Factors Associated with HIV Status Awareness and Linkage to Care Following Home Based Testing in Rural Malawi

Factors associated with HIV status awareness and Linkage to Care following home based testing in rural Malawi

D. Maman[1], J. Ben-Farhat[1], B. Chilima[2], C. Masiku[3], L. Salumu[4], N. Ford[5,6], P. Mendiharat[4], E. Szumilin[4], S. Masson[1] and J. F. Etard[1,7]

1 *Epicentre, Médecins Sans Frontières, Paris, France*
2 *Community Health Sciences Unit, Malawi Ministry of Health, Lilongwe, Malawi*
3 *Médecins Sans Frontières, Lilongwe, Malawi*
4 *Médecins Sans Frontières, Paris, France*
5 *Department of HIV/AIDS, World Health Organization, Geneva, Switzerland*
6 *Centre for Infectious Disease Epidemiology and Research, University of Cape Town, Cape Town, South Africa*
7 *UMI 233, Institut de Recherche pour le Développement, Montpellier, France*

Abstract

OBJECTIVE HIV diagnosis and linkage to care are the main barriers in Africa to achieving the UNAIDS 90-90-90 targets. We assessed HIV-positive status awareness and linkage to care among survey participants in Chiradzulu District, Malawi.

METHOD Nested cohort study within a population-based survey of persons aged 15–59 years between February and May 2013. Participants were interviewed and tested for HIV (and CD4 if found HIV-positive) in their homes. Multivariable regression was used to determine factors associated with HIV-positive status awareness prior to the survey and subsequent linkage to care.

RESULTS Of 8277 individuals eligible for the survey, 7270 (87.8%) participated and were tested for HIV. The overall HIV prevalence was 17.0%. Among HIV-positive participants, 77.0% knew their status and 72.8% were in care. Women (adjusted odds ratio [aOR] 6.5, 95% CI 3.2–13.1) and older participants (40–59 *vs.* 15–29 years, aOR 10.1, 95% CI 4.0–25.9) were more likely to be aware of their positive status. Of those newly diagnosed, 47.5% were linked to care within 3 months. Linkage to care was higher among older participants (40–59 *vs.* 15–29, adjusted hazard ratio [aHR] 3.39, 95% CI 1.83–6.26), women (aHR 1.73, 95% CI 1.12–2.67) and those eligible for ART (aHR 1.61, 95% CI 1.03–2.52).

CONCLUSIONS In settings with high levels of HIV awareness, home-based testing remains an efficient strategy to diagnose and link to care. Men were less likely to be diagnosed, and when diagnosed to link to care, underscoring the need for a gender focus in order to achieve the 90-90-90 targets.

keywords linkage to care, population survey, sub-Saharan Africa, cascade of care, epidemiology

Introduction

UNAIDS has recently defined new ambitious targets that call for 90% of people living with HIV to know their status, 90% of those diagnosed to receive antiretroviral therapy (ART) and 90% of those on treatment to achieve an undetectable viral load. In sub-Saharan Africa, where the majority of people receiving antiretroviral therapy live, timely access to HIV diagnosis and linkage to care remain the main challenges to achieving this objective [1–3]. WHO estimates that only 50% of HIV-positive individuals in Africa are aware of their status, and this figure rises to 80% in some countries [4, 5]. Among those testing positive, there is substantial attrition between receipt of HIV test result and engagement in HIV care [6].

Recent attention has focused on the need to move beyond facility-based HIV testing in order to reach greater numbers of people earlier in their disease progression. Community-based and mobile HIV testing and counselling services (HTC) increase rates of test uptake and reach people at an earlier stage of their HIV infection [7–11]. Community testing approaches are considered cost-effective in high prevalence settings [12] and have been recommended by WHO in generalised HIV epidemic settings in addition to facility-based HIV testing since 2013 [13].

In Malawi, despite limited resources and high HIV burden, 46% of the adult HIV-positive population were receiving treatment in 2013 [14]. However, as in most countries in sub-Saharan Africa, diagnosis and linkage to

care remain the main gaps in the cascade of care. It was also estimated that in 2010, 48% of the men and 27% of the women had never been tested for HIV [1].

In order to better understand the challenges associated with improving HIV status awareness and engagement in care in Malawi, we measured HIV status awareness at population level, assessed linkage to care among newly diagnosed HIV-positive individuals and assessed risk factors associated with knowledge of HIV-positive status and linkage to care.

Methods

Setting

Chiradzulu District in southern Malawi is a rural district with a population of approximately 289 000 inhabitants [15]. HIV prevalence for the southern region was estimated in 2010 at 14.5% among 15- to 49-year-olds [16]. The population is served by 11 public health facilities (one district hospital and 10 health centres), all of which have provided free HIV care, including ART, with the support of Médecins Sans Frontières (MSF) since 2001. In 2012, 27 000 individuals were actively followed up on ART in the district.

An observational cohort study measuring linkage to HIV care was implemented after a cross-sectional population-based survey in Chiradzulu District, Malawi, between February and May 2013. The method of the cross-sectional survey, along with its main results on population viral load and HIV incidence, is described in detail elsewhere [17]. Its objective was to estimate HIV incidence, prevalence, population viral load and coverage at each step of the HIV cascade of care within the population of the district. Using a multistage cluster sampling method, the original study recruited all individuals age 15 to 59 living in 4125 randomly selected households (165 clusters of 25 households). Consenting individuals were interviewed and tested for HIV at home. Information on demographic characteristics, antenatal and delivery care for women, circumcision status for men, and knowledge, access and history of HIV testing information were collected during the interview using a standardised questionnaire.

HIV testing and counselling was offered by nationally certified HTC counsellors in accordance with national guidelines. Rapid testing was performed using serial tests with Determine Rapid HIV-1/2 antibody followed, if positive, by Unigold Rapid HIV test using finger prick whole blood samples. ELISA test was used as the 'tiebreaker' in the event of discordant rapid tests (Determine positive, Unigold negative).

All HIV-positive participants answered an additional questionnaire to identify individuals who were already aware of their status and collect information about their history of access to HIV care, including ART initiation where relevant. CD4 count was taken for all HIV-positive individuals on the same day by a registered nurse either at home or in a tent in the cluster using whole venous blood and point-of-care Alere Pima™ Analyzer, and participants received their CD4 count results within 20 min. All HIV-positive individuals were referred to the health facility of their choice (public or private, within the district or outside the district) with a referral letter indicating their unique study number, date of HIV test, CD4 cell count, age, sex and patient file number if already in care.

Linkage-to-care data collection and study population

After specific onsite training and regular reminders, health facility staff were requested to indicate the date of visit of the patient on the referral letter and keep the reference letter filed with the patient record. Reference forms were prospectively collected by the study team regularly up to 3 months after the cross-sectional population-based survey ended. Unique study number, date of visit and health facility attended were recorded in a separate database merged with the main survey database at the end of this prospective linkage-to-care study.

Participants testing positive who had complete information about their previous history of HIV testing were included in the analysis of factors associated with awareness of HIV status. Newly diagnosed individuals were included in the analysis of factors associated with linkage to HIV care.

Awareness of HIV status was defined as reporting a previous positive HIV test before the study inclusion. Linkage to HIV care was defined as attending at least one visit to a health facility within 3 months of HIV diagnosis. ART eligibility was defined as CD4 count $\leq$350 cells/mm^3 or being pregnant or breastfeeding at the time of study, corresponding to CD4 threshold and PMTCT strategy recommended in the Malawian national guideline at the time of the study [18].

Data analysis

This analysis explored factors associated with HIV awareness at population level and linkage to care of the newly diagnosed. A secondary analysis of the survey data was used for the first part, whereas the nested cohort was used to explore linkage to care.

For the analysis of awareness of status, descriptive statistics were performed to describe baseline characteristics and random intercept logistic models using backward stepwise approach and likelihood ratio test were fitted to explore factors associated with being already diagnosed; the random intercept was added to account for intra- and interclusters correlation. The main study outcome was linkage to care. Study follow-up started the day the participant was tested during the population survey, and censoring occurs at linkage to care or at 92 days (the end of the observation period for linkage to occur).

For the analysis of linkage to care, descriptive statistics were again generated and the probability of being linked within 92 days assessed using the nonparametric Kaplan–Meier estimation method. Wilcoxon rank sum tests were used to assess linkage-to-care differences by gender, age, ART eligibility, marital status, education level, subdistrict areas (Traditional Authorities), ethnicity and work categories. Factors associated with linkage to care were explored with fitted parametric shared frailty Weibull models to take into account intra- and intercluster correlation, using backward stepwise approach. All analyses were performed with Stata 12 (Stata Corp, College Station, TX, USA).

Ethics

The study was reviewed and approved by the Malawian National Health Science Research Committee and 'Comité de Protection des Personnes' of Saint Germain en Laye, France. Written Informed consent was obtained from all participants.

Results

Study inclusion and HIV prevalence

A total of 8277 individuals, living in 4126 randomly selected households, met the eligibility criteria (Figure 1). From this total, 7270 (87.8%) were included in the study and tested for HIV. More women (93.4%, 4275/4575) than men (80.3%, 2995/3730) were included. Absence from home (539 individuals or 73.9% of all individuals not included), refusal to participate (100 individuals or 12.4% of those not included) and not being able to sign the inform consent (62 individuals or 7.7% of those not included) were the main reasons for non-participating to the survey.

Of the 7270 tested participants, 1233 were found to be HIV-positive. The weighted HIV prevalence was estimated at 17.0% (95% CI, 15.8–18.1). It was 19.6% (95% CI, 18.3–21.0) among women and 13.2% (95% CI, 11.9–14.5) among men. A total of 1213 (98.4%) of the 1233 HIV-positive individuals had complete information and were included in the analysis; 68.2% were women, 70% were married and 72.8% had attended primary school as highest level of schooling. Median age was 37 years [IQR 31–44] (Table 1).

Factors associated with HIV-positive status awareness

For those already diagnosed, the median time since diagnosis was 4.3 years [IQR 2.3–6.2]; 24.7% (95% CI, 20.0–30.2) of those newly diagnosed by the study reported having tested negative in the previous 12 months.

In total, 76.8% (95% CI, 73.6–79.5) of individuals had already been diagnosed as HIV-positive at the time of the study. This proportion was higher for women (81.6% (95% CI, 78.2–84.4)) than men (66.3% (95% CI, 61.7–70.7 ($P < 0.01$)) and increased with age from 63.8% (95% CI, 57.6–69.0) among 15- to 29-year-olds to 83.0% (95% CI, 78.6–86.6) among 40- to 59-year-olds. HIV-positive status awareness fell with increasing education, from 84.4% (95% CI 77.2–89.6) for those with no education to 71.9% (95% CI 64.6–78.3) for those with secondary or university education. In multivariate analysis, awareness of HIV-positive status was strongly associated with gender (adjusted odds ratio, aOR=6.48, 95% CI 3.22–13.07 for women *vs.* men) and increasing age (aOR= 10.13, 95% CI 3.96–25.92 for 40- to 59-year-olds and aOR=3.48, 95% CI 1.63–7.40 for 30- to 39-year-olds, *vs.* people aged 15–29 years). There was also a trend towards a greater likelihood of awareness of HIV status among those who were married than those who were never married (aOR 4.63, 95% CI 0.98–21.78).

Factors associated with linkage to care

Of the 282 individuals newly diagnosed during the population survey, 244 (86.5%) who had complete referral information and were referred to public health facilities within the district were included in the linkage-to-care analysis. Of those not included, 20 had a missing reference place and 18 were referred to a facility outside Chiradzulu District (Figure 1). A quarter (59, 24.2%) reported having tested HIV-negative within the previous 12 months and 119 (48.8%) were considered eligible for ART at the time of diagnosis (≤350 cells/mm^3) (Table 2). Men had lower median CD4 counts at diagnosis than women (328 *vs.* 440 cells/μL, $P < 0.01$).

Table 2 presents the cumulative probability of being linked to care up to 3 months after diagnosis, stratified by individual characteristics. At 3 months, the linkage

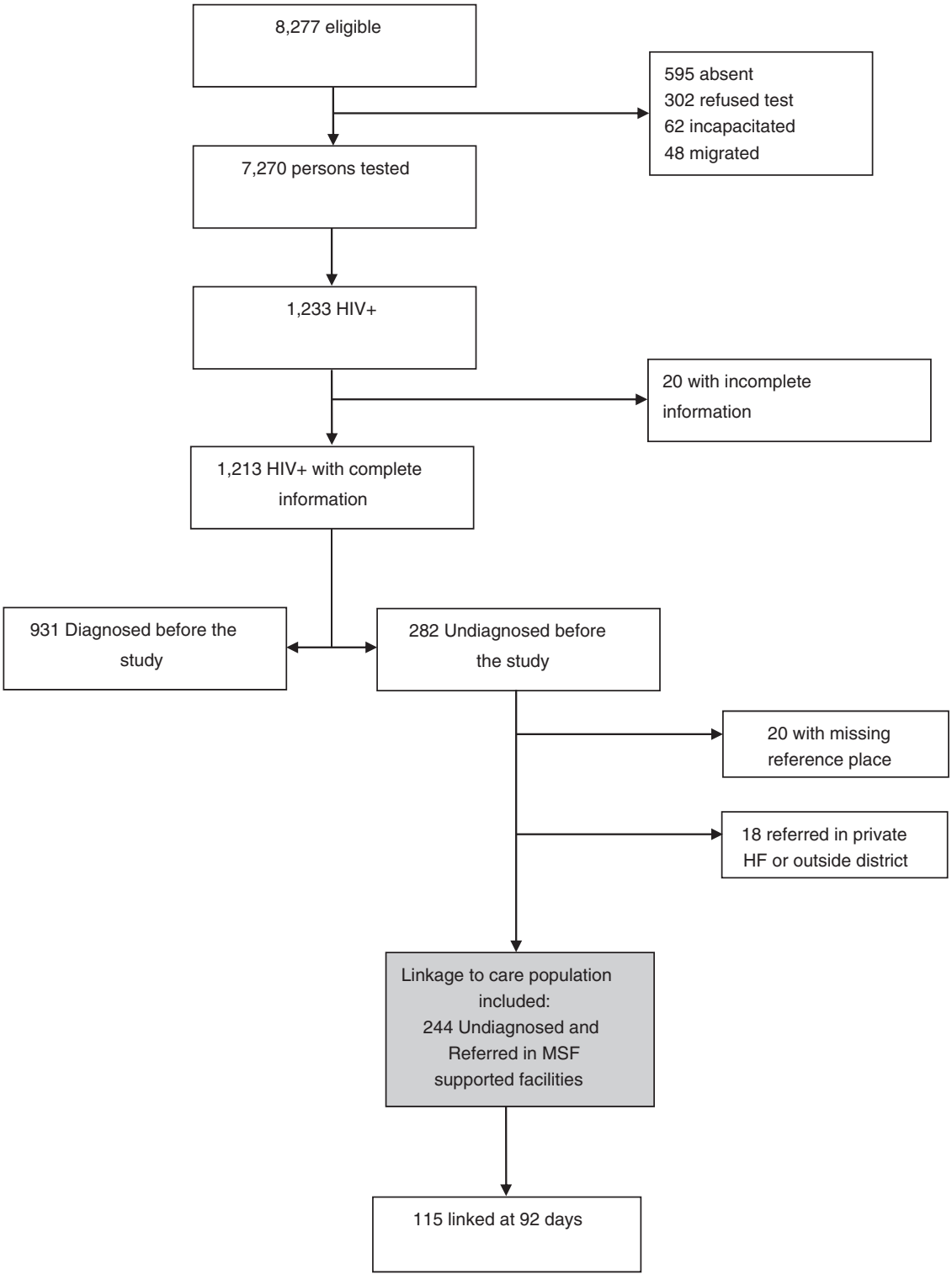

Figure 1 Flowchart of study inclusion.

Table 1 Multivariable mixed-effect logistic regression exploring risk factors associated with awareness of HIV status, Chiradzulu District, Malawi, 2013. (N = 1213)

Factors	Number of positive participants	Diagnosed before study *n* (%)	Univariable analysis OR (95% CI)	Multivariable aOR (95% CI)
Gender			*P < 0.01*	*P < 0.01*
Men	386	256 (66.3)	1	1
Women	827	675 (81.6)	5.04 (2.82–9.01)	6.48 (3.22–13.07)
Age groups			*P < 0.01*	*P < 0.01*
15–29	240	153 (63.8)	1	1
30–39	509	393 (77.2)	2.49 (1.44–4.29)	3.48 (1.63–7.40)
40–59	464	385 (83.0)	4.33 (2.38–7.89)	10.13 (3.96–25.92)
Mean	37.4	38.4		
Median (IQR)	37 (31–44)	37 (32–45)		
Marital status			*P < 0.01*	*P* = 0.13
Never married	47	25 (53.2)	1	1
Married/living together	849	647 (76.2)	8.38 (2.57–27.35)	4.63 (0.98–21.78)
Divorced/separated/widowed	317	259 (81.7)	15.50 (4.14–58.04)	4.74 (0.93–24.19)
Education Level			*P* = 0.02	*P* = 0.61
No education	151	128 (84.8)	1	1
Primary	884	677 (76.6)	0.44 (0.21–0.93)	0.64 (0.26–1.59)
Secondary/Higher	177	126 (71.2)	0.27 (0.11–0.68)	0.71 (0.23–2.19)
Missing	1	0 (0.0)		
Ethnicity			*P* = 0.80	
Lomwe	749	578 (77.2)	1	
Yao	248	186 (75.0)	1.01 (0.57–1.80)	
Other	215	166 (77.2)	1.23 (0.66–2.29)	
Missing	1	1 (100.0)		
Work category			*P < 0.01*	*P = 0.06*
Farmer/Fisher man	690	530 (76.8)	1	*1*
City workers	368	273 (74.2)	0.76 (0.44–1.32)	0.98 (0.54–1.79)
Student	17	8 (47.1)	0.04 (0.01–0.28)	0.55 (0.05–6.08)
Housewife/None	134	116 (86.6)	4.25 (1.56–11.58)	3.58 (1.22–10.56)
Other	1	1 (100.0)	–	–
Missing	3	3 (100.0)	–	–
Traditional authorities			*P = 0.88*	
Chitera	64	52 (81.3)	1	
Kadewere	343	265 (77.3)	0.74 (0.21–2.66)	
Likoswe	196	147 (75.0)	0.62 (0.16–2.35)	
Mpama	280	220 (78.6)	0.82 (0.22–3.01)	
Nkalo	188	138 (73.4)	0.50 (0.13–1.94)	
Ntchema	142	109 (76.8)	0.72 (0.17–2.95)	
Total	1213	931 (76.8)		

probability reached 47.1% (95% CI, 41.1–53.6). Linkage to care was more likely to occur in the initial weeks after HIV diagnosis. Indeed, two weeks and one month after diagnosis, the cumulative probability of having linked to care was 30.7% (95% CI, 25.4–36.9) and 36.5% (95% CI, 30.8–42.9), respectively. At the end of follow-up, linkage to care was 51.5% (95% CI, 43.4–60.1) among women and 41.7% (95% CI, 33.0–51.5) among men, although these differences were not statistically significant (P = 0.17). The probability of being linked to care increased with age. At 3 months after diagnosis, it was 33.3% (95% CI, 23.9–45.2) for those aged 15 to 29 years of age, 50.5% (95% CI, 41.1–60.7) among the 30- to 39-year-old group and 57.1% (95% CI, 46.0–68.8) among 40- to 59-year-olds. Linkage occurred faster among the oldest group: at 2 weeks, only 16% (95% CI, 9.4–26.5) of the individuals aged 15 to 29 years of age had linked, whereas 40.0% (95% CI, 29.6–52.4) in the oldest age group had. Of those already eligible for ART at the time of diagnosis, 52.1% (95% CI, 43.5–61.3) had linked at 3 months, while the cumulative probability of linkage was 42.4% (95% CI, 34.3–51.6) among those not yet eligible, but these differences were not statistically significant (P = 0.09).

Table 2 Cumulative linkage to care following an HIV diagnosis through HBCT, Kaplan–Meier estimations at 14 days, 1 month and at 3 months, Chiradzulu District, Malawi, 2013. (N = 244)

Factors	Number of patients newly diagnosed	Linked at 3 months *n*	Cumulative Linkage at 14 days %(95% CI)	Cumulative Linkage at 1 month %(95% CI)	Cumulative Linkage at 3 months %(95% CI)	Wilcoxon test *P*-value
Gender						
Men	108	45	27.8 (20.3–37.3)	33.3 (25.3–43.1)	41.7 (33.0–51.5)	$P = 0.17$
Women	136	70	33.1 (25.9–41.7)	39.0 (31.4–47.7)	51.5 (43.4–60.1)	
Age groups						
15–29	75	25	16.0 (9.4–26.5)	21.3 (13.7–32.4)	33.3 (23.9–45.2)	$P < 0.01$
30–39	99	50	35.4 (26.8–45.6)	38.4 (29.6–48.7)	50.5 (41.1–60.7)	
40–59	70	40	40.0 (29.6–52.4)	50.0 (39.0–62.2)	57.1 (46.0–68.8)	
Mean age	34.3	36.0				
Median age	34 (28–40)	36 (31–42)				
ART eligible						
No	125	53	28.0 (21.0–36.8)	30.4 (23.1–39.3)	42.4 (34.3–51.6)	$P = 0.09$
Yes	119	62	33.6 (25.9–42.9)	42.9 (34.5–52.2)	52.1 (43.5–61.3)	
History of testing (within 12 months)						
Yes	59	25	28.8 (19.0–42.2)	32.2 (21.9–45.7)	42.4 (31.0–56.0)	$P = 0.33$
No	185	90	31.4 (25.2–38.6)	37.8 (31.3–45.2)	48.7 (41.7–56.1)	
Marital status						
Never married	17	5	11.8 (3.1–39.4)	17.7 (6.1–45.3)	29.4 (13.4–56.9)	$P = 0.07$
Married/living together	177	81	29.9 (23.8–37.3)	35.6 (29.0–43.1)	45.8 (38.8–53.4)	
Divorced/separated/ widowed	50	29	40.0 (28.0–54.9)	46.0 (33.4–60.7)	58.0 (44.9–71.7)	
Education level						
No education	21	13	47.6 (29.1–70.3)	52.4 (33.3–74.3)	61.9 (42.2–81.7)	$P = 0.15$
Primary	177	81	30.5 (24.3–37.9)	35.6 (29.0–43.1)	45.8 (38.9–53.4)	
Secondary/Higher	45	21	24.4 (14.4–39.8)	33.3 (21.6–49.1)	46.7 (33.4–62.1)	
Missing	1	0	0	0	0	
Ethnicity						
Lomwe	151	77	33.7 (26.9–41.9)	41.1 (33.7–49.3)	51.0 (43.3–59.2)	$P = 0.24$
Yao	52	21	23.1 (13.8–37.0)	28.9 (18.5–43.2)	40.4 (28.5–54.9)	
Other	41	17	29.3 (17.8–45.7)	29.3 (17.8–45.7)	41.5 (28.2–58.0)	
Work category						
Farmer/Fisher man	143	71	32.9 (25.8–41.2)	35.7 (28.4–44.1)	49.7 (41.8–58.1)	$P = 0.56$
City workers	79	34	26.6 (18.2–37.8)	36.7 (27.2–48.3)	43.0 (33.0–54.7)	
Student	9	3	11.1 (1.6–56.7)	22.2 (6.1–63.5)	33.3 (12.2–71.8)	
Housewife/None	13	7	46.2 (24.0–75.2)	53.9 (30.4–80.8)	53.9 (30.4–80.8)	
Traditional authorities						
Chitera	11	4	18.2 (4.9–55.3)	18.2 (4.9–55.3)	36.4 (15.5–70.3)	$P = 0.22$
Kadewere	70	33	30.0 (20.7–42.2)	35.7 (25.7–48.1)	47.1 (36.3–59.4)	
Likoswe	32	15	31.3 (18.2–50.3)	40.6 (26.0–59.5)	46.9 (31.5–65.3)	
Mpama	56	22	23.2 (14.2–36.6)	25.0 (15.6–38.5)	39.3 (27.9–53.3)	
Nkalo	43	25	46.5 (33.0–62.4)	51.2 (37.4–66.7)	58.1 (44.1–72.9)	
Ntchema	32	16	28.1 (15.7–47.1)	40.6 (26.0–59.5)	50.0 (34.3–68.1)	
Total	244	115	30.7 (25.4–36.9)	36.5 (30.8–42.9)	47.1 (41.1–53.6)	

Overall, participants contributed to 451 person-months of follow-up. The mean rate of linkage to care was 25.1 per 100 person-months (95% CI, 20.9–30.1) and fell with time since diagnosis. The highest rate of 92.8 per 100 person-months (95% CI, 70.5–122.12) was observed within the first 8 days; it dropped to 3.9 per 100 person-months (95% CI, 1.61–9.27) during the third month. The rate of linkage was 28.8 per 100 person-months (95% CI, 22.8–36.4) among women, and 20.9 per 100 person-months (95% CI, 15.6–28.0) among men, with a similar rate of decline over time (Figure 2).

In multivariate analysis, gender appeared as a significant predictor of linkage to care (adjusted hazard ratio (aHR=1.73, 95% CI 1.12–2.67 among women,

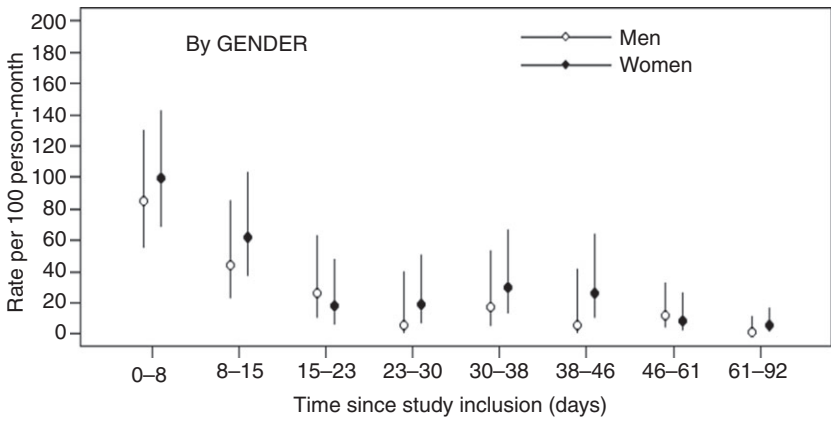

Figure 2 Rate of linkage to HIV care per 100 person-months, by gender and per time to linkage following an HIV diagnosis through HBCT, Chiradzulu District, Malawi, 2013.

men=reference). Increased age was also significantly associated with better linkage to care (aHR=2.14, 95% CI 1.23–3.73 for the 30- to 39-year-old group and aHR=3.39, 95% CI 1.83–6.26 for the 40- to 59-year-old group, compared to the 15- to 29-year-old group). Eligibility for ART was also associated with better linkage to care (adjusted HR=1.61, 95% CI 1.03–2.52) (Table 3).

Discussion

In this representative sample of the population of a rural Malawian District, more than three quarters (77%) of the HIV-positive adult population were already diagnosed at the time of the survey and half (49%) of the newly diagnosed individuals had linked to care within three months after diagnosis. Men, adolescents and young adults were less likely to be aware of their status and linked to care.

The proportion of adults aware of their status at the time of the survey is higher than data from other recent population surveys in resource-limited settings including Kenya (50%) and Swaziland (60%) [19, 20]. Other countries such as South Africa, France and North America [21–24] have reported similarly high results, indicating that high awareness coverage can be achieved in a variety of settings, including resource-limited settings in sub-Saharan Africa. Chiradzulu was the first district in Malawi to introduce and to scale-up ART, in 2001 [25]. Our results suggest that when testing and treatment are widely available and accessible, sub-Saharan Africa countries could achieve similar level of HIV diagnosis if the resources were put into services. People may be more likely to test when they know treatment is available. Malawi increased the number of HIV tests per year from 40 000 in 2001 to 2 200 000 in 2013, mostly through multiplication of fixed testing sites, systematic testing at ANC and campaigns [16].

These linkage-to-care results (49% at 3 months) are in line with other studies conducted in sub-Saharan Africa using home-based [26, 27] and other testing strategies [6]. Our study adds to the evidence base that home-based testing strategies are effective to diagnose and link to care remaining undiagnosed individuals in a population where an already high proportion is diagnosed, but also underscores that more attention is needed to support timely linkage to care.

Our intervention combined home-based testing and point-of-care CD4 count to assess ART eligibility immediately and at the participant's home. Point-of-care CD4 count is known to improve linkage to care and ART initiation [28, 29]. We found that those eligible for ART, using the national Malawian guidelines implemented at the time of the survey (CD4 threshold of 350 cells/μL for ART initiation and PMTCT option B+), were more likely to link to care after home-based testing. Our findings suggest that newly eligible diagnosed individuals who know they would receive ART if they link to care may be more likely to do so. As only half of the newly diagnosed HIV-positive individuals were eligible for treatment, universal treatment can be expected to increase ART initiation rates, first by increasing the number of individuals in need of ART and secondly by improving linkage to care as those diagnosed positive would know that they will receive ART if they link to care.

Linkage-to-care rates were highest during the first weeks after diagnosis and declined rapidly afterwards. A new contact with patients who have not linked to care after one month may be beneficial to target individuals who not yet linked to care, as the chances of them doing so without support are reduced.

Table 3 Multivariable Weibull model exploring risk factors associated with linkage to HIV care following an HIV diagnosis through HBCT, Chiradzulu District, Malawi, 2013. (*N* = 244)

Factors	Number of patients newly diagnosed	Rate of linkage/100 person-months (95% CI)	Crude HR (95% CI)	*P*-value	Adjusted HR (95% CI)	*P*-value
Gender						
Men	108	20.9 (15.6–28.0)	1		1	
Women	136	28.8 (22.8–36.4)	1.41 (0.93–2.13)	0.10	1.73 (1.12–2.67)	0.01
Age groups						
15–29	75	14.5 (9.8–21.4)	1		1	
30–39	99	28.3 (21.4–37.3)	1.90 (1.12–3.22)	0.02	2.14 (1.23–3.73)	0.01
40–59	70	36.8 (27.0–50.1)	2.74 (1.54–4.88)	<0.01	3.39 (1.83–6.26)	<0.01
ART Eligible						
No	125	21.2 (16.2–27.7)	1		1	
Yes	119	29.8 (23.2–38.2)	1.56 (1.02–2.39)	0.04	1.61 (1.03–2.52)	0.04
History of testing (within 12 months)						
Yes	59	20.5 (13.8–30.3)	1			
No	185	26.8 (21.8–32.9)	1.30 (0.79–2.13)	0.30		
Marital status						
Never married	17	12.2 (5.1–29.2)	1			
Married/living together	177	23.9 (19.2–29.7)	1.90 (0.71–5.09)	0.20		
Divorced/separated/widowed	50	37.3 (25.9–53.7)	2.88 (1.01–8.19)	0.05		
Education level						
No education	21	44.3 (25.7–76.2)	1			
Primary	177	23.9 (19.3–29.8)	0.59 (0.30–1.16)	0.13		
Secondary/Higher	45	23.9 (15.6–36.7)	0.63 (0.28–1.39)	0.25		
Missing	1	–	–			
Ethnicity						
Lomwe	151	28.9 (23.1–36.2)	1			
Yao	52	19.5 (12.7–29.9)	0.70 (0.40–1.21)	0.20		
Other	41	20.1 (12.5–32.3)	0.75 (0.41–1.37)	0.35		
Work category						
Farmer/Fisher man	143	27.0 (21.4–34.1)	1			
City workers	79	22.0 (15.7–30.7)	0.80 (0.50–1.26)	0.33		
Student	9	14.7 (4.8–45.7)	0.63 (0.17–2.25)	0.47		
Housewife/None	13	34.6 (16.5–72.6)	1.23 (0.50–3.01)	0.65		
Traditional Authorities						
Chitera	10	16.4 (6.2–43.7)	1			
Kadewere	71	24.8 (17.6–34.9)	1.59 (0.47–5.39)	0.45		
Likoswe	32	25.3 (15.3–42.0)	1.90 (0.50–7.23)	0.35		
Mpama	56	18.4 (12.1–27.9)	1.15 (0.33–4.01)	0.82		
Nkalo	43	39.2 (26.5–58.1)	2.71 (0.77–9.55)	0.12		
Ntchema	32	27.4 (16.8 –44.8)	1.76 (0.48–6.45)	0.40		
Total	244	25.1 (20.9–30.1)				

Our study provides a further insight into the gender disparity in the early stages of the cascade of care. First, men were less likely than women inclined to get tested for HIV, mostly because of their absence due to labour migration, which was also found in other sites in sub-Saharan Africa [11, 30, 31]. We managed to reach 80% testing coverage among eligible men by repeating visits, including during weekends. HIV-positive men were less likely to be diagnosed at the time of the survey, which was also found in other population studies [32]. Finally, men newly diagnosed were less likely to link to care than women. This global male delay in engagement in care has contributed to increased mortality among men due to lower CD4 count at diagnosis [33]. Our study suggests cumulative disparities at each step of the continuum of care and that strategies to reach, test and link men to care need to be developed.

Similar to other studies, we found that young HIV-positive adolescents and young adults (age 15–29) were less likely to be diagnosed and to link to care once diagnosed. Survey data collected from sub-Saharan Africa indicate that only 10% of young men and 15%

of young women (15–24 years) were aware of their HIV status [34]. The lower HIV awareness for this age group is likely to be explained by higher HIV incidence. Adolescents may be undiagnosed in part because they have been infected for a shorter time [20, 32]. The lower probability of linkage once diagnosed, which was also found in other studies, highlights the need of specific interventions targeting youth and adolescents [26, 34–36].

This study was based on a large and representative population sample. Nevertheless, a number of limitations should be noted. First, HIV status awareness was self-reported by participants, which could lead to self-reporting bias. Linkage to care was measured using vouchers regularly collected by teams working in the health facilities in the district and not assessed using new home visits, which can lead to an underestimation of linkage, as some participants may have either died, moved away or decided to link to a facility outside the district. The sample of newly diagnosed individuals was small, and consequently, the risk factor analysis for linkage to care lacked precision. Finally, as with any observational study we were limited in the number of variables for analysis and there may be other, unmeasured factors that contribute to the observed associations.

In conclusion, our study showed high rates of diagnosis and linkage to care in this rural district of Malawi, 10 years after introduction of ART in the region. Individuals in need of ART were more likely to link to care, suggesting the positive impact universal treatment could have on linkage to care and ART initiation through home-based testing campaigns. Finally, men and adolescents and young adults were less likely to be diagnosed and to link to care once diagnosed, confirming the need of specific approaches for these groups to reach the UNAIDS 90-90-90 targets in 2020.

Acknowledgement and funding

The authors would like to thank the participants and their family for their participation and collaboration. We are also grateful to the Chiradzulu community for their support and to the field team of Epicentre for their commitment to conduct this study in difficult conditions, with a special mention for Isaac Nabaasa, May Atieno and Patrick Kibira, and to the Epicentre headquarter team (Serge Balandine, Stephane Crisan) for their continuous support. We are thankful to the team of the biostatistics department of the University of Lyon (Benjamin Riche, René Ecochard and Stephanie Blaizot) for statistical support.

References

1. WHO. Towards Universal Access: Scaling Up Priority HIV/AIDS Interventions in the Health Sector: Progress Report 2010. Geneva: WHO, UNAIDS, UNICEF; 2010.
2. WHO, Unicef. Global HIV/AIDS Response: Epidemic update & health sector progress towards universal access. Prog report November. 2011;233.
3. McMahon JH, Medland N. 90-90-90: how do we get there? *Lancet HIV* 2014: **1**: e10–e11.
4. World Health Organization, UNICEF, UNAIDS. Global Update on HIV Treatment 2013 : Results, Impact and Opportunities. Glob Updat HIV Treat 2013 results, Impact Oppor. 2013;7.
5. Staveteig S, Wang S, Head SK, Bradley SEK, Nybro E. Demographic patterns of HIV testing uptake in Sub-Saharan Africa. *DHS Comparative Report no*. 30, published in April 30, Funded by USAID Calverton, Maryland, USA
6. Rosen S, Fox MP. Retention in HIV care between testing and treatment in sub-Saharan Africa: a systematic review. *PLoS Med* 2011: **8**: e1001056.
7. Suthar AB, Ford N, Bachanas PJ *et al.* Towards universal voluntary HIV testing and counselling: a systematic review and meta-analysis of community-based approaches. *PLoS Med* 2013: **10**: e1001496.
8. Van Schaik N, Kranzer K, Wood R, Bekker L. Earlier HIV diagnosis – are mobile services the answer ? *South African Med J* 2010: **100**: 671–674.
9. Matovu JKB, Makumbi FE. Expanding access to voluntary HIV counselling and testing in sub-Saharan Africa: alternative approaches for improving uptake, 2001–2007. *Trop Med Int Health* 2007: **12**: 1315–1322.
10. Grabbe KL, Menzies N, Taegtmeyer M *et al.* Increasing access to HIV counseling and testing through mobile services in Kenya: strategies, utilization, and cost-effectiveness. *J Acquir Immune Defic Syndr* 2010: **54**: 317–323.
11. Wachira J, Kimaiyo S, Ndege S, Mamlin J, Braitstein P. What is the impact of home-based HIV counseling and testing on the clinical status of newly enrolled adults in a large HIV care program in Western Kenya? *Clin Infect Dis* 2012: **54**: 275–281.
12. Smith JA, Sharma M, Levin C *et al.* Cost-effectiveness of community-based strategies to strengthen the continuum of HIV care in rural South Africa: a health economic modelling analysis. *Lancet HIV* 2015: **2**: e159–e168.
13. World Health Organisation. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection: recommendations for a public health approach. Geneva, Switzerland: World Health Organization; 2013.
14. Granich R, Gupta S, Hersh B *et al.* Trends in AIDS Deaths, New Infections and ART Coverage in the Top 30 Countries with the Highest AIDS Mortality Burden; 1990–2013. *PLoS ONE* 2015: **10**: e0131353.
15. Office of National Statistics. *2008 Population and Housing Census - Malawi*. Office of National Statistics: Zomba, Malawi, 2008.

16. Ministry of Heath. 2014 Global AIDS response progress report: Malawi Country Report for 2012 and 2013. Ministry of Health Malawi; 2012
17. Maman D, Chilima B, Masiku C *et al.* Closer to 90-90-90. The cascade of care after 10 years of ART scale-up in rural Malawi: a population study. *J Int AIDS Soc* 2016: **19**: 20673.
18. Ministry of Health. *Clinical Management of HIV in Children and Adults*. Ministry of Health: Lilongwe, Malawi, 2011.
19. Bicego GT, Nkambule R, Peterson I *et al.* Recent patterns in population-based HIV prevalence in Swaziland. *PLoS ONE* 2013: **8**: e77101.
20. Kimanga DO, Ogola S, Umuro M *et al.* Prevalence and incidence of HIV infection, trends, and risk factors among persons aged 15–64 years in Kenya: results from a Nationally Representative Study. *JAIDS J Acquir Immune Defic Syndr* 2014: **66**: S13–S26
21. Johnson LF, Rehle TM, Jooste S, Bekker L-G. Rates of HIV testing and diagnosis in South Africa: successes and challenges. *AIDS* 2015: **29**: 1401–1409.
22. Supervie V, Costagliola D. The spectrum of engagement in HIV care in France: strengths and gaps. 20th Conference on Retroviruses and Opportunistic Infections. Atlanta, USA; 2013. p. Abstract 1030.
23. Nosyk B, Montaner JSG, Colley G *et al.* The cascade of HIV care in British Columbia, Canada, 1996–2011: a population-based retrospective cohort study. *Lancet Infect Dis* 2014: **14**: 40–49.
24. Gardner EM, McLees MP, Steiner JF, Del RC, Burman WJ. The spectrum of engagement in HIV care and its relevance to test-and-treat strategies for prevention of HIV infection. *Clin Infect Dis* 2011: **52**: 793–800.
25. Ferradini L, Jeannin A, Pinoges L *et al.* Scaling up of highly active antiretroviral therapy in a rural district of Malawi: an effectiveness assessment. *Lancet* 2006: **367**: 1335–1342.
26. Naik R, Doherty T, Jackson D *et al.* Linkage to care following a home-based HIV counselling and testing intervention in rural South Africa. *J Int AIDS Soc* 2015: **18**: 19843.
27. Genberg BL, Naanyu V, Wachira J *et al.* Linkage to and engagement in HIV care in western Kenya: An observational study using population-based estimates from home-based counseling and testing. *Lancet HIV* 2015: **2**: e20–e26.
28. Larson BA, Schnippel K, Ndibongo B *et al.* Rapid point-of-care CD4 testing at mobile HIV testing sites to increase linkage to care: an evaluation of a pilot program in South Africa. *J Acquir Immune Defic Syndr* 2012: **61**: e13–e17.
29. Jani IV, Sitoe NE, Alfai ER *et al.* Effect of point-of-care CD4 cell count tests on retention of patients and rates of antiretroviral therapy initiation in primary health clinics: an observational cohort study. *Lancet* 2011: **378**: 1572–1579.
30. Naik R, Tabana H, Doherty T, Zembe W, Jackson D. Client characteristics and acceptability of a home-based HIV counselling and testing intervention in rural South Africa. *BMC Public Health* 2012: **12**: 824.
31. Novitsky V, Bussmann H, Okui L *et al.* Estimated age and gender profile of individuals missed by a home-based HIV testing and counselling campaign in a Botswana community. *J Int AIDS Soc* 2015: **18**: 19918.
32. Maman D, Zeh C, Mukui I *et al.* Cascade of HIV care and population viral suppression in a high-burden region of Kenya. *AIDS* 2015: **29**: 1557–1565.
33. Druyts E, Dybul M, Kanters S *et al.* Male sex and the risk of mortality among individuals enrolled in antiretroviral therapy programs in Africa: a systematic review and meta-analysis. *AIDS* 2013: **27**: 417–425.
34. World Health Organization. HIV and Adolescents: Guidance for HIV Testing and Counselling and Care for Adolescents Living with HIV: Recommendations for a Public Health Approach and Considerations for Policy-Makers and Managers. Geneva, Switzerland: World Health Organisation; 2013.
35. Nakigozi G, Makumbi F, Reynolds S *et al.* Non-enrollment for free community HIV care: findings from a population-based study in Rakai, Uganda. *AIDS Care* 2011: **23**: 764–770.
36. Kranzer K, Zeinecker J, Ginsberg P *et al.* Linkage to HIV care and antiretroviral therapy in Cape Town, South Africa. *PLoS ONE* 2010: **5**: e13801.

Corresponding Author **David Maman**, Epicentre, Médecins Sans Frontières, 8 rue Saint Sabin, 75011 Paris, France. Tel.:+33 1 40215518; E-mail: david.maman@epicentre.msf.org