



# Home-based oral self-testing for absent and declining individuals during a door-to-door HIV testing campaign in rural Lesotho (HOSENG): a cluster-randomised trial

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## Summary

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**Background** In sub-Saharan Africa, home-based HIV testing is validated and accepted, but coverage is low because household members are often absent during home-based testing campaigns. We aimed to measure the effect of a secondary distribution of oral-fluid HIV self-tests on coverage during home-based testing in rural Lesotho.

**Methods** The Home-Based Self-Testing (HOSENG) trial was a cluster-randomised, non-blinded superiority trial in rural villages in the catchment area of 20 health facilities of two districts in Lesotho (Butha-Buthe and Mokhotlong). Eligible villages had a consenting village chief and at least one registered village health worker; eligible households had a consenting representative aged 18 years or older. The HOSENG trial provided a recruitment platform for the interlinked Village-Based Refill of Antiretroviral Therapy (VIBRA) trial. Villages were randomly assigned 1:1:1:1 with block sizes of four to one of four groups: VIBRA control and HOSENG control; VIBRA control and HOSENG intervention; VIBRA intervention and HOSENG control; and VIBRA intervention and HOSENG intervention. Randomisation was stratified by district, village size, and access to the nearest health facility. An independent statistician was responsible for the computer-generated randomisation list. In the intervention group, oral-fluid HIV self-tests were left for absent or declining household members (aged  $\geq 12$  years) during a home visit from the HIV testing campaign team. One present household member was trained on self-test use. Distributed self-tests were followed up by village health workers. In control village clusters, absent or declining household members were referred to the clinic for HIV testing. The primary outcome was HIV testing coverage among all household members aged 12 years or older within 120 days, defined as a confirmed HIV test result or known status, reported in testing registers at the health facilities or on the follow-up forms of the village health worker. Adjusted random-effects logistic regression with individuals as the unit of analysis was used. This trial is registered with ClinicalTrials.gov, NCT03598686.

**Findings** Between July 26, 2018, and Dec 12, 2018, 3091 consenting households with 7816 household members aged 12 years or older were enrolled and randomly assigned (intervention: 57 village clusters, 1620 households, 4174 household members; control: 49 village clusters, 1471 households, 3642 household members). In the control group, 38 (3%) of 1455 initially absent or declining household members tested at a clinic within 120 days. In the intervention group, 841 (53%) of 1601 initially absent or declining household members had a confirmed status within 120 days; 12 (1%) of 841 tested at the clinic and 829 (99%) used their self-test kit. This resulted in a testing coverage of 2201 (60%) of 3642 in the control group versus 3386 (81%) of 4174 in the intervention group (odds ratio 3.00 [95% CI 2.52–3.59];  $p < 0.0001$ ).

**Interpretation** Secondary distribution of oral-fluid HIV self-tests during home-based testing increases testing coverage substantially and thus presents a promising add-on during testing campaigns.

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## Introduction

Concerted global efforts in scaling up HIV services in the past decade have led to substantial progress towards the UNAIDS 90-90-90 targets.<sup>1</sup> However, the gains have become smaller each year and efforts to reduce HIV infections are off track.<sup>1,2</sup> In 2018, 21% of people living with HIV worldwide and 15% in southern Africa were undiagnosed.<sup>1</sup>

Offering HIV testing and counselling at people's homes is highly acceptable in southern Africa.<sup>3–5</sup> Home-based

testing data from Lesotho have shown uptake prevalence of more than 90%, similar between men and women, and including a substantial number of first-time testers.<sup>6,7</sup>

It is crucial to distinguish between testing uptake (proportion of the population reached for testing who had the test) and testing coverage (proportion of the population eligible for testing who had the test). Although uptake is high during home-based testing, coverage is often less than 90% because of a high number of household members being absent at the time of the campaign, mainly

## Research in context

### Evidence before this study

We searched PubMed for randomised trials or reviews published between Jan 1, 1999, and Jan 24, 2020, using the search terms “HIV” AND (“HIVST” OR “self-testing”) AND (“distribution” OR “distributed”) AND (“randomised” OR “randomized”) with no language restrictions, yielding 15 articles. Study protocols and articles not assessing testing outcomes (ie, uptake or coverage) were excluded, resulting in five randomised trials and one review. Among the five trials, there was only one that assessed HIV self-test distribution in the general community population. It showed high uptake during door-to-door distribution of HIV self-tests and modestly increased knowledge of HIV status from 65% to 68% through secondary HIV self-test distribution among absent partners of present household members. A review from 2018 concluded that based on evidence from small-scale observational studies and a few randomised trials in sub-Saharan Africa, HIV self-testing seems to be feasible, acceptable, accurate, safe, and overall leads to high testing uptake rates, especially among underserved and high-risk populations. The authors suggested that more evidence is needed on effectiveness and cost-effectiveness under different delivery models, including unrestricted distribution of self-testing kits to the general population.

### Added value of this study

Although HIV self-testing has been shown to be a promising tool, little evidence exists about secondary HIV self-test kit distribution during home-based or community-based testing. To our knowledge, our cluster-randomised trial in rural Lesotho is the first to specifically assess the effect of one-time secondary distribution of oral-fluid HIV self-testing kits during door-to-door HIV testing on testing coverage. It resulted in a substantial increase in testing coverage of more than 20%. The intervention was particularly successful among men, adolescents, and migrant workers. It also showed that an existing lay health worker network in the villages could be used to do the follow-up of the distributed tests.

### Implications of all the available evidence

The provision of oral HIV self-test kits during a one-time outreach visit, followed up by an existing network of village health workers, requires little additional human resources, finances, or logistics. As countries in southern Africa develop and implement self-testing policies and programmes, this home-based HIV testing strategy should be considered.

men and young adults, resulting in low coverage rates among these key populations.<sup>3,7,8</sup> In Lesotho, adding weekend visits to the weekday home-based campaign increased testing coverage, but did not reach the 90% target and is a costly strategy, especially in rural settings.<sup>7</sup>

Oral-fluid rapid HIV self-testing has been shown to increase uptake in facility-based and home-based testing models, particularly among men and young people,<sup>9,10</sup> including in Lesotho.<sup>11</sup> HIV self-testing has recently expanded in southern Africa because of a growing number of countries adopting specific policies, WHO's endorsement and prequalification of the test kit, and market changes catalysed by the Self-Testing Africa initiative.<sup>12</sup>

In the Home-Based Self-Testing (HOSENG) trial, we aimed to measure the added effect on HIV testing coverage of secondary distribution of oral-fluid HIV self-testing kits to individuals who were absent or declined to test during home-based HIV testing in rural Lesotho.

## Methods

### Study design and participants

HOSENG was a cluster-randomised, non-blinded superiority trial done in rural villages in the catchment area of 20 health facilities of two districts in Lesotho (Butha-Buthe and Mokhotlong). A detailed study protocol has been published previously.<sup>13</sup> Eligible villages had a consenting village chief and at least one registered village health worker who agreed to participate and passed a skill assessment. Clusters were defined as the individual villages except in cases where several villages shared

one village health worker and were therefore considered one cluster. Eligible households had a head of household or representative aged 18 years or older who gave written informed consent to participate. The consent allowed the study team to enter the house and enumerate all household members. Illiterate household heads provided a thumb print after a literate witness of their choice read, explained, and co-signed the form. A household member was defined as being acknowledged by the household head as such and sleeping in the household at least once every 3 months. No other individual-level eligibility criteria were applied, because the primary endpoint is a population-level outcome. Detailed study consent procedures are outlined in the study protocol.<sup>13</sup>

The HOSENG trial with its home-based HIV testing campaign provided a recruitment platform for another trial, the Village-Based Refill of Antiretroviral Therapy (VIBRA) trial.<sup>14</sup> Together, HOSENG and VIBRA constitute the GET ON (Getting Towards Ninety) research project. This trial was approved by the National Health Research and Ethics Committee of the Ministry of Health of Lesotho (ID06-2018) and the Ethics Committee in Switzerland (Ethikkommission Nordwest- und Zentralschweiz; 2018-00283).

### Randomisation

Because it was not feasible for the study team to visit all eligible villages within the two districts, eligible villages were randomly selected proportional to the randomisation stratification factors. We sampled more villages than

For information about the GET ON research project see [www.getonproject.wordpress.com](http://www.getonproject.wordpress.com)

eventually needed in case recruitment had to be extended to enable VIBRA to reach its target sample size.

To ensure balance in the exposure to the HOSENG intervention in the two VIBRA groups, villages were randomly assigned in a 1:1:1:1 ratio with block sizes of four to one of four groups: VIBRA control and HOSENG control; VIBRA control and HOSENG intervention; VIBRA intervention and HOSENG control; and VIBRA intervention and HOSENG intervention. We stratified the randomisation by district (Butha-Buthe *vs* Mokhotlong), village size ( $\geq 30$  households *vs*  $< 30$  households), and access to the nearest health facility (easy to reach *vs* hard to reach, defined as needing to cross a mountain or river or travel  $> 10$  km to a health facility). An independent statistician was responsible for the computer-generated randomisation list. Villages and their randomisation allocation were uploaded into the study database by the study data manager as required, and provided to the study teams before visiting the village to enable proper preparation according to the allocation. Two slightly different household consent forms for intervention versus control were used to conceal the details of the intervention of the other group from the participants.

### Procedures

During the recruitment period, two specifically trained teams, each consisting of six to ten lay counsellors, one campaign organiser, and one supervising study nurse visited all households in the enrolled villages. The procedures in each cluster are outlined in the appendix (p 1) and happened during the same household visit, on the same day. After randomisation but before the main trial start, a pilot phase was launched in both study districts to get the campaign teams fully operational.

In each participating household in both intervention and control groups, the study team proposed blood-based HIV testing and counselling as well as multidisease screening (tuberculosis and alcohol use using the questionnaire with categories: cut down, annoyed, guilty, and eye-opener [CAGE]<sup>15</sup>) and HIV prevention services (voluntary male medical circumcision and condom distribution) to all household members who were present at the time of the visit. Point-of-care blood-based HIV testing followed the national testing algorithm, including the national written consent procedure, and was offered to all household members with unknown HIV status who were present.<sup>16</sup> Household members who had tested HIV-negative within the previous 4 weeks (with proof in their health booklet) or who were known to be HIV-positive were not tested. Individuals who tested HIV-positive were assessed for eligibility for the interlinked subsequent VIBRA trial.<sup>14</sup>

In villages in the control group, the study teams followed the standard of care during home-based HIV testing, referring every absent household member and those declining to test to a nearby health facility for testing. In villages in the intervention group, the study team asked

for consent to leave an oral-fluid HIV self-testing kit for every household member aged 12 years or older who was absent or declined HIV testing on the day of the testing campaign. The HIV self-testing kit was the OraQuick ADVANCE HIV I/II (OraSure Technologies; Bethlehem, PA, USA), a second generation serology assay with a sensitivity of more than 93% and specificity of more than 99%.<sup>17</sup> The study team had prepacked the kit, included pictorial and written instruction for use in the local language (Sesotho), and added a written request to consult the village health worker within 2 weeks after use of the test, irrespective of the result. The team labelled the kit with the name of the absent household member before dispensation. One present household member was trained to correctly use the HIV self-testing kit and offered testing using the kit. The village health workers received a study list of all household members for whom a self-testing kit was dispensed and the date that household member was due to return (reported by their family members). The village health worker revisited all households 2–4 weeks after the reported date of the absent family member's return to collect the HIV self-testing kit if it had not been returned before. There was a follow-up period of 120 days after the home visit, which allowed sufficient time for absent members to return to their households, do the self-testing, and return the test kit to the village health worker. The village health workers reread the result of the oral-fluid HIV self-test strip and documented the outcome on the study-specific form. In the case of a reactive test, the health worker coordinated further blood-based testing to confirm the outcome.

All village health workers from both the intervention and control groups received 1-day refresher training on HIV testing and counselling as well as the referral system for testing. Additionally, the health workers from the intervention group received training about oral-fluid HIV self-testing, handling disclosure and stigma, and proper data entry in paper-based study forms and the patient's health booklet. More details about the procedures and the training of the involved staff were published previously.<sup>13</sup>

At the end of the follow-up period, at all health facilities in both study districts, the study team searched through the testing registers to collect testing outcomes for those participants from control and intervention clusters who might have decided to attend the clinic for testing. The study team captured the data collected during the testing campaign using a tablet-based electronic data capture system (MACRO; Elsevier, Philadelphia, PA, USA). The random assignment of the villages was preloaded into the program and a unique household and individual identifier automatically generated. The team uploaded data regularly via secure electronic transfer to a secure server at the Swiss Tropical and Public Health Institute. The data collected during the follow-up was captured by the village health workers, double-checked by the study team, and then entered into the MACRO database. Data integrity checks

See Online for appendix

written into the database limited missing fields and entry of incorrect data. The study data manager monitored data quality and completeness on a weekly basis. The trial was visited for independent external monitoring by the Ministry of Health of Lesotho in June, 2019. Data closure was on Sept 18, 2019 (9 months after the last participant was enrolled).

### Outcomes

The primary endpoint was HIV testing coverage among household members aged 12 years or older within 120 days after the home visit, defined as the proportion of household members aged 12 years or older living in a household of the surveyed area with a confirmed HIV test result. 12 years was chosen as the age threshold because this is the legal age for providing HIV testing consent in Lesotho.<sup>16</sup> We defined a confirmed HIV test result as being known HIV-positive (tested HIV-positive with documentation in patient booklet before study); being known HIV-negative (tested HIV-negative within 4 weeks before the start of the study with documentation in patient booklet); or having a confirmed HIV test result during the study period according to the national HIV testing guidelines.<sup>16</sup> Importantly, we regarded a reactive oral-fluid HIV self-test as valid only if confirmed by a follow-up blood-based test. HIV self-testing kits that were not returned to the village health worker or that were not found in the household during the health worker's follow-up were documented as unused.

The study had three secondary endpoints. First, HIV testing coverage irrespective of age, defined as the proportion of all household members who had a confirmed HIV test result within 120 days after the home visit (including previous HIV-positive or HIV-negative test results as defined for the primary endpoint). Second, blood-based HIV testing uptake irrespective of age, defined as the proportion of all household members eligible for blood-based HIV testing who were unaware of their HIV status who consented to blood-based point-of-care HIV testing. Third, oral-fluid HIV self-test uptake, defined as the proportion of household members aged 12 years or older for whom a self-testing kit was left behind who had a documented self-testing result within 120 days. Linkage to care after testing outcome and treatment outcomes will be reported in the interlinked VIBRA trial.<sup>14</sup> Exploratory outcomes were a cost analysis and a mixed-method nested study (ADORE study<sup>18</sup>) and will be reported elsewhere. There were no systematic safety endpoints.

### Statistical analysis

On the basis of an earlier home-based HIV testing campaign,<sup>7</sup> we estimated an HIV testing coverage for the control group of 63%. We considered a 15% increase in coverage as relevant from a policy perspective. Using a conservative intracluster correlation of 0.1 for villages and 0.5 for households, resulting in a variance inflation factor

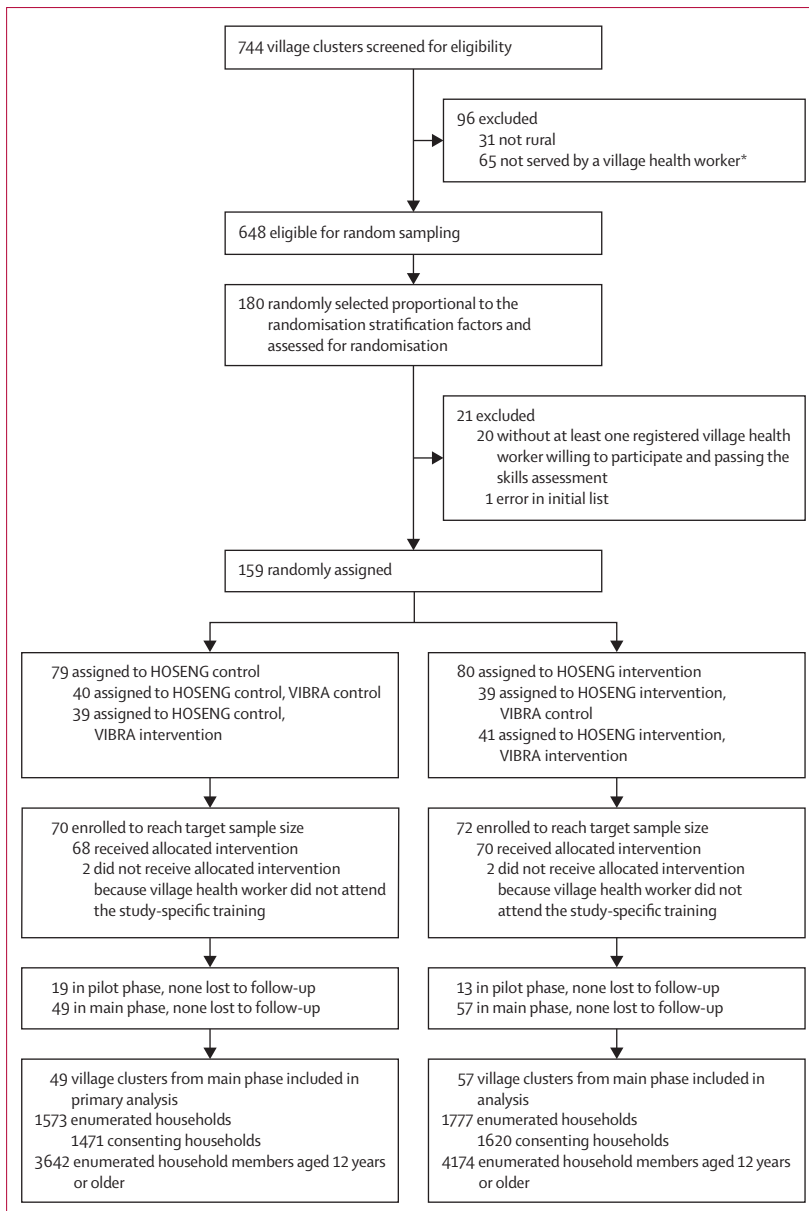
of 8.3, a sample size of 3204 individuals was needed to ensure 90% power. The detailed sample size calculation considering all relevant factors under different scenarios has been provided in the published study protocol.<sup>13</sup> However, recruitment for the HOSENG trial continued after reaching the desired sample size to reach the target sample size for the VIBRA trial.

The study analysis followed an intention-to-treat approach; villages in the pilot phase were not included in the primary analysis, but were included in the sensitivity analysis. Village clusters were the unit of randomisation whereas individuals were the unit of analysis. We analysed the primary endpoint and the secondary endpoints of blood-based HIV testing uptake and overall HIV testing coverage with multilevel logistic regression models including village and household as random effects. We adjusted these models for the prespecified randomisation stratification factors (district, size of village, and village access to the nearest health facility) and did a quadrature check to assess model fit. Results are shown as odds ratios and 95% CIs. The secondary endpoint of oral-fluid HIV self-testing uptake was summarised across the intervention clusters with median, IQR, and 95% CI.

As predefined subgroup analyses, we assessed the potential effect modification of five prespecified socio-demographic determinants by including interaction terms in the multivariable model of the primary outcome. The prespecified determinants were age groups using WHO age thresholds (adolescents aged 12–19 years, young adults aged 20–24 years, adults aged  $\geq 25$  years), gender (male, female), education status (no education, any primary, any secondary or tertiary), employment status (employed in Lesotho, employed in South Africa, self-employed, subsistence farming, no regular income, housewife, student), and HIV testing history (tested for the first time during the study, previously tested). Intervention effects were presented separately by the levels of these factors only in the case of significant interaction terms. We did two post-hoc sensitivity analyses on the primary endpoint. First, because of an imbalance in control and intervention clusters caused by the pilot phase we analysed overall testing coverage including the pilot phase data. Second, because the randomisation was done together with an interlinked follow-up study (VIBRA trial), we analysed the interaction of the VIBRA trial on testing coverage (ie, if randomisation into the VIBRA control group *vs* the VIBRA intervention group had any effect on the HOSENG primary endpoint). All analyses were done using Stata (version 15). The trial is registered with ClinicalTrials.gov, NCT03598686.

### Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.



**Figure 1: Trial profile**

\*Due to inactivity or death of the village health worker.

## Results

Between July 26, 2018, and Dec 12, 2018, 744 villages in the study districts were assessed for eligibility, 648 of which were eligible for random sampling. Of these, 180 villages were proportionally sampled to maintain the distribution of stratification factors in the original populations. After excluding 21 villages that did not meet eligibility criteria, the remaining 159 villages were randomly assigned to the control (n=79) or intervention group (n=80; figure 1). In the main phase, 49 village clusters with 1573 occupied households were included in the control group, and 57 village clusters with

1777 occupied households were included in the intervention group. There was a median of 78 (IQR 50–123) households per village cluster in the control group, and a median of 80 (49–109) households per village cluster in the intervention group. There were a total of 3091 consenting households: in the control group, 1471 (94%) of the 1573 households consented (median number of household members: four [IQR 3–6]), and in the intervention group, 1620 (91%) of 1777 households consented (median number of household members: four [3–6]; figure 1). From the consenting households, we counted a total of 7816 household members aged 12 years or older: 3642 (2059 present, 1583 absent) in the control group and 4174 (2400 present, 1774 absent) in the intervention group (tables 1, 2).

Among the present household members aged 12 years and older, 70% were women and girls, median age was 41 years, there was a median 6 years of schooling, 44% had no regular income, and 27% reported harmful or hazardous alcohol consumption (table 1). Among absent household members aged 12 years and older, the majority were men and boys (64%), the median age was 24 years, and the main reason for being absent was being at school at the time of the home visit (29%; table 2). Baseline characteristics were broadly similar across the intervention and control groups among present (table 1) as well as absent (table 2) household members.

Figure 2 shows HIV testing coverage of all household members aged 12 years and older. On the day of the home-based testing campaign, 2163 (59%) of 3642 eligible individuals in the control group and 2545 (61%) of 4174 eligible individuals in the intervention group had a known HIV-positive or HIV-negative status or were tested for HIV as part of the study. Within 120 days, 38 (3%) of 1455 initially absent or declining household members in the control group had been tested at a health facility. In the intervention group, 841 (53%) of 1601 initially absent or declining household members had a confirmed HIV status within 120 days: 12 (1%) of 841 were tested at the clinic, and 829 (99%) used their self-testing kit. This resulted in significantly greater HIV testing coverage within 120 days in the intervention group than in the control group (table 3). In the sensitivity analyses, we found consistent results for the primary endpoint with and without the pilot phase data (appendix pp 2, 3) and we did not find evidence of any interaction between the VIBRA study groups and the HOSENG primary endpoint (appendix p 4).

HIV testing coverage 120 days after the testing campaign irrespective of age was significantly greater in the intervention group than in the control group (table 3). Across both study groups, 3500 (90%) of 3903 eligible present household members of any age with unknown HIV status consented to blood-based testing during the home visit; uptake of blood-based HIV testing was



similar between the two groups (table 3). In the intervention group, an HIV self-testing kit was left for 1438 (84%) of 1704 household members who were aged 12 years or older, had an unknown HIV status, and were either absent on the day of the home visit (n=1402) or declined blood-based testing (n=36). 829 (58%) of 1438 individuals used and returned the testing kit within 120 days, with an uptake of 814 (58%) of 1402 people who were absent and 15 (42%) of 36 who declined initial blood-based testing. For 106 (17%) of 609 people who did not use and return the HIV self-testing kit, a reason was noted: mistrust of the test (36 [34%] of 106), they were not ready to test (26 [25%]), the absent person had not returned home yet (19 [18%]), they had lost the test (17 [16%]), and they reported to have tested recently (eight [8%]).

73 (3%) of 2977 tests across both groups were positive during the home visit. Among 829 absent or declining household members aged 12 years or older in the intervention group who did the HIV self-test, seven (1%) had reactive tests, three of which (43%) were confirmed HIV-positive, two (29%) were confirmed negative, and two (29%) did not have confirmatory testing. 38 (2%) of 1583 absent or declining household members aged 12 years and older in the control group and 19 (1%) of 1774 in the intervention group sought testing at the health facility. Three tested HIV-positive (two [11%] of 19 in the intervention group and one [3%] of 38 in the control group). Therefore, the overall HIV positivity yield among absent or declining household members aged 12 years or older during the 120-day follow-up period was six (1%) of 889.

In the subgroup analysis, the intervention effect for the primary outcome was greater in male participants than in female participants (table 3). There was evidence of a beneficial effect of the intervention in all age groups, but the size of the effect varied, with the biggest impact seen in adolescents (table 3). The intervention was more successful in those with only primary education than in those with secondary or tertiary education. The intervention had a greater effect on students and those working in South Africa than on other employment groups, although each employment group benefited except those who were self-employed (table 3). HIV testing history (first-time testers vs previously tested) could not be reliably assessed among the absent household members and was therefore not included in the subgroup analysis.

## Discussion

In this trial, HIV testing coverage was significantly greater in the intervention group (81%) with one-time secondary distribution of oral-fluid HIV self-testing kits to individuals aged 12 years or older who were absent or declined testing during door-to-door HIV testing, than in the control group (60%), in which no self-tests were dispensed. The intervention also significantly increased

	Control group	Intervention group	Total
<b>Aged ≥12 years and present during the day of home visit</b>			
Number of household members	2059	2400	4459
Age, years			
Median	43 (27–64)	40 (26–61)	41 (27–62)
12–19	173 (8%)	279 (12%)	452 (10%)
20–24	220 (11%)	255 (11%)	475 (11%)
≥25	1666 (81%)	1866 (78%)	3532 (79%)
Gender			
Male	618 (30%)	739 (31%)	1357 (30%)
Female	1441 (70%)	1661 (69%)	3102 (70%)
Currently pregnant	24 (2%)	43 (3%)	67 (2%)
Years of schooling	6 (3–7)	6 (3–7)	6 (3–7)
Employment*			
Employed in Lesotho	77 (4%)	120 (5%)	197 (4%)
Employed in South Africa	25 (1%)	24 (1%)	49 (1%)
Self-employed with regular income	179 (9%)	197 (8%)	376 (9%)
Subsistence farmer	281 (14%)	330 (14%)	611 (14%)
No regular income	918 (45%)	1006 (42%)	1924 (44%)
Housewife	435 (21%)	479 (20%)	914 (21%)
Student	129 (6%)	222 (9%)	351 (8%)
Alcohol misuse according to CAGE†	121 (30%)	89 (24%)	210 (27%)
<b>Aged &lt;12 years and present during the day of home visit</b>			
Number of household members	588	649	1237
Median age, years	5 (2–7)	4 (3–7)	5 (3–7)
Gender			
Male	281 (48%)	309 (48%)	590 (48%)
Female	307 (52%)	340 (52%)	647 (52%)
Orphan‡			
No	493 (86%)	546 (87%)	1039 (86%)
Single orphan	77 (13%)	75 (12%)	152 (13%)
Double orphan	4 (1%)	8 (1%)	12 (1%)

Data are n, median (IQR), or n (%). Percentages have been rounded and might not total 100%. CAGE=cut down, annoyed, guilty, eye-opener (from the four categories used in the questionnaire). \*31 individuals (14 in the control group and 17 in the intervention group) were missing employment status data. †CAGE score of 2 or higher. ‡34 children (14 in the control group and 20 in the intervention group) were missing this information.

**Table 1: Demographic information for present household members by age group**

testing coverage among all individuals, irrespective of age. The intervention was particularly successful among men, adolescents, and migrant workers.

Worldwide, universal HIV testing—the prerequisite for universal treatment—is far from being achieved in most settings.<sup>1</sup> Testing uptake is high with community-based approaches. However, most home-based testing campaigns fall short of the targeted 90% testing coverage because people are absent during the campaign<sup>4</sup> or the campaigns do not report testing coverage.<sup>19</sup> With a 2-week multidisease screening health fair followed by door-to-door testing for non-attendees of the fair, the SEARCH project achieved a testing coverage of 89% among adults in Uganda and Kenya.<sup>20</sup> Another study done in Uganda employed 62 community health workers to do home-based HIV testing and achieved an adult testing coverage of 69% after 6 months.<sup>21</sup>

	Control group (n=1583)	Intervention group (n=1774)	Total
<b>Age, years</b>			
Median	23 (16–38)	24 (17–38)	24 (16–38)
12–19	624 (39%)	641 (36%)	1265 (38%)
20–24	219 (14%)	270 (15%)	489 (15%)
≥25	740 (47%)	863 (49%)	1603 (48%)
<b>Gender</b>			
Male	1017 (64%)	1133 (64%)	2150 (64%)
Female	566 (36%)	641 (36%)	1207 (36%)
<b>Employment*</b>			
Employed in Lesotho	145 (9%)	195 (11%)	340 (10%)
Employed in South Africa	131 (8%)	113 (6%)	244 (7%)
Self-employed with regular income	65 (4%)	88 (5%)	153 (5%)
Subsistence farmer	189 (12%)	229 (13%)	418 (13%)
No regular income	425 (27%)	513 (29%)	938 (28%)
Housewife	64 (4%)	70 (4%)	134 (4%)
Student	547 (35%)	552 (31%)	1099 (33%)
<b>Reason for absence†</b>			
At school	505 (32%)	474 (27%)	979 (29%)
At work	289 (18%)	325 (18%)	614 (18%)
Within the village	272 (17%)	381 (22%)	653 (20%)
Outside the village	481 (30%)	561 (32%)	1042 (31%)
Unknown and other	34 (2%)	28 (2%)	62 (2%)

Data are median (IQR) or n (%). Percentages have been rounded and might not total 100%. \*17 individuals (eight in the control group and nine in the intervention group) were missing employment status data. †Seven individuals (two in the control group and five in the intervention group) were missing a reason for being absent.

**Table 2: Demographic information for absent household members 12 years or older, as reported by household members**

Another approach to increase testing coverage during home-based testing is to use oral-fluid HIV self-testing. To our knowledge, there are two large-scale published HIV self-testing projects reporting population-based testing coverage. STAR (Self-Testing Africa), a research initiative to gather evidence for HIV self-testing in several countries of sub-Saharan Africa, reported a testing coverage of 42.5% in rural Malawi and 50.3% in rural Zimbabwe with community-based HIV self-testing kit distribution.<sup>22,23</sup> However, so far the STAR community-based HIV self-testing campaign does not include a secondary test distribution. A cluster-randomised nested trial within the HIV Prevention Trials Network 071 study (PopART), consisting of a door-to-door HIV testing campaign in Zambia, offered HIV self-testing to present household members and secondary distribution of HIV self-testing kits to the absent partner.<sup>24</sup> This led to a modest increase in knowledge of HIV status to 68% from 65% in the control group in which no self-testing kits were used nor distributed, and was particularly successful among men and young adults aged 16–29 years. Although the testing

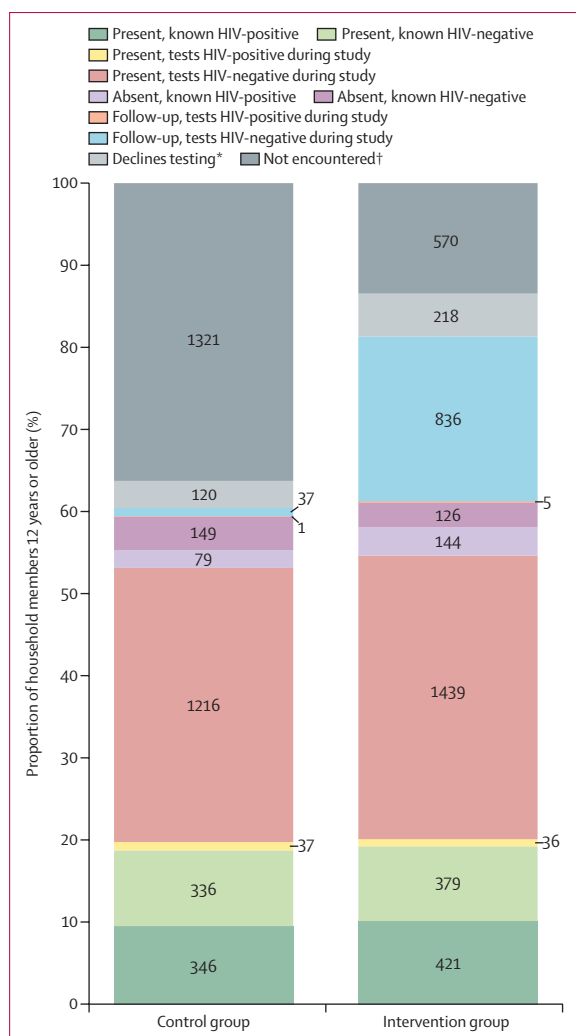
coverage of our control group is similar to that achieved in this nested study, our intervention group yielded a substantially higher coverage. The reason is probably the extension of secondary distribution in the HOSENG trial: we provided HIV self-testing not only to the absent partner but also to all absent household members (aged ≥12 years) and present members who declined to test during the home visit. PopART could not assess whether the effect on coverage was driven by the increased uptake of HIV self-testing among the present household members during the campaign or its secondary distribution among the absent partners. The HOSENG trial is, to our knowledge, the first randomised trial specifically showing the benefit of secondary HIV self-testing kit distribution during home-based testing.

Our study shows that secondary distribution of HIV self-testing kits results in a substantially higher testing coverage, particularly in population groups that often have a low testing coverage, such as migrant workers,<sup>25</sup> men,<sup>26</sup> and young adults.<sup>27</sup> This effect might be driven by the fact that more men than women and more young people than adults are usually absent during door-to-door testing in this setting.<sup>7</sup> In our study, the absent population was 64% men and had a median age of 24 years, compared with 30% men and a median age of 41 years among the present population. On the other hand, some studies suggest that men and young people prefer home-based HIV self-testing to facility-based testing because they have more control over the testing process.<sup>28</sup>

We found an unexpectedly low positivity rate of 1% during the follow-up. This is substantially lower than the rate found among the people who used secondarily distributed HIV self-testing kits during home-based testing in PopART.<sup>24</sup> This difference might be because some individuals who had a reactive HIV self-test result in our study did not bring the test kit back to the village health worker or the health facility, at least not within the set outcome window of 120 days.

Watson and colleagues<sup>29</sup> investigated the stability of oral-fluid HIV self-testing kit (OraQuick) results and observed 29% of initially non-reactive results (one line on the test strip) turning weak-reactive, the majority within 15 days. In our study, delayed rereading by the village health worker might be the reason why two out of the five participants with a reactive oral-fluid HIV self-test during the follow-up were tested negative when using blood-based testing.

PopART and HOSENG question the generalised use of HIV self-tests during home-based testing as STAR<sup>10</sup> and similar recent large-scale projects suggest,<sup>30</sup> but rather support a more targeted use—ie, only by secondary distribution. Although oral-fluid HIV self-testing is about double the cost of the standard blood-based point-of-care test, our approach might be a more cost-effective approach: it could reduce health system costs by requiring a single outreach, and reduce client travel costs by allowing people to do the self-test in the village and being followed



**Figure 2: Testing coverage by cluster arm**  
 In the control group n=3642; in the intervention group n=4174. \*Declined testing during home visit and no follow-up testing outcome was available. †Absent during the home visit and no follow-up testing outcome was available.

	Control group	Intervention group	Adjusted odds ratio* (95% CI)	p value
<b>Primary endpoint</b>				
HIV testing coverage in participants aged ≥12 years†	2201/3642 (60%)	3386/4174 (81%)	3.00 (2.52–3.59)	<0.0001
<b>Secondary endpoints</b>				
HIV testing coverage irrespective of age†	2731/4882 (56%)	3997/5634 (71%)	1.93 (1.63–2.28)	<0.0001
Blood-based HIV testing uptake irrespective of age	1627/1820 (89%)	1873/2083 (90%)	1.20 (0.82–1.75)	0.35
Oral HIV self-testing uptake in participants aged ≥12 years†	..	829/1438 (58%)	..	..
<b>Subgroup analyses on primary endpoint</b>				
Gender‡	..	..	..	<0.0001§
Male	724/1635 (44%)	1391/1872 (74%)	4.82 (3.63–6.41)	<0.0001
Female	1477/2007 (74%)	1994/2300 (87%)	2.42 (1.95–3.00)	<0.0001
Age group	..	..	..	<0.0001§
Adolescents (12–19 years)	241/797 (30%)	701/920 (76%)	22.15 (11.76–41.73)	<0.0001
Young adults (20–24 years)	243/439 (55%)	385/525 (73%)	3.15 (1.98–5.01)	<0.0001
Adults (>24 years)	1717/2406 (71%)	2300/2729 (84%)	2.23 (1.85–2.70)	<0.0001
Education	..	..	..	<0.0033§
Primary	1687/2767 (61%)	2591/3114 (83%)	3.30 (2.74–3.96)	<0.0001
Secondary or tertiary	514/875 (59%)	795/1060 (75%)	2.62 (1.84–3.73)	<0.0001
Employment¶	..	..	..	<0.0001§
Employed in Lesotho	99/222 (45%)	231/315 (73%)	4.28 (2.30–7.96)	<0.0001
Employed in South Africa	37/156 (24%)	75/137 (55%)	14.99 (3.06–73.31)	0.0001
Self-employed with regular income	183/244 (75%)	237/285 (83%)	1.53 (0.85–2.74)	0.16
Subsistence farming	312/470 (66%)	456/559 (82%)	2.38 (1.59–3.55)	<0.0001
No regular income	915/1343 (68%)	1265/1519 (83%)	2.62 (1.99–3.46)	<0.0001
Housewife	438/499 (88%)	508/549 (93%)	1.82 (1.14–2.89)	0.012
Student	201/676 (30%)	581/774 (75%)	31.42 (14.40–68.54)	<0.0001

Data are n/N (%) unless otherwise stated. \*Multilevel logistic regression models adjusted for clustering (village and household as random effects) and stratification factors (district, village size, and access to health facility as fixed effects). †Within 120 days of the home visit. ‡Two individuals (one in each group) were missing information on gender. §p values for interaction term. ¶68 individuals (32 in the control group and 36 in the intervention group) were missing information on employment status.

**Table 3: Outcomes for the primary and secondary endpoints and subgroup analysis**

up by a nearby village health worker. It is vital to tailor home-based testing campaigns in such a way that costs are minimised but coverage maximised, at a time when positivity yield during home-based testing is low and donor investment for the HIV epidemic is stagnating.

Our trial had several limitations. First, secondarily distributed HIV self-tests were used without assistance from the study team. This maximises the potential of self-testing uptake, but presents challenges of how to ensure the correct use of the self-testing kit, how to ascertain the outcome measurement if the kit was not returned, and discerning whether this might have limited the effect of the intervention. These challenges were mitigated in our study by the close relationship between the trained village health worker who did the follow-up and their local rural community. The villages in rural Lesotho are generally small, with only about

25 HIV self-testing kits needing to be followed up by each village health worker.

Second, 42% of distributed HIV self-testing kits were not used or returned to the village health worker within 120 days. In a subset of 106 participants, we were able to gather some more information on the reasons for not returning the kit, but further qualitative research to investigate the underlying causes is warranted. Third, calculation of HIV testing coverage considered only those who either had proof of recent testing (within the past 4 weeks) or who were tested within the study. Some individuals, particularly among those absent, might have tested for HIV at a different occasion or at facilities outside of the study districts. Furthermore, tracking linkage to health facilities using testing registers has its challenges, with people using different names and identifiers. On the other hand, some participants in the



intervention clusters might have used the oral self-test but did not return it to the village health worker. All these factors would have led to an underestimation of the actual testing coverage in both groups.

Fourth, unlike the village health workers in the intervention group, those in the control group were not given a list of the absent or declining household members of their villages to document their outcome. However, any of these individuals who went for testing at a health facility would have been in the health facility testing registries that were extensively searched by the study team. Thus, we judged this approach to be a minor source of bias. Fifth, there was an imbalance of control and intervention clusters during the pilot phase. The reason was an operational challenge: stock of the oral-fluid HIV self-tests ran out directly after the study teams were trained and engaged. Thus, we started piloting the testing campaign in control villages. Importantly, the initial randomisation was done correctly, and the sensitivity analysis showed that the results are consistent, with and without the pilot data (appendix p 3). Last, it was not feasible to do the randomisation after recruitment of individual households and participants. That means the recruiters (campaign team) were aware of the allocation when recruiting. This bias was mitigated by a standard campaign algorithm, the nature of a door-to-door campaign that aimed to recruit everyone, and a different consent form for each group. The participating households and individuals were aware of being in a study, but not of being in a trial, because the two slightly different consent forms concealed the allocation.

In conclusion, secondary distribution of oral-fluid HIV self-testing kits during home-based HIV testing in rural Lesotho resulted in high testing coverage, especially among men, migrant workers, and adolescents. Collaboration with the community by involving an existing lay health cadre in the follow-up of HIV self-tests was feasible. Village health worker programmes exist and are growing in most countries of southern Africa,<sup>31</sup> allowing the HOSENG approach to be scaled up in other settings. The provision of oral self-test kits during a one-time outreach visit, followed up by village health workers, requires little additional human resources, finances, or logistics. As countries in southern Africa develop and implement self-testing policies and programmes, this home-based HIV testing strategy needs to be considered.

#### Contributors

AA, TIL, JM, ND, and TRG conceptualised and designed the study. AA, ND, and TRG drafted the first version of the manuscript. AA, TIL, LK, MKo, and MKa coordinated the field implementation and data collection. TRG analysed the data with input from FV. MBr was the data manager. JM, BLN, KT, TK, and MBa provided technical and laboratory support. All authors read, critically revised, and approved the final manuscript.

#### Declaration of interests

We declare no competing interests.

#### Data sharing

Data from this study, including deidentified participant data, study protocol, and informed consent documents will be made available to researchers upon request and after signing a data confidentiality agreement. To access data, researchers should contact the corresponding author. Researchers will need to present a concept sheet for their proposed analysis. This will have to be reviewed and approved by all coauthors. The coauthors will consider overlap of the proposed project with active or planned analyses and the appropriateness of study data for the proposed analysis. A subset of the key pseudo-anonymised individual participant data collected during the study, along with a data dictionary, will be made available at the time of publication through the data repository Zenodo.

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