24%) | 22 (28%) | 10 (24%) | 588 (24%) | |
| woman FSW-based channels | 685 (26%) | 14 (18%) | 15 (36%) | 656 (26%) | |
| man other-based channels | 137 (5.2%) | 1 (1.3%) | 2 (4.8%) | 134 (5.4%) | |
| woman other-based channels | 73 (2.8%) | 1 (1.3%) | 1 (2.4%) | 71 (2.8%) | |
| Age group | | | | | 0.5 |
| 24 years or younger | 1 164 (45%) | 27 (35%) | 20 (48%) | 1 117 (45%) | |
| 25-34 years | 1 063 (41%) | 38 (49%) | 16 (38%) | 1 009 (40%) | |
| 35 years or older | 388 (15%) | 13 (17%) | 6 (14%) | 369 (15%) | |
| Marital status | | | | | 0.3 |
| single | 1 761 (67%) | 54 (69%) | 28 (67%) | 1 679 (67%) | |
| living with partner / married | 757 (29%) | 18 (23%) | 12 (29%) | 727 (29%) | |
| divorced / separated / widowed | 97 (3.7%) | 6 (7.7%) | 2 (4.8%) | 89 (3.6%) | |
| Educational level | | | | | 0.057 |
| none / primary | 503 (19%) | 13 (17%) | 10 (24%) | 480 (19%) | |
| secondary | 1 432 (55%) | 50 (64%) | 28 (67%) | 1 354 (54%) | |
| higher | 680 (26%) | 15 (19%) | 4 (9.5%) | 661 (26%) | |
| First time testers | | | | | 0.3 |
| yes | 1 078 (41%) | 38 (49%) | 20 (48%) | 1 020 (41%) | |
| No | 1 537 (59%) | 40 (51%) | 22 (52%) | 1 475 (59%) | |

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

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

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377 Table S2. 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
378 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 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%) |

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

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382 Table S3. Time between HIVST and confirmatory testing among phase 2 participants who did link to confirmatory testing, by reported number of lines and self-
 383 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 and two 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%) |

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

385

386 Table S4. 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%) |

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

388

389 Table S5. 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-
 390 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%) |

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

392

393

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396 collecting this sensitive data. Finally, we are grateful to the participants who were kind enough to give us
397 some of their time by agreeing to take part in the survey.

398

Data, scripts, code, and supplementary information availability

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

401

Conflict of interest disclosure

402 The authors declare that they comply with the PCI rule of no financial conflicts of interest in relation
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404

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410

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