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Feasibility and effectiveness of two community-based HIV testing models in rural Swaziland

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Abstract

OBJECTIVES To evaluate the feasibility (population reached, costs) and effectiveness (positivity rates, linkage to care) of two strategies of community-based HIV testing and counselling (HTC) in rural Swaziland.

METHODS Strategies used were mobile HTC (MHTC) and home-based HTC (HBHTC). Information on age, sex, previous testing and HIV results was obtained from routine HTC records. A consecutive series of individuals testing HIV-positive were followed up for 6 months from the test date to assess linkage to care.

RESULTS A total of 9 060 people were tested: 2 034 through MHTC and 7 026 through HBHTC. A higher proportion of children and adolescents (<20 years) were tested through HBHTC than MHTC (57% *vs.* 17%; $P < 0.001$). MHTC reached a higher proportion of adult men than HBHTC (42% *vs.* 39%; $P = 0.015$). Of 398 HIV-positive individuals, only 135 (34%) were enrolled in HIV care within 6 months. Of 42 individuals eligible for antiretroviral therapy, 22 (52%) started treatment within 6 months. Linkage to care was lowest among people who had tested previously and those aged 20–40 years. HBHTC was 50% cheaper (US$11 per person tested; $797 per individual enrolled in HIV care) than MHTC ($24 and $1698, respectively).

CONCLUSION In this high HIV prevalence setting, a community-based testing programme achieved high uptake of testing and appears to be an effective and affordable way to encourage large numbers of people to learn their HIV status (particularly underserved populations such as men and young people). However, for community HTC to impact mortality and incidence, strategies need to be implemented to ensure people testing HIV-positive in the community are linked to HIV care.

keywords AIDS, HIV testing and counselling, HIV prevention, community-based interventions, HIV diagnosis and management

Introduction

Despite intense global commitment to fight HIV/AIDS and years of preventative campaigns, there were an estimated 1.6 million AIDS-related deaths in 2012 (73% of which were in sub-Saharan Africa) and 2.3 million new infections [1]. There is a growing body of evidence showing that a reduction in HIV transmission at population level can be achieved through high coverage of regular HIV testing combined with access to lifelong antiretroviral therapy (ART) of all identified HIV-positive individuals [2–5]. Swaziland has the highest HIV prevalence in the world: approximately 31% of 18- to 49-year-olds are HIV positive, and it is estimated that each year 2.4% of HIV-negative Swazis become HIV positive [6]. Despite substantial efforts to expand access to HIV testing and counselling (HTC), more than one in three HIV-infected adults in Swaziland are unaware of their status [6].

In many generalised epidemics, including Swaziland, HTC coverage is higher among women than men [7]. This difference is largely explained by routine HIV testing in antenatal care services; in Swaziland, 94% of pregnant women undergo HIV testing [8]. Furthermore, the rural clinics in Swaziland were originally developed as maternal and child health services. Although they now provide primary health care including integrated HIV and tuberculosis care, it is possible that men are reluctant to attend as that they still perceive them to be 'female' spaces. Offering HTC in the community represents a crucial strategy for increasing HTC coverage among individuals who do not use health services regularly such as young men or individuals with work-related barriers [9].

Both home-based HTC (HBHCT) and mobile HTC (MHTC) have been successfully implemented in several sub-Saharan settings, demonstrating high uptake and high acceptability [10–12]. Relative to facility-based HTC, community-based strategies have been shown to reach HIV-positive populations earlier in the course of their HIV infection [12], thereby enabling earlier access to treatment and a reduction in avoidable morbidity, mortality and transmission of the virus. In 2012, Médecins Sans Frontières (MSF) introduced intensive community-based HTC in the rural Shiselweni region of the country in collaboration with the Regional Health Department of the Ministry of Health (MoH) of Swaziland.

While it is clear that community-based HTC increases the number of people who learn their status, it must also be recognised that it may increase the proportion of HIV-infected persons who know their positive status but fail to enrol in HIV programmes. A study from Malawi showed that of 837 individuals screened HIV-positive, only 209 (27%) completed CD4 staging [13]. In fact, significant drop-offs at all steps in the cascade from HIV testing to treatment have been described, for example between enrolment and ART initiation or poor adherence after initiation [14–16]. Gardner *et al* [17] showed that even with an ART coverage rate of 75%, this translated to only 19% of all persons with HIV being on treatment and adherent as shown by a suppressed viral load. It has been suggested that men, young adults and people with work-related barriers are at risk for not accessing care [18]. When evaluating HTC strategies, exploring the factors associated with failed linkage to care is essential, as this can enable development of more focussed interventions during and after post-test counselling which target those most at risk of not linking to care [15].

Here, we describe the characteristics of the population reached and the costs of HBHTC and MHTC in rural Swaziland. We also determine whether the people who tested HIV positive subsequently accessed HIV care services, underwent antiretroviral treatment eligibility determination and, for those who were eligible, started treatment. The overall objective of this study was to describe the experience of community-based HTC approaches in the generalised epidemic context of Swaziland, to inform national and regional HIV programming.

Methods

Setting

Swaziland is a landlocked lower-middle income country in Southern Africa, with a population of 1.2 million. This study was carried out in the Shiselweni region, approximately one quarter of the geographical area of the country, and has a relatively poor rural population. The region had an estimated 41 000 people who are HIV positive, of whom approximately 15 000 were thought to be unaware of their status [6, 7]. There were a total of 25 health facilities in Shiselweni during the time of the study, three secondary health facilities and 22 rural clinics. All facilities had integrated HIV and tuberculosis care and were owned and managed by the Swaziland Ministry of Health, supported by MSF. For HTC, the country uses a serial testing algorithm, starting with the Determine HIV1/2. If positive, the more specific Unigold HIV1/2 test is used for confirmation. If after these two tests, the HIV status remains indeterminate (e.g. one positive and one negative), a dry blood spot (DBS) sample is sent to the National Reference Laboratory for enzyme-linked immunosorbent assay (ELISA) testing [19].

Specific details of the testing strategy used are available in online Supplementary Information S1. Briefly, two different community-based HTC strategies were evaluated. The first strategy was mobile HTC (MHTC), introduced on an ongoing basis from September 2012. MSF testing teams visited community sites identified by community leaders, attended mobile 'outreach' clinics and set up testing sites at major events. The second strategy was home-based HTC (HBHTC), implemented on a campaign basis in August 2013. The campaign took place in three remote communities that were sensitised ahead of time via radio announcements. During the campaign, the testers moved through the community by foot visiting the households door to door.

In accordance with national HTC guidelines, individuals who gave informed consent were considered eligible for HTC provided they were over 12 years of age and deemed by the health worker to be competent to make this decision; those under 12, or lacking competence to consent, were tested if a legal guardian provided consent on their behalf [19]. No specific algorithm assessing was used to determine HIV risk among children and adolescents, such that all individuals aged over 18 months were considered eligible for testing. Children under the age of 18 months were referred to the nearest health facility in accordance with national guidelines, as a positive test would require virological confirmation which is currently only provided at health facilities. Individuals who tested HIV positive or had indeterminate test results were referred to the health facility of their choice at a date of their choice (recommended to be no later than 14 days). For the purpose of the study, we visited the structures to ascertain whether the individuals had attended their referral appointment and were subsequently enrolled in the

National HIV programme. Tracing individuals who missed their appointment followed national protocol and was led by the nurses and expert client counsellors in the health centres (see Supplementary Information S1; referral process). Antiretroviral treatment eligibility assessment through point-of-care (PoC) CD4 testing or WHO staging was not provided at the community testing events.

Population and data collection

To determine the characteristics of the population undergoing HTC in the community, individual level data were obtained from paper testing records of two consecutive samples (subgroups 1 & 2: Individuals tested from 01/08/2013 to 30/08/2013 for HBHTC; and individuals tested from 15/03/2013 to 17/0572013 for MHTC). For MHTC, detailed information was also collected regarding the type of event, and categorised as:

- Testing at comprehensive outreach: mobile 'outreach' clinics organised in collaboration with Ministry of Health (MOH) facilities. MOH staff were present offering primary healthcare services, while MSF provided logistical support and offered HTC.
- MSF-led mobile testing. MSF testing teams set up tents and offered HTC at community sites identified by community leaders or workplaces.
- Testing at major events such as football matches or world AIDS day.
- If more than one site was visited in 1 day, the information regarding each site was collected accordingly, and they were considered as two separate testing events.

To determine the proportion of HIV-positive patients who were successfully linked to HIV care (registered in the HIV programme at their chosen facility within 6 months), a consecutive sample of community-based testing participants who tested HIV positive (or had an indeterminate HIV result) was followed up for 6 months from the test date (subgroup 3: Individuals testing HIV positive from 11/02/2013 to 29/08/2013). MSF data clerks visited each of the health facilities in the region to trace referrals using the Swaziland HTC client record. This triplicate form has a unique form number allowing the data clerks to identify individuals who had attended their appointment. Given that some individuals may have sought care without using the referral form, the data clerks also performed a manual search of clinic HIV care records (paper ART and pre-ART registers) using name, age, village and date. Clients who were referred to a health facility outside Shiselweni region were excluded from the analysis of linkage to care. We did not follow referrals to preventative services for clients that tested HIV negative.

Costing

The cost of MHTC and HBHTC was estimated from a service provider perspective using an ingredient costing approach [20], whereby the total costs of each testing strategy was estimated and divided by the total number of tests performed, individuals newly identified as HIV positive, and HIV-positive individuals linked to HIV care within 6 months. Further details of the costing analysis can be found in Supplementary Information S2.

Data analysis

To estimate testing coverage through HBHTC, we obtained estimates regarding the number of homesteads and total population from the local councils. For MHTC, we did not estimate coverage or uptake due to the lack of a realistic target population (denominator) and the difficulty in determining who was really offered the test and who refused the test due to having a known HIV-positive status. With regard to the demographic characteristics of the population reached, statistical comparisons between the two strategies were made with regard to the main indicators (gender, previous testing and HIV positivity) among adults only (≥20 years) using a Pearson's chi-squared test. Linkage to care was defined as attendance at the referral facility and registration in the pre-ART register within 6 months of the test date. Linkage status was established for all individuals who tested HIV positive, irrespective of their expressed motivation to seek treatment and care, unless they intended to access care outside Shiselweni (and thus could not be followed up). To analyse factors associated with linkage to care, odds ratios (OR) and 95% confidence intervals (95% CI) were calculated using unconditional logistic regression. Variables that were associated with linkage in univariable analysis with a P -value of <0.10 were included in the multivariable model. Data entry was carried out using Epidata (The EpiData Association, Odense, Denmark) data analysis used Stata/SE Version 12 (StataCorp, Texas, USA).

Ethics

This study used routine programme data without patient identifiers. The study was approved by the Swaziland Scientific and Ethics Committee and met the criteria for exemption from full ethics review from the international MSF ERB. Both institutional review boards waived the need for written informed consent.

Results

Testing coverage and uptake

We analysed a consecutive sample of 2 043 people tested through MHTC (Figure 1, subgroup 1.) There were a total of 135 events, of which 37 (27%) were comprehensive outreach events (run by clinics), 83 (62%) were MSF run mobile testing events and 15 (11%) were organised around a major event. In the month of August, 7 026 individuals were tested through an intensive HBHTC campaign in the three rural constituencies (Figure 1, subgroup 2). 2 005 (26%) of 7 681 homesteads were tested. The main reason for homesteads not being reached was lack of time; each constituency was tested over seven consecutive days, and this was not sufficient to reach all homesteads in this rural setting.

According to local council records, a total of 12 269 people lived in the 2 005 households that were visited during the HBHTC campaign. 8 768 (71%) were present the day of testing. 673 (8%) of those present had a known HIV-positive status and 395 (5%) reported that they knew their status as they had tested negative in the previous 2 months. Of the remaining 7 484 individuals, 6 452 (86%) were tested. A further 597 individuals were tested outside the households.

Demographics and previous testing among the population reached by MHTC and HBHTC

A higher proportion of children and adolescents were tested during the HBHTC campaign than by MHTC ($P < 0.001$). A total of 110 (5.4%) of those tested through MHTC were under the age of 10, 245 (12%) were adolescents (10–19 years old) and 1 679 (83%) were adults (20 years or older). By contrast, 2086 (30%) of those tested by HBHTC were children under the age of 10, 1924 (27%) were adolescents and 3016 (43%) were adults. Given the equal gender distribution among children and the fact that children and adolescents were more likely to be first-time testers, comparisons between HBHTC and MHTC in terms of gender and previous testing were made among the adult population only. Details of the gender and previous testing characteristics among the children and adolescents can be found in Table 1.

Among adults, a higher proportion of men were tested by MHTC than HBHTC (702, 42% *vs.* 1163, 39%, $P = 0.020$). The proportion of males tested was higher among the subgroup of MHTC that was categorised as major events, where 243 of 426 people tested were male (57%, data not shown in tables).

Of the adults tested through HBHTC, 1 013 (34%) were testing for the first time. This was significantly higher than for MHTC (359, 22%, $P < 0.001$). Similarly, the proportion of adults who had not tested within the last 12 months was higher among those tested by HBHTC compared to MHTC (Table 1, $P > 0.001$).

HIV positivity rate

Overall, the HIV positivity rate was highest among those tested though MHTC where 96 individuals (4.7%) tested

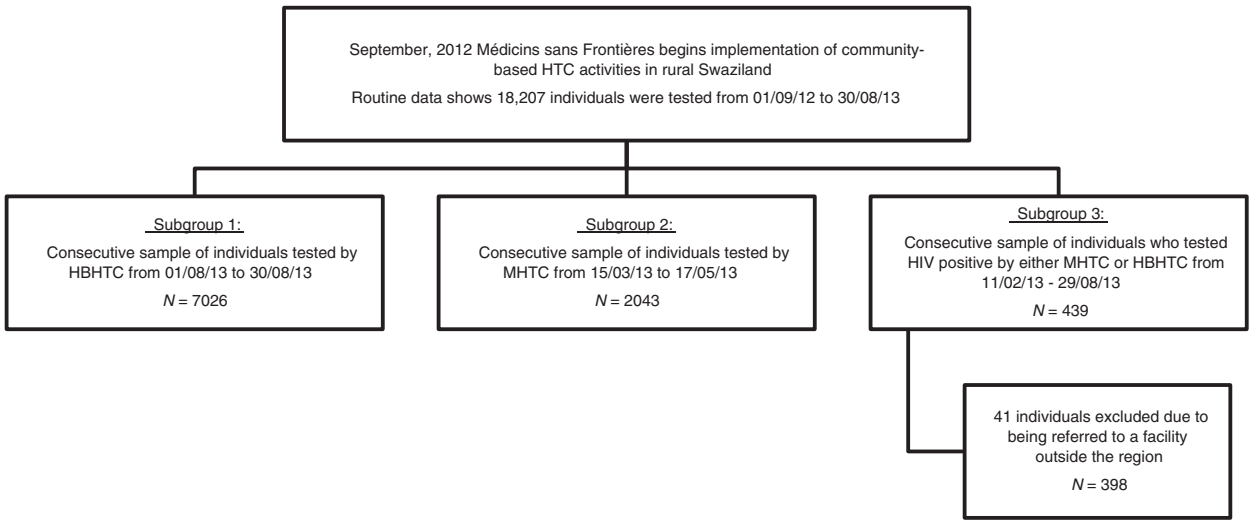

Figure 1 Participants of MSF supported community-based HTC activities from in rural Swaziland from 01/09/12 to 30/30/13. Individuals testing prior to 11/02/13 were not included because the L&R SOPs had not been fully implemented at this time.

Table 1 Characteristics of the participants tested through community-based HTC in rural Swaziland

	MHTC								HBHTC								
	Children (1–9 years)		Adolescent (10–19 years)		Adult (≥20 years)		Total*		Children (1–9 years)		Adolescent (10–19 years)		Adult (≥20 years)		Total*		
	n	%	*n*	%	N	%	*n*	%	*n*	%	*n*	%	N	%	*n*	%	*P*†
Total	110	–	245	–	1679	–	2034	–	2086	–	1924	–	3016	–	7026	–	
Gender																	
Male	50	46	142	58	703	42	895	44	1025	49	918	48	1163	39	3106	44	0.020
Female	58	54	103	42	969	58	1130	56	1058	51	1005	52	1851	61	3914	56	
Previous HIV test																	
Never	91	83	153	63	359	22	603	30	1899	92	1576	83	1013	34	4488	64	<0.001
Within last 12 months	9	8	56	23	715	43	780	39	57	3	113	6	781	26	951	14	
Over a year ago	9	8	35	14	592	35	636	32	114	6	219	11	1181	40	1514	22	
HIV test result																	
Negative	109	100	240	98	1578	95	1927	94	2058	99	1884	98	2806	94	6748	96	0.285
Positive	0	–	5	2	91	5	96	6	21	1	32	2	189	6	242	4	
Indeterminate	0	–	0	–	0	0	0	0	0	–	3	0	2	0	5	0	

*32 individuals had missing information on age and do not appear in this table. Furthermore, the sum of the subtotals does not add up to the total because 1 (0.01%) individual had missing information on gender, 75 (0.83%) had missing info for previous HIV testing and 42 (0.5%) had a missing HIV test result.
†*P* value from Pearson's chi-squared test comparing proportions among adults only.

HIV positive *vs.* 243 (3.5%) of those tested by HBHTC ($P = 0.009$). The number needed to screen to identify one HIV-positive individual was 21 (95% CI: 17–26) for MHTC and 29 (95% CI: 26–33) for HBHTC. Among adults only, there was no difference in the HIV positivity rates between the two strategies (Table 1, $P = 0.285$), with 5-6% found to be HIV positive through either strategy. The number of adults needed to screen to identify one HIV-positive individual was 18 (95% CI: 15–23) for MHTC and 16 (95% CI: 14–18) for HBHTC. Of the 4 010 children and adolescents tested during the HBHTC campaign, 53 (1.3%) tested HIV positive and a further three had indeterminate test results.

Linkage to HIV care

We analysed a consecutive sample of 439 individuals that tested HIV positive at a MHTC event or during the HBHTC campaign (Figure 1, subgroup 3). Of the 398 HIV-positive individuals referred within Shiselweni, 135 (34%) were registered in pre-ART care within 6 months of the test date (figure 2). Of these, 103 (76%) had a CD4 count taken and completed ART eligibility assessment (equivalent to 26% of those tested HIV positive). Forty-two (41%) were eligible for combined ART according to national guidelines (CD4 < 350 and/or WHO clinical stages III or IV), of whom 22 (52%) initiated treatment. The median time from HIV testing to pre-ART enrolment was 12 days (IQR 6–29 days), and the median time from HIV test to ART initiation was 34 days (IQR 20–60).

There was no difference in linkage to care between the two testing strategies or between men and women (Table 2). Linkage to care was highest among children and older individuals (approximately half of the children aged 18 months to 9 years or adults aged over 50 were linked to care, Table 2). Particularly, low rates of linkage to care were observed for individuals aged 20–29 and 30–39 years old (Table 2). Enrolment in HIV care was highest among first-time testers (44% compared to 28% of those who had tested previously, $P = 0.004$). Single people were less likely seek HIV care than individuals

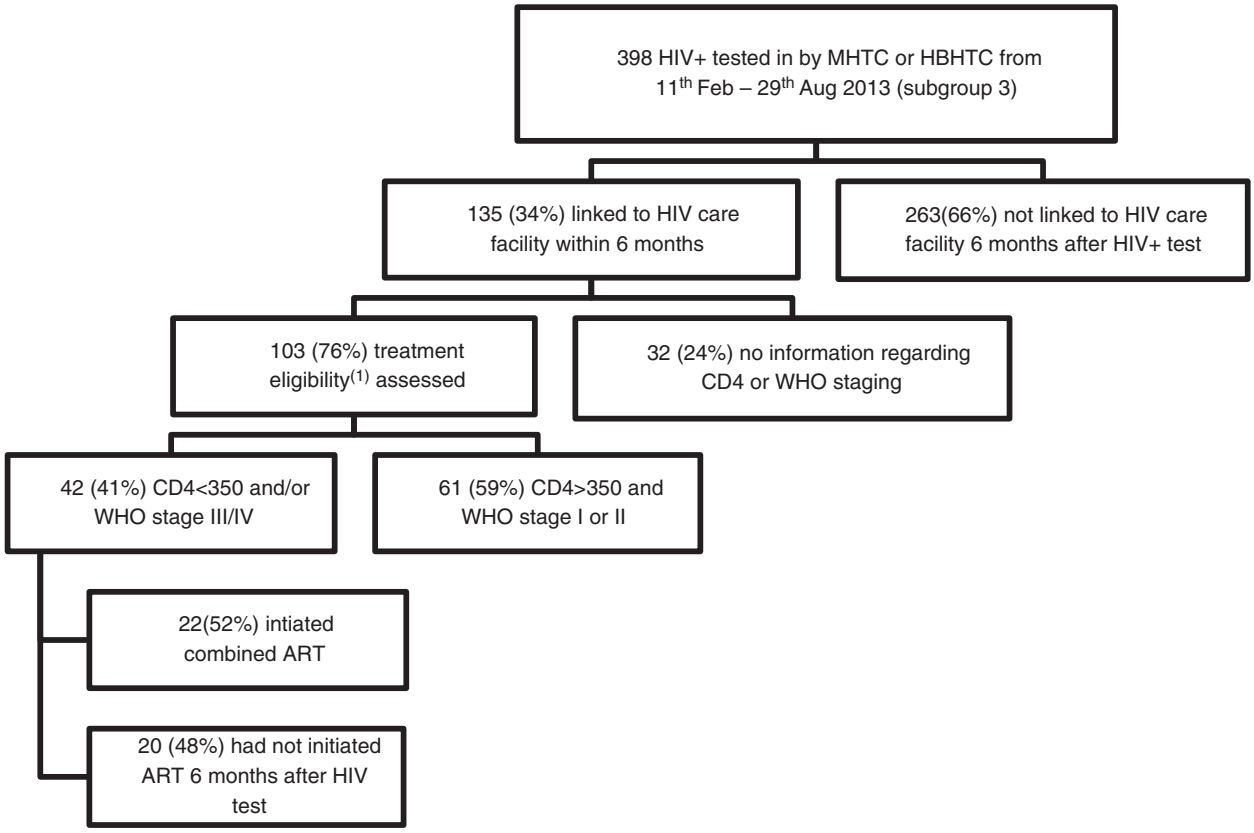

Figure 2 Linkage-to-care, assessment of ART eligibility and treatment initiation among individuals testing HIV+ through community testing in Shiselweni, Swaziland. [(1)]Treatment eligibility was defined as any client with CD4 < 350 and/or WHO III/IV stage.

Table 2 Factors associated with linkage to care among individuals testing HIV positive or with indeterminate test results in community-based testing events

	N	Linked to HIV care facility within 6 months (%)	*P*	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Total	398	135 (34)			
Strategy type					
MHTC	228	60 (35)	0.617	1	–
HBHTC	170	75 (33)		1.1 (0.7–1.7)	–
Age					
Children (1–9 years)	14	7 (50)	0.001	3.4 (1.1–10.6)	3.1 (0.9–10.1)
Adolescents (10–19 years)	33	14 (42)		2.5 (1.1–5.7)	2.5 (1.0–6.0)
Adults (20–29 years)	120	27 (23)		1	1
Adults (30–39 years)	104	28 (27)		1.3 (0.7–2.3)	1.1 (0.6–2.1)
Adults (40–49 years)	62	27 (44)		2.7 (1.4–5.1)	2.2 (1.1–4.5)
Adults (≥50 years)	60	30 (50)		3.4 (1.7–6.7)	2.3 (1.1–5.0)
Gender					
Female	242	84 (35)		1	–
Male	155	51 (33)	0.711	0.9 (0.6–1.4)	–
Previous HIV test					
Never	161	71 (44)	0.004	1	1
Within last 12 months	70	19 (27)		0.4 (0.3–0.9)	0.5 (0.3–1.0)
Over a year ago	160	45 (28)		0.5 (0.3–0.8)	0.6 (0.3–0.9)
Marital status					
Single/separated	153	44 (29)	0.044	1	1
Married/cohabitation	194	67 (36)		1.3 (0.8–2.1)	1.5 (0.9–2.7)
Widowed	38	19 (50)		2.5 (1.2–5.1)	2.1 (0.9–5.2)

NB: 5 (1.3%) had missing information on age, 1 (0.3%) on sex, 7 (1.8%) on previous testing and 19 (4.7%) on marital status.

who reported being married or living in stable partnership although this association lost statistical significance after controlling for age and previous testing (Table 2). Of four individuals who had indeterminate test results and were referred to a facility within Shiselweni, none were linked to care within 6 months, and hence, none were retested.

Cost of MHTC and HBHTC campaign

From service provider perspective, HBHTC was significantly cheaper ($11 per person tested, $343 per HIV-positive individual identified, and $797 per HIV-positive individual linked to care) than MHTC ($24, $543 and $1 698, respectively, Table 3). The main cost driver for HBHTC was accommodation and food for staff during the campaign, accounting for nearly one-third of the total costs (Table 3). The main cost drivers for MHTC were human resources, followed by transport costs.

Table 3 Cost of community-based HIV testing strategies led by MSF in Shiselweni, Swaziland, 2013

	MHTC	HBHTC
Cost per person reached	24 USD	11 USD
Cost per HIV positive identified	543 USD	343 USD
Cost per HIV positive identified and linked to care	1698 USD	797 USD
Break-up of costs (%)		
Transport	25	6
Human resources	52	26
Testing equipment	16	30
Infection control	2	1
Information, education and counselling	1	3
Other*	3	33

*Other costs included trailers, tents, furniture for MHTC; accommodation, food, airtime for HBHTC.

Discussion

We found mobile- and home-based HTC to be feasible and affordable ways to reach a substantial number of people and hence have the potential to increase the number of people who know their HIV status, in this rural, low-resourced, high-prevalence setting of Swaziland. Rates of sero-positivity were similar between strategies, but HBHTC cost 50% less than the mobile strategies, and was a more effective strategy for reaching first-time

testers. MHTC appeared more effective for reaching specific target groups (such as men), and thus, both testing strategies may have a complementary role to play, depending on the specific objectives of the testing programme. Only one-third of those testing HIV positive were subsequently enrolled in pre-ART care and hence ensuring that people who test HIV positive in the community access HIV prevention and care services remains a significant challenge in this setting.

In high-prevalence generalised HIV epidemics, as is the case in Swaziland, increasing the proportion of people who know their HIV status is an important public health goal, and both strategies evaluated contributed to this process (almost half of those testing in the Shiselweni region in this evaluation period were tested by this small community team). A significant number of children were tested by HBHTC; 54 tested HIV positive, of whom 22 were under the age of 10, which demonstrates the potential of HBHTC for reaching HIV-positive children missed by the PMTCT programme and child welfare services. Community testing offering HIV testing to all individuals over 18 months of age can therefore complement the detection of HIV-positive children for linkage into HIV care and treatment. Other studies have also identified home-based testing to be a good strategy to target children [21, 22]. Furthermore, we showed that HBHTC was a more effective strategy for reaching people who are overdue for retesting (national HTC guidelines recommend that HIV-negative adults undergo yearly testing) [19]. In a high-incidence setting, increasing rates of annual retesting is of particular relevance, as identifying people with HIV infection, who believe they are still HIV negative, may be an important element of transmission reduction.

The costs reported here for both HBHTC and MHTC here were comparable to those summarised in a recent systematic review [12]. It is worth noting that HBHTC in this study was carried out in the form of an intensive door-to-door campaign with supplementary working hours for the testing teams, and as such incurred some additional costs (staff accommodation and food) that could be avoided to make the activity more economical. However, it is difficult to calculate what impact this would have on costs as the number of people tested during the campaign is likely to be higher than the number tested if door-to-door testing were to be undertaken as a routine activity. Relative to HBHTC, MHTC was significantly more expensive which can be explained by the fact that some mobile events had very low attendance levels (e.g. remote communities), yet HR and transport costs remained constant. If MHTC is directed at high-risk groups with poor access to HTC, it is possible that even when testing numbers are low the number of HIV-positive individuals identified will increase and the cost per HIV-positive individual identified will be reduced.

A key challenge highlighted in our study was the low rate of linkage to HIV care among individuals who tested HIV-positive. If linkage to HIV care for HIV-positive individuals were the sole objective of HTC, the community-based strategies as described here could not be deemed effective. Two-thirds of the HIV-positive individuals identified were not registered in HIV care within 6 months of the test. While high levels of attrition after HIV testing have been observed in numerous studies [14–16, 23, 24], some studies have shown relatively high levels of linkage [10, 12]. In the light of our findings, and reviewing the details of the different studies, it appears that PoC ART eligibility determination could be a valuable addition to HBHTC and MHTC programmes, for the purposes of increasing linkage of HIV-positive people to HIV care. Nevertheless, determination of ART eligibility does not guarantee that an individual initiates ART. One study showed that one in five people did not undergo CD4 staging even with PoC CD4 available [18], and of those that did a further 27% did not receive their results. Furthermore, even when CD4 staging is close to 100%, treatment initiation can be as low as 50%[25]. In our study, we found that one in four people attending the clinic did not have CD4 staging recorded, and only half of the individuals eligible for ART after CD4 testing and WHO staging initiated ART within 6 months of the HIV test.

Linkage to care was especially poor among individuals who had tested in the past. It is possible that these individuals are more reluctant to believe and act upon the test results, given they had had a negative test in the past. Furthermore, we showed linkage was low among people aged 20–40, which may reflect occupational barriers preventing these individuals from attending the clinic for HIV care. However, it is alarming that linkage to care was not higher than 50% for any of the subgroups considered. Strategies to improve linkage to care and to reduce attrition between testing and treatment initiation are urgently needed [23]. Providing incentives has been suggested to have positive impact on linkage rates [26], as has incorporating POC CD4 counts and follow-up visits by a lay counsellor [27]. Reducing the number of health facility visits has also been suggested as a key facilitator for improving access [26]. Indeed, one study in Malawi has shown that offering home initiation after home self-testing significantly increased the proportion of adults initiating ART [28].

During the HBHTC campaign, nearly a third of the reported households members were not present the day

of testing, perhaps due to work commitments. Improving HBHTC testing coverage by visiting the homesteads in the evenings may be a useful strategy to reduce health inequalities caused by work-related barriers. HBHTC was introduced as a campaign, and it is not clear if uptake (acceptance) would be similarly high if HBHTC were to be carried out on a routine basis or if recurrent campaigns were to take place. Furthermore, it is important to respect the opt-in nature of HBHTC as concerns have been raised about HBHTC and the possibility of household members participating in HTC under coercion. In our analysis of factors associated with linkage to care, one key limitation was the lack of availability of CD4 or WHO staging to determine eligibility for ART. It is possible that individuals who feel healthy are less likely to attend the clinic, potentially acting as a confounder in our risk factor analysis. Finally, we must recognise as a limitation that our costing analysis is limited to the service provider's perspective. However, if we had considered the patient perspective, both community-based HTC strategies are likely to be even more cost-effective because from a patient perspective the main costs are transport costs (to go to a site offering HTC) and opportunity cost (loss of time travelling to the HTC site and waiting for ones turn to test).

In conclusion, community-based testing appears to be an effective and affordable way to improve HTC coverage in high-prevalence settings. We found that HBHTC cost less than MHTC and was more effective at reaching first-time testers and people who had not tested in the past 12 months. Furthermore, in a setting with high antenatal HIV prevalence and low coverage of infant testing throughout breastfeeding, HBHTC enabled identification of HIV-positive children missed by the PMTCT programme and child welfare services. MHTC, although more expensive, can still be a useful strategy to reach specific target groups with poor access to HTC (e.g. young men or people with work-related barriers). Community-based testing can thus contribute to increasing the number of people who know their HIV status. However, for it to have impact on HIV morbidity, mortality and incidence, it should include not only PoC treatment eligibility determination but also other 'directive' linkage strategies to help guide people testing HIV positive in the community into HIV care and treatment.

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