Use, awareness and willingness to self-test for HIV: An analysis of cross-sectional population-based surveys in Malawi and Zimbabwe

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Abstract

Background Many southern African countries are nearing the global goal to diagnose 90% of people with HIV by 2020. In 2016, 84% and 86% of people with HIV knew their status in Malawi and Zimbabwe respectively. Despite this progress, gaps remain, particularly among men (≥25 years). We investigated awareness, use and willingness to HIV self-test (HIVST) prior to large scale implementation and explored sociodemographic associations.

Methods We pooled responses from two of the first cross-sectional Demographic Health Surveys to include HIVST questions: Malawi and Zimbabwe in 2015-16. Sociodemographic factors and sexual risk behaviours associated with previously testing for HIV, and awareness, past use and future willingness to self-test were investigated using univariable and multivariable logistic regression, adjusting for the sample design and limiting analysis to participants with completed questionnaire and a valid HIV result. Analysis of willingness to self-test was restricted to Zimbabwean men, as Malawians and women were not asked this question.

Results Of 31 385 individuals, the proportion never-tested was higher for men (31.2%) than women (16.5%), p<0.001. For men, having ever tested increased with age. Past use and awareness of HIVST was very low, 1.2% and 12.6% respectively. Awareness was lower among women than men (9.1% vs 15.3%, adjusted odds ratio (aOR)=1.55; 95% confidence interval [CI]: 1.37-1.75), and at younger ages, and lower education and literacy levels. Willingness to self-test among Zimbabwean men was high (84.5%), with having previously tested for HIV, high sexual risk, and being ≥25 years associated with greater willingness. Wealthier men had greater awareness of HIVST than poorer men (p<0.001). Men at higher HIV-related sexual risk, compared to men at lower HIV-related sexual risk, had the greatest willingness to self-test (aOR=3.74; 95%CI: 1.39-10.03, p<0.009).

Conclusions In 2015-16 many Malawian and Zimbabwean men had never tested for HIV. Despite low awareness and minimal HIVST experience at that time, willingness to self-test was high among Zimbabwean men, especially in older men with moderate to high HIV-related sexual risk. These data provide a valuable baseline against which to investigate population-level uptake of HIVST as programmes scale-up. Programmes introducing, or planning to introduce HIVST, should consider including questions in population-based surveys.

Background

Both Malawi and Zimbabwe have made tremendous progress toward the “first 90” target of diagnosing 90% of people with HIV, with 2016 estimates showing 84% of people with HIV in Malawi and 86% in Zimbabwe aware of their status [1]. By end-2018, 90% of all people with HIV were diagnosed: 940,000 and 1.3 million people in Malawi and Zimbabwe, respectively [1]. As a result, reaching the remaining people with HIV who do not know their status is becoming costly and challenging; with national programmes reporting declining numbers of people with HIV diagnosed through HIV testing services [2, 3]. Global and national priorities now include defining sustainable approaches that maintain these high rates of coverage, while reaching individuals and groups still in need of HIV testing, prevention and treatment.

Across southern Africa, men continue to be less well served by HIV programmes than women, being less likely to have ever-tested [4] and more likely to develop advanced HIV disease, reflecting late diagnosis and/or treatment initiation [5]. Men have fewer opportunities for HIV testing compared to women, as well as social-cultural, economic and systemic barriers which reduce access to and uptake of services [6, 7].

HIV self-testing (HIVST) is recommended by the World Health Organization (WHO) [2] and is a key intervention for reaching populations who may not test otherwise, particularly among men [8]. Results from multiple evaluations show HIVST has high uptake, can increase the population-coverage of HIV testing and has high safety and acceptability,

globally [9, 10]. As of July 2019, this recommendation has been taken up globally, with nearly 7 million HIVST kits procured by major donors, and 77 countries reporting that they have an HIVST policy; 38 of which are fully implementing self-testing [11, 12].

Both Malawi and Zimbabwe were early adopters of self-testing, with pilot studies starting between 2010 and 2015 [13, 14]. This pilots were then followed by the development of national policies and initiation of large scale implementation in mid-2015 under the STAR (Self-Test AfRica) Initiative [15]. Since then, multiple evaluations of HIVST in each country have shown community-based and facility-based HIVST, as well as partner-delivered HIVST, to be a feasible and effective way to reach first time testers, men, young people, as well as partners of people with HIV [10, 16-19]. Recent mathematical modelling suggests that, with appropriate targeting toward men in southern Africa among other priority groups, HIVST can also be cost-effective [20, 21].

As both countries move toward broader self-testing scale-up, we used Demographic Health Survey (DHS) data from 2015-16 to analyse population-level awareness, use and willingness to self-test prior to large scale implementation [22, 23]. These questions were first added as optional additions to the DHS questionnaire in 2015. As such, the objective of this study was to provide a point of comparison with future evaluations post national scale-up, as well as to inform future implementation, of HIVST. Here we assess early implementation of HIVST questions in population-based surveys, and assess associations with awareness, use and future willingness to self-test.

Methods

We obtained population-based survey data from the 2015-16 Malawi and Zimbabwe DHS with standard permissions from DHS and ICF International [22, 23], which provide data from a representative sample of men (15-54 years) and women of reproductive age (15-49 years) living in Malawi and Zimbabwe, with linked laboratory HIV results. We limited our analysis to participants who had completed interviewer-administered questionnaires, provided blood specimens for HIV testing, and had a valid result from this HIV test.

Our main outcomes of interest were self-reported by survey respondents: ever testing for HIV; awareness of and use of HIVST and willingness to self-test in the future. Willingness to self-test was only asked in Zimbabwe, and only included in the male questionnaire. Full survey questionnaires are accessible on the DHS website: https://dhsprogram.com/.

Independent variables

The choice of independent covariates was informed by literature on factors influencing testing for HIV and adaptation of the simplified hierarchical framework for HIV testing (including self-testing) among men in sub-Saharan Africa (See **Fig. 1**). We also pre-specified a stratified analysis by HIV testing history to explore differences in awareness and use of, and willingness to, self-test for HIV.

Independent variables used in the analysis included country (i.e. Malawi or Zimbabwe), sex (i.e. male or female), household wealth (i.e. measured by standard quintiles), age (i.e. measured five-year age bands from 15-45 years and 45+ years), education (i.e. measured by secondary education or lower), literacy (i.e. measured by the ability to read, or not read, a full sentence), employment (i.e. measured by actively working in past seven days), marital status (i.e. measured by married or cohabiting), and HIV status reported during the survey (i.e. HIV-positive or HIV-negative). A three-category HIV-related sexual risk variable was defined from reported sexual activity (i.e. measured by sexual activity, or inactivity, in the past four weeks), and the following high-risk exposures in the previous 12 months: multiple (i.e. ³2) partners; any paid sex (asked to men); having received gifts, cash or other compensation in exchange for sex (asked to women); and having a sexually transmitted infection (STI). Individuals with one or more of these risk

variables were classified as “high-risk”. The remaining respondents reporting no other risk exposures were classified as “moderate risk” if sexually active in the past 4-weeks and “low-risk” if reporting no sexually activity in the past four weeks.

Data analysis

Analysis used Stata version 11 (College Station, Texas). Standard country-specific sampling and cluster weights provided by DHS were set using the survey (svy) commands. Participants with missing data for outcomes or independent variables were excluded from the analysis. This study is reported as per the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [25]. (Supplementary data S1 includes the checklist.)

Independent variables were all categorical, and so baseline characteristics were reported as proportions. Variables for inclusion in multivariable models were selected by the putative causal framework (**Fig. 1**), and by investigating effect modification and collinearity. Univariable and multivariable analyses used logistic regression. P-values across age, wealth and HIV-related sexual risk were calculated using the Wald Test.

Associations between independent and outcome variables were investigated using univariable odds ratios (OR) with 95% confidence intervals (CI). Before multivariable analysis, confounding and collinearity between independent variables was explored by investigating associations between variables for all with significant associations with any given outcomes. Potential effect modification [24] was explored using stratified analyses by sex, HIV status, previous HIV testing history and HIV-related sexual risk category.

Results

Baseline characteristics

A total of 31 385 survey respondents reporting on HIV testing history were included: 14 911 and 16 474 records from Malawi and Zimbabwe and 14 027 and 17 358 among men and women respectively (**Table 1**). Of these, a total of 24 683 individuals were asked about HIVST with 6702 (21.4%, n=31 385) not asked about HIVST. An additional 15 individuals (0.06%, n=24 683) asked about HIVST had missing data related to questions on sexual activity used to determine HIV-related sexual risk. A total of 78.6% and 75.4% of people reported ever having tested for HIV in Malawi and Zimbabwe, respectively (p<0.001). More women, compared to men (31.2% vs. 16.5%; p<0.001), and more urban, compared to rural, residents (24.1% vs 21.0%; p<0.001) had tested previously. Compared to those aged ≥25 years, a larger proportion of those never-tested were young people (aged 15-24) (39.2% vs 14.1%; p<0.001).

Table 1. Baseline characteristics in Malawi and Zimbabwe, 2015-16

Variables*	Ever tested (N=31 385)**			Ever self-test (N= 24 683)**			Aware self-test (N=24 683)**		
	N	%	p-value§	N	%	p-value§	n	%	p-value§
Total population	24 148	76.9		287	1.2		3118	12.6	
Country			<0.001			<0.001			<0.001
Malawi	11 726	75.4		141	1.0		1671	11.4	
Zimbabwe	12 422	78.6		146	1.5		1447	14.5	
Sex			<0.001			0.008			<0.001
Female	14 500	83.5		103	1.0		983	9.1	
Male	9648	68.8		184	1.3		2135	15.3	
Residence			<0.001			<0.001			<0.001
Urban	7951	79.9		151	2.1		1516	21.2	
Rural	16 197	75.9		136	0.8		1602	9.1	
Age group (yrs)			<0.001			<0.001			<0.001
15-19	3252	44.8		30	0.5		437	7.0	
20-24	4703	80.7		42	0.9		562	12.1	
25-29	4337	90.3		59	1.6		580	16.0	
30-34	4070	91.1		55	1.7		497	15.2	
35-39	3247	89.2		42	1.5		426	15.7	
40-44	2446	87.4		35	1.7		303	15.0	
45+	2093	80.8		24	1.1		313	14.7	
Wealth			<0.001			<0.001			<0.001
Poorest	3697	76.4		18	0.5		246	6.4	
Poorer	4029	75.8		38	0.9		336	7.8	
Middle	4252	75.3		26	0.6		279	8.3	
Rich	5594	77.6		56	0.9		669	12.2	
Richest	6576	78.5		149	2.3		1488	22.8	
HIV status			<0.001			0.108			0.029
HIV negative	20 646	75.0		249	1.1		2760	12.5	
HIV positive	2570	90.6		38	1.5		358	10.4	
Marital status			<0.001			0.005			<0.001
Single	7595	58.9		99	0.9		1175	11.2	
Married or cohabiting	16 553	89.5		188	1.3		1943	13.7	
Employment			<0.001			0.033			<0.001
Not actively working	8719	70.1		85	1.0		823	9.4	
Actively working	15 429	81.4		202	1.3		2295	14.4	
Education			<0.001			<0.001			<0.001
≤ Primary	10 617	74.8		70	0.6		927	7.5	
≥ Secondary	13 531	78.7		217	1.8		2191	17.8	
Literacy			<0.001			<0.001			<0.001
Being illiterate	5211	73.5		44	0.7		488	8.0	
Being literate	18 937	77.9		243	1.3		2630	14.2	
Sexually active			<0.001			<0.001			<0.001
Sexually inactive	9064	64.0		107	1.5		1225	17.7	
Active in past 4-weeks	15 053	87.6		180	1.5		1890	14.2	
HIV-related risk* **			<0.001			<0.001			<0.001
Having low risk	8457	63.5		94	0.9		1102	10.3	
Having moderate risk	13 092	88.7		134	1.2		1497	13.6	
Having high risk	2570	78.8		59	2.0		516	17.2	

*Ever tested refers to people surveyed on HIV testing history who reported they previously tested for HIV before the survey. Overall, 31 385 people were asked about their HIV testing history and 24 148 responded they had tested previously. Ever self-tested refers to people surveyed on HIV self-testing who reported they had previously self-tested. Overall, 24 683 people were asked whether they had self-tested and 287 reported they self-tested previously. Aware of self-testing refers to people surveyed who reported they were aware of HIV self-testing. Overall, 24 683 people were asked whether they were aware of self-testing and 3118 reported they were aware of self-testing.

**Out of 31 385 people surveyed, 31 348 were included as 37 people were missing information on sexual activity and HIV-related risk. Not all participants were systematically surveyed on self-testing questions. Out of 31 385 people surveyed 24 683 were asked about self-testing resulting in smaller sample size. Among these were 15 people reporting on self-testing who did not provide information on sexual activity and HIV risk. Population size asked about ever testing for HIV: 31 347 (HIV risk/sexual activity). Population size asked about awareness or ever self-testing for HIV: 24 668 (HIV risk/ activity).
***HIV risk is defined in this analysis includes reported sexual activity in the past four weeks, and the following high-risk exposures in the previous 12 months: multiple (i.e. ≥2) partners, any paid sex (asked to men), having received gifts, cash or other compensation in exchange for sex (asked to women), and having a sexually transmitted infection (STI). Individuals with any "high-risk" exposures were classified as "high-risk", with the remaining respondents classified as "low risk" if reporting no sexually activity in the past four weeks, and as "moderate risk" otherwise.
[§] P-value based on cluster-adjusted chi-squared test

The proportion of people who had ever self-tested was very low (1.2%) and similar in both countries. However, while awareness was low (12.6%) there was greater awareness of HIVST in Zimbabwe compared to Malawi (14.5% vs 11.4%; p<0.001) and for men compared to women (15.3% vs. 9.1%; p<0.001) (**Table 1**). Adults ≥30 years of age (≥30 years: 21.1% vs. <30 years: 9.1%; p<0.001), wealthier (richest: 22.8% vs poorest: 6.4%; p<0.001) and individuals with higher education (17.8% vs 7.5%; p<0.001) had greater awareness of self-testing than those aged <30 years, poorer, and individuals with lower education-levels.

Willingness to self-test could only be assessed among 7372 Zimbabwean men (48 men missing data on willingness) as only men were asked about willingness to self-test, and this question was not included in the Malawi DHS questionnaires.

Most Zimbabwean men (84.5%) were willing to self-test (Supplementary table S1 includes for baseline characteristics of Zimbabwean men on willingness to self-test, 2015-16). Men aged ≥25 reported greater willingness to self-test than men aged <25 (88.7% vs. 78.8%; p<0.001). High-risk men also reported greater willingness to self-test than low-risk men (78.8% vs 63.5%; p<0.001). Most men willing to self-test had tested in the past 12 months (88.5%). However, a high proportion of men who had not tested for HIV in the previous two or more years were also willing to self-test (86.4%).

Ever testing for HIV

HIV-related age, HIV status and sexual risk appeared to modify effects in the multivariable analysis across a number of variables **(Table 2)**. Collinearity affected results of multivariable analysis, notably between age and HIV-related sexual risk, marital status and HIV-related sexual risk, age and education level and education level and literacy.

Table 2. Univariable and multivariable associations between sociodemographic factors and ever testing for HIV in Malawi and Zimbabwe, 2015-16

Variables	Univariable (weighted) n=31 375*		Multivariable (weighted) n=31 347*	
OR	95% CI and p-value	aOR	95% CI and p-value	
Country				
Zimbabwe	1		1	
Malawi	1.18	1.10-1.28	1.26	1.15-1.38
Sex				
Female	1		1	
Male	0.42	0.39-0.45	0.39	0.36-0.42
Age (years)				
15-19	1	p<0.001§	1	p<0.001§
20-24	5.40	4.87-5.98	4.37	3.91-4.87
25-29	11.89	10.48-13.48	8.24	7.18-9.46
30-34	14.19	12.38-16.27	8.86	7.63-10.29
35-39	10.42	9.01-12.05	6.41	5.47-7.50
40-44	8.44	7.27-9.80	5.30	4.50-6.25
45+	5.16	4.50-5.91	3.72	3.20-4.34
Residence				
Urban	1		1	
Rural	0.83	0.76-0.90	1.00	0.88-1.14
HIV status				
HIV negative	1		1	
HIV positive	3.44	2.98-3.97	2.11	1.80-2.49
Marital status				
Single	1		1	
Married or cohabiting	6.07	5.62-6.54	**	**
Wealth				
Poorest	1	p<0.003§	1	p<0.581§
Poor	0.94	0.84-1.05	1.02	0.89-1.16
Middle	0.91	0.81-1.01	1.09	0.96-1.25
Rich	1.04	0.93-1.16	1.05	0.91-1.20
Richest	1.09	0.97-1.23	1.11	0.94-1.31
Employment				
Not actively working	1		1	
Actively working	1.81	1.69-1.95	1.16	1.06-1.26
Education				
≤ Primary	1		1	
≥ Secondary	1.26	1.17-1.35	**	**
Literacy				
Being illiterate	1		1	
Being literate	1.30	1.20-1.40	1.63	1.50-1.78
HIV-related risk* **				
Having low risk	1	p<0.001§	1	p<0.001§
Having moderate risk	4.58	4.23-4.96	2.15	1.96-2.36
Having high risk	2.14	1.92-2.40	1.54	1.80-2.49

* Both samples were weighted based on standard DHS weights; Strata = 56; PSU=1256. Univariable draws from a total of 31 385 observations, population size 31 375. Multivariable draws from a total of 31 348 observations and population size of 31 338. This excludes 37 people who did not report on sexual activity and risk behaviours and are missing from the “HIV risk category”.

**Represents variables which were not included in the multivariable analysis due to identified collinearity.

*** HIV risk is defined in this analysis includes reported sexual activity in the past four weeks, and the following high-risk exposures in the previous 12 months: multiple (i.e. ≥2) partners, any paid sex (asked to men), having received gifts, cash or other compensation in exchange for sex (asked to women), and having a sexually transmitted infection (STI). Individuals with any “high-risk” exposures were classified as “high-risk”, with the remaining respondents classified as “low risk” if reporting no sexually activity in the past four weeks, and as “moderate risk” otherwise.

§ P-value based on Wald Test. P-values for variables with more than two categories are shown.

On multivariable analysis, after assessing for collinearity, being Malawian was associated with ever having tested for HIV included (adjusted odds ratio (aOR)=1.26; 95% confidence interval [CI]: 1.15-1.38, p<0.001) (**Table 2**). However, men had substantially lower odds of having ever tested for HIV compared to women (aOR=0.36; 95%CI: 0.32-0.41, p<0.001).And individuals between 30 and 34 years of age had greater odds of ever having tested for HIV compared to 15-19 year olds (aOR=8.86; 95%CI: 7.63-10.29, p<0.001). Additional factors associated with ever having tested fore HIV included: an HIV-positive test result in the survey (HIV-positive vs. HIV-negative: aOR =2.11, 95%CI:1.80-2.49, p<0.001), employment (actively working vs not actively working: aOR=1.16; 95%CI: 1.06-1.26, p<0.001), literacy (being literate vs being illiterate: aOR=1.63, 95%CI:1.50-1.78, p<0.001), and reporting more HIV-related sexual risk behaviours (moderate vs. low: aOR=2.15; 95%CI:1.96-2.36, p<0.001, and high-risk vs. low: aOR=1.54; CI:1.80-2.49, p<0.001).

Use and awareness of self-testing

A complete analysis of ever self-testing is shown in supplementary table S2. Table 3 provides outcomes from univariable and multivariable analysis for awareness of HIV self-testing.

In the multivariable analysis, men aged 30-34 years old had greater odds of past self-testing use compared to younger men (age 15-19) (aOR= 2.89; 95%CI: 1.47-5.68, p<0.002) (**Table S2**). Across wealth quintiles, being wealthier was also associated with previous self-testing (p<0.001) with wealthiest individuals having the greatest odds of past self-testing (aOR for richest vs. poorest=3.59; 95%CI:1.79-7.18, p<0.001).

On multivariable analysis, respondents in Malawi and those from a rural setting were less likely to be aware of HIVST compared with Zimbabweans and urban participants (**Table 3**). However, the following variables were significantly associated with being aware of HIVST: being male (male vs female: aOR=1.55;95%CI:1.37-1.75, p<0.001), older than 15-19 years (when compared with those aged 25-29 years: aOR=1.76; 95%CI:1.43-2.17, p<0.001 and aged 35-39 years: aOR=1.69; 95%CI: 1.34-2.12, p<0.001), wealthier (richest vs poorest: aOR=3.03; 95%CI: 2.46-3.73, p<0.001), employment (actively working vs not actively working: aOR=1.25; 95%CI: 1.12-1.42, p<0.001), literate (being literate vs being illiterate: aOR= 1.17; 95%CI: 1.01-1.36, p<0.035) and having previously tested for HIV (ever tested vs never tested: aOR=1.89; 95%CI:1.65-2.17, p<0.001).

Table 3. Univariable and multivariable associations between sociodemographic factors and awareness of HIV self-testing in Malawi and Zimbabwe, 2015-16

Variables	Univariable (weighted) n=24 683*		Multivariable (weighted) n=24 668*	
OR	95% CI and p-value	aOR	95% CI and p-value	
Country				
Zimbabwe	1		1	
Malawi	0.76	0.67-0.87	0.82	0.70-0.94
Sex				
Female	1		1	
Male	1.73	1.54-1.92	1.55	1.37-1.75
Age				
15-19	1	p<0.001§	1	p<0.001§
20-24	1.79	1.50-2.12	1.35	1.12-1.62
25-29	2.52	2.11-3.00	1.76	1.43-2.17
30-34	2.44	2.02-2.94	1.66	1.32-2.08
35-39	2.46	2.04-2.97	1.69	1.34-2.12
40-44	2.09	1.70-2.55	1.45	1.14-1.86
45+	2.00	1.64-2.46	1.31	1.04-1.66
Residence				
Urban	1		1	
Rural	0.33	0.29-0.39	0.64	0.55-0.77
Ever tested				
No	1		1	
Yes	2.18	1.94-2.45	1.89	1.65-2.17
HIV status				
HIV negative	1		1	
HIV positive	1.12	0.95-1.31	0.89	0.75-1.06
Marital status				
Single	1		1	
Married or cohabiting	1.26	1.13-1.39	**	**
Wealth				
Poorest	1	p<0.001§	1	p<0.001§
Poor	1.26	1.04-1.53	1.24	1.02-1.51
Middle	1.26	1.03-1.53	1.25	1.02-1.53
Rich	1.87	1.53-2.28	1.49	1.20-1.84
Richest	4.30	3.54-5.22	3.03	2.46-3.73
Employment				
Not actively working	1		1	
Actively working	1.63	1.47-1.82	1.25	1.12-1.42
Education				
≤Primary	1		1	
≥ Secondary education	2.69	2.38-3.04	**	**
Literacy				
Unable to read	1		1	
Can read	1.84	1.59-2.12	1.17	1.01-1.36
HIV risk* **				
Low risk	1	p<0.001§	1	p<0.518
Moderate risk	1.37	1.24-1.53	1.03	0.90-1.17
High risk	1.75	1.51-2.03	1.10	0.93-1.31

* Both samples were weighted based on standard Demographic Health Survey weights; Strata = 56; PSU=1256. Not all participants were systematically surveyed on self-testing questions. Out of 31 385 people surveyed 24 683 were asked about self-testing resulting in smaller sample size. Among those reporting on HIV self-testing, 15 did not provide information on sexual activity and HIV risk. Population size asked about awareness or ever self-testing for HIV: 24 668 (HIV risk), 24 668 (sexual activity).

‹Represents variables which were not included in the multivariable analysis due to identified collinearity.
*** HIV risk is defined in this analysis includes reported sexual activity in the past four weeks, and the following high-risk exposures in the previous 12 months: multiple (i.e. ≥2) partners, any paid sex (asked to men), having received gifts, cash or other compensation in exchange for sex (asked to women), and having a sexually transmitted infection (STI). Individuals with any “high-risk” exposures were classified as “high-risk”, with the remaining respondents classified as “low risk” if reporting no sexually activity in the past four weeks, and as “moderate risk” otherwise.

[§] P-value based on Wald Test. P-values for variables with more than two categories are shown.

Willingness to self-test among Zimbabwean men

The relationship between willingness to test and socio-economic variables (wealth and actively working) and HIV status, substantially differed according to both high and low HIV-related sexual risk (Table 4): see for example univariable OR for HIV status and employment. Thus, we adapted our planned multivariable analysis to account for effect-modification between HIV-related sexual risk categorization and socioeconomic variables. On multivariable analysis, comparing men with high HIV-related sexual risk behaviours to those with low HIV-related sexual risk behaviour, high-risk men were more likely than low-risk men to express willingness to self-test if they were also from higher socioeconomic quintiles, not working, in rural settings and tested previously (interaction terms: socioeconomic status, p = 0.066, rural residence, p=0.071, employment p=0.003, literacy, p=0.225, married, p=0.401, aware of self-test, p=0.605, previous testing, p=0.001, and HIV status p = 0.162) (**Table 4**).

Univariable and multivariable associations between sociodemographic factors and willingness to self-test among men in Zimbabwe, by w, moderate and high HIV-related risk, 2015-16

les	Univariable (weighted)						Multivariable (weighted)					
	Having low risk (n=3142)*		Having moderate risk (N=2988)*		Having high risk (n=1241)*		Having low risk (n=3142)*		Having moderate risk (N=2988)*		Having high risk (n=1241)*	
	95% CI and p-value	OR	95% CI and p-value	OR	95% CI and p-value	aOR	95% CI and p-value	aOR	95% CI and p-value	aOR	95% CI and p-value	
ars)												
	1	p<0.001§	1	p=0.063§	1	p=0.028§	1	p=0.106§	1	p=0.343§	1	p=0.030§
	1.78	1.37-2.30	1.49	0.70-3.23	2.44	1.21-4.92	1.47	1.11-1.92	1.31	0.60-2.85	2.71	1.32-5.57
	2.00	1.36-2.96	2.43	1.18-4.99	2.09	0.99-4.41	1.50	1.00-2.27	1.89	0.90-3.95	2.66	1.23-5.75
	2.01	1.11-3.63	2.52	1.24-5.09	2.86	1.35-6.05	1.44	0.79-2.64	1.98	0.96-4.07	3.82	1.82-8.00
	1.69	0.96-2.99	2.31	1.10-4.85	3.77	1.75-9.14	1.17	0.65-2.10	1.92	0.91-4.07	4.87	2.14-11.07
	1.82	0.88-3.78	2.52	1.16-5.44	2.21	0.95-5.16	1.27	0.59-2.72	2.09	0.96-4.59	3.02	1.18-7.71
	1.61	0.93-2.81	1.70	0.87-3.33	1.94	0.93-4.07	1.05	0.56-1.95	1.44	0.72-2.88	2.46	1.09-5.54
ce												
	1		1		1		1		1		1	
	0.81	0.64-1.02	1.18	0.89-1.55	1.33	0.86-2.06	0.71	0.49-1.03	1.14	0.74-1.76	3.56	1.61-7.90
	1	p=0.128§	1	p=0.113§	1	p=0.981§	1	p=0.102§	1	p=0.260§	1	p=0.080§
	1.04	0.75-1.45	1.87	1.13-3.09	1.16	0.58-2.30	1.02	0.74-1.41	1.72	1.02-2.91	1.27	0.64-2.50
	0.97	1.00-1.90	1.27	0.85-1.88	0.96	0.49-1.89	0.98	0.71-1.35	1.20	0.78-1.84	1.04	0.51-2.10
	1.38	0.70-1.34	1.12	0.71-1.77	1.03	0.52-2.05	1.04	0.73-1.47	1.03	0.60-1.77	2.64	1.07-6.53
	1.02	0.74-1.42	1.12	0.75-1.67	1.10	0.57-2.12	0.65	0.42-1.02	1.02	0.54-1.94	3.74	1.39-10.03
ment												
vely												
	1		1		1		1		1		1	
	1.64	1.35-1.99	1.19	0.86-1.63	0.72	0.44-1.18	1.41	1.13-1.77	1.12	0.78-1.61	0.57	0.34-0.95
tus												
e	1		1		1		1		1		1	
itive	1.82	1.19-2.79	0.94	0.56-1.59	0.76	0.43-1.35	1.41	0.87-2.30	0.84	0.49-1.42	0.67	0.37-1.21
	1		1		1		1		1		1	
or												
ng	0.59	0.40-89	0.72	0.47-1.10	0.72	0.49-1.06	**	**	**	**	**	**
on												
cy	1		1		1		1		1		1	
ary	1.52	1.22-1.89	1.20	0.91-1.58	1.19	0.77-1.86	**	**	**	**	**	**
e	1		1		1		1		1		1	
e	1.23	0.98-1.55	1.66	1.18-2.32	1.36	0.83-2.22	1.16	0.91-1.48	1.55	1.07-2.25	1.32	0.78-2.23
sted												

les	Univariable (weighted)						Multivariable (weighted)					
	Having low risk (n=3142)*		Having moderate risk (N=2988)*		Having high risk (n=1241)*		Having low risk (n=3142)*		Having moderate risk (N=2988)*		Having high risk (n=1241)*	
	1		1		1		1		1		1	
	1.74	1.40-2.15	2.00	1.47-2.72	1.40	0.88-2.20	1.48	1.18-1.85	1.87	1.37-2.55	1.20	0.76-1.90
of												
	1		1		1		1		1		1	
	1.35	0.95-1.92	0.96	0.69-1.34	1.00	0.56-1.78	1.09	0.76-1.55	0.94	0.66-1.33	0.89	0.50-1.60

Weighted analysis using standard Demographic Health Survey (DHS) sample weights: Sample size = 7041.0867; Strata = 19; PSU=400. Out of 7420 men surveyed, 7372 reported on willingness to self-test. 48 men did not respond and 1 not provide information on sexual activity (HIV risk). Sexual activity was not reported by 1 respondent and could not be used in HIV risk variable. These variables have a total sample size of 7 371.

*Represents variables which were not included in the multivariable analysis due to identified collinearity.

HIV risk is defined in this analysis includes reported sexual activity in the past four weeks, and the following high-risk exposures in the previous 12 months: multiple (i.e. ≥2) partners, any paid sex (asked to men), having received gifts, cash or other compensation in exchange for sex (asked to women), and having a sexually transmitted infection (STI). Individuals with any "high-risk" exposures were classified as "high-risk", with the remaining respondents classified as "low risk" if reporting no sexually activity in the past four weeks, and as "moderate risk" otherwise.

§ P-value based on Wald Test. P-values for variables with more than two categories are shown.

On multivariable analysis of men at high HIV-related sexual risk, willingness to self-test increased with age (p=0.030) with the strongest association for those aged 35-39 compared to those aged 15-19 (aOR=4.87; 95%CI: 2.14-11.07, p<0.001). Similarly, willingness to self-test among men with high HIV-related sexual -risk increased in rural settings (rural vs urban: aOR=3.56, 95%CI: 1.61-7.90, p=0.002) and with greater wealth quintile (wealthiest vs least wealthy: aOR=3.74, 95%CI:1.39-10.53, p=0.009).

While actively working men with high HIV-related risk were less willingness to self-test (actively working vs not actively working: aOR: 0.57, 95%CI: 0.34-0.95, p=0.030), employed low-risk men were more willing to self-test than unemployed low-risk men (aOR 1.41; 95%CI: 1.13-1.77, p=0.003). The association with previous testing and willingness to test was also more pronounced for low-risk men (ever tested vs never tested: aOR 1.48; 95%CI: 1.18-1.85, p<0.001) than high-risk men (ever tested vs never tested: aOR 1.20; 95%CI: 0.76-1.90, p=0.435), while associations with age (p=0.106) and wealth (p=0.102) were less pronounced than for high-risk men (**Table 4**, described above).

We additionally conducted *a* stratified analysis to investigate whether willingness to self-test varied by past HIV-testing behaviour (i.e. previously tested or not) (supplementary table S3). Patterns of willingness to self-test were similar for the 2,437/7,372 (33.1%) men who had never previously tested as for those with at least one past HIV test, with greater willingness in older men.

Discussion

The main findings from this analysis of 2015-16 survey data captured immediately before HIVST implementation in Malawi and Zimbabwe were that awareness of and life-time use of self-testing were low, with only 12.6% of respondents aware of self-testing and only 1.2% having ever self-tested for HIV. Willingness to self-test was high, although this question was asked only of male Zimbabweans, with 84.5% respondents reporting themselves willing, including 30.4% of all previously untested men. Self-testing appeared to appeal most strongly to older men and those with high to moderate HIV-related sexual risk. The highest willingness to self-test was in men aged 35-39 and for those

in rural settings, where having never previously tested for HIV was more common than in urban settings. Factors independently associated with greater awareness of HIVST included men, urban residence, and literacy: with many of these same factors also associated with having tested for HIV at least once in this analysis of 2015-16 data. Poorer and unemployed individuals were less likely to be aware of self-testing.

Despite significant gains and scale-up of HIV testing in both Malawi and Zimbabwe, men continue to be missed [1, 2]. According to recent first-90 estimates in sub-Saharan Africa, men with HIV aged ≥25 years are much less likely to know their HIV-positive status than younger men and women [26]. As the median age of all people with HIV continues to increase [27], identifying and scaling-up strategies which appeal to older age groups, especially older men and those at high risk, will be needed. Greater efforts are needed to roll-out evidence-based HIVST approaches for reaching men, such as health facilities and secondary distribution from a female partners at antenatal care in in high HIV burden, or through networks of other high risk sexual, drug injecting or social contacts, including those with HIV [9, 16, 28, 29].

Considering the high willingness to self-test in high-risk men in rural areas, additional community outreach strategies may still be needed. HIVST in workplaces and through faith-based organizations should also be considered, as early programmatic data suggests it may be particularly useful for reaching older men [30]. However, more focused programmatic efforts and communication strategies for workplace HIVST may be needed, as in contrast to low-risk men, high-risk men who were working were less willing to self-test. Further evaluation is needed to understand the utility of HIVST through formal and informal workplace programmes and how well they can reach high-risk men. It will be important to assess differences in HIVST awareness, use and willingness among older and higher risk men in future surveys.

The importance of high willingness to self-test among older Zimbabwean men, including those with higher risks, should not be underestimated. This challenges perceptions that men may not want to test, or are afraid to test, for HIV and underscores the importance of providing more opportunities and HIV testing options which are acceptable to men. As reported in a recent analysis among never tested men in sub-Saharan Africa, nearly all those offered HIV testing in the survey accepted and learned their results [4].

Since these surveys, HIVST alongside conventional testing has been rapidly scaled-up, notably so for Malawi and Zimbabwe. Between May 2015 and July 2017, the STAR Initiative alone distributed 172,830 and 265,091 kits in Malawi and Zimbabwe respectively [10]. Following WHO guidelines and WHO-prequalification of four HIVST products, and multiple large scale implementation studies [2, 31], volumes continue to increase annually, with latest estimates suggesting that between 2017 and 2020, with existing donor support, both countries will have procured at least 4 million self-tests [12].

High willingness to self-test in Malawi and Zimbabwe has also been underscored by observed high uptake in community-based HIVST interventions, with uptake by 45% to 75% reported by endline surveys between 2016 and 2019 in three population-level cluster randomized trials in rural communities [18, 19, 32]. In 2017, a survey following community-based HIVST distribution in rural Zimbabwe with or without supply-side financial incentives for post-test linkage showed that 81.7% of residents were aware of self-testing and 55.8% had self-tested [18]. Two trials of community distribution of HIVST in rural Malawi showed high uptake of HIVST, with significantly increases in ever-testing for HIV in men and adolescents [19, 32]. Even in the standard of care arms, 31.5% of participants in the 2016-17 trial and 32.3% in the 2018-19 trial, respectively, were aware of HIVST [18, 19, 32].

These are substantial increases compared to the low awareness and use of self-testing in the 2015-16 DHS, and highlight the broader impact on awareness from large implementation science studies, such as STAR. In 2015-16,

HIVST was limited to small pilot studies in each country, as national and international policies were still in development and there were no nationally registered or WHO-prequalified products available [33].

As HIVST continues to expand globally, monitoring overall HIVST awareness, use and willingness will contribute to better understanding of the reach and impact of HIVST. Ideally, the extent to which social determinants such as urban residence, literacy and affluence dictate awareness of HIVST will diminish with more comprehensive distribution strategies such as those through community outreach, health facilities, by sexual partners and in other venues such as workplace and private sector pharmacies. Population-based surveys, like the DHS, will then provide an important source of information for countries implementing HIVST, as well as those planning to add HIVST as part of existing HIV testing services. Together with routine programmatic data and special studies, population-based surveys that have included questions on HIVST can then provide a meaningful baseline and point of comparison for future analyses and important insights for future implementation.

Although Malawi and Zimbabwe have scaled-up HIV testing and have now achieved the first 90, gaps remain particularly among men. Efforts to reach the first 95 – diagnosing 95% of all people with HIV – by 2030 is now the new goal. As a result, strategies for diagnosing the shrinking number of people with HIV who do not know their status are becoming more challenging and also less cost-effective unless targeted toward specific populations and settings with lower knowledge of status among people with HIV [3]. Maintaining the high testing coverage and knowledge of status achieved will not be inexpensive and HIVST is likely to play a role. Furthermore, HIVST also addresses patient costs of accessing services and equity concerns which also need to be considered, especially as programmes get closer to the national goals.

Programmes will need to carefully evaluate how they both maintain essential HIV testing services in facilities, while also deploying highly-focused and effective outreach, with limited resources. Strategies such as offering HIVST through highly focused channels among priority populations, or through time-limited and geographically focused community outreach (such as every 5 years), may be more cost-effective and affordable as more people with HIV learn their status and new infections decline [20].

Limitations

This study has many strengths, namely its large sample size and that it is one of the first to provide an assessment of HIVST awareness, use, and willingness to self-test in two early adopter African countries prior to wide-scale implementation. As such, it provides insight into the progress and changes made since HIVST has been rolled-out, serving as an example for countries monitoring HIVST implementation and scale-up. Pooling results, however, may have limited the ability to analyse some differences between countries.

As a cross-sectional survey using self-reported information there may be reporting bias due to social desirability [34]. Previous studies have highlighted challenges with collecting self-reported data, particularly related to sexual risk behaviours and HIV testing history [35, 36]. Thus, it is possible that there may be differences between what people reported and their actual behaviour. Given that HIVST was relatively new during the surveys, it is possible that willingness may also change as more people have experiences self-testing. Additionally, few respondents reported awareness of and past self-testing which may introduce bias and affect the reliability of the results. It will be important to assess awareness and use of self-testing, as well as willingness to self-test in the future, following broader implementation and scale-up.

Like many population-based surveys, respondents included were limited to women 15-49 years old and men 15-54 years old. Efforts continue to be needed to consider older populations, particularly as the median age of people with

HIV increases. Also, given that we included two of the first countries to include questions on HIVST, there were discrepancies in implementation such that not all those surveyed were asked about self-testing and willingness to self-test could not be assessed in Malawians or in Zimbabwean women. Willingness to self-test may be similar or different among women and among Malawians, and it will be important to ensure that they are included in future surveys.

Conclusions

Even in 2019, the percentage of people who had never tested for HIV remained above target for Malawian and Zimbabwean men aged ≥25 years [26]. Reaching these men will be critical to achieving 2030 goals and maintaining low HIV incidence. Despite very low awareness and previous use of HIVST among 2015-16 DHS respondents, willingness to self-test was high, especially among older Zimbabwean men with high sexual risk. Reaching these groups is a priority for HIV testing, prevention and care services as we move towards HIV elimination. Social determinants – notably urban residence, paid employment, literacy and wealth – had a pronounced impact on awareness of HIVST in 2015-16, a time that preceded programmatic implementation.

These data provide a valuable baseline against which to investigate population-level HIVST uptake and equity as programmes scale-up. Countries conducting population-based surveys, especially those where HIVST is being used or soon to be introduced, should consider including questions to assess knowledge, awareness and willingness to self-test aiming to provide baseline data and to better understand the potential impact of HIVST overtime and across and within countries.

List Of Abbreviations

aOR	Adjusted odds ratio
CI	Confidence internal
DHS	Demographic Health Surveys
HIV	Human immunodeficiency virus
HIVST	HIV self-testing
IRB	International Review Board
OR	Odds ratio
STAR	Self-Testing AfRica
STI	Sexually transmitted infection
WHO	World Health Organization

Declarations

Competing interests: Authors have no competing interests. The contents in this article are those of the authors and do not necessarily reflect the view of the World Health Organization or the U.S. President's Emergency Plan for AIDS Relief, the U.S. Agency for International Development or the U.S. Government.

Ethics approval and consent to participate: All DHS and data collection procedures were approved by the ICF Institutional Review Board (IRB), as well as in the country of research. Participation was voluntary, and all individuals provided informed consent.

Consent for publication: Individual-level data not presented. Not applicable.

Data availability: Data and materials used in this analysis are all publicly available through the DHS programme: https://dhsprogram.com/.

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Author's contributions: CJ, led on manuscript preparation, data analysis and interpretation. ELC, MN and PM contributed to interpretation and manuscript and statistical analysis. All other authors provided input and contributed to manuscript.

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Figures

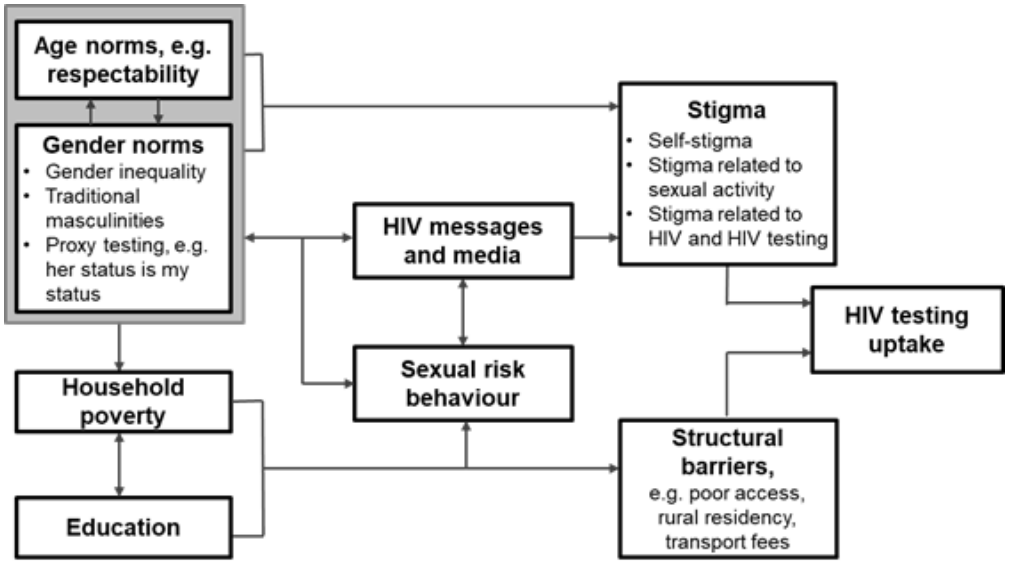

Figure 1

Mechanisms affecting HIV testing uptake in adults (aged 15+) in southern Africa, by age, gender, and sexual risk behaviour

Supplementary Files

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- AdditionalFile3TableS2v2.docx
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