International Health 2023; **15**: 573–584
https://doi.org/10.1093/inthealth/ihad031 Advance Access publication 26 April 2023

HIV testing among women of reproductive age in 28 sub-Saharan African countries: a multilevel modelling

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Received 2 April 2022; revised 15 March 2023; editorial decision 11 April 2023; accepted 13 April 2023

Background: Human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) remains one of the most significant public health challenges globally, particularly in sub-Saharan Africa (SSA). Although HIV testing is a vital step for both prevention and treatment, its uptake is still low in SSA. We therefore examined HIV testing in SSA and its individual/household and community factors among women of reproductive age groups (15–49 y).

Methods: Demographic and Health Survey data collected between 2010 and 2020 from 28 SSA countries were used for this analysis. We analysed the coverage of HIV testing and individual/household and community factors on 384 416 women in the reproductive age groups (15–49 y). Bivariate and multivariable multilevel binary logistic regression analysis were conducted to select candidate variables and to identify significant explanatory variables associated with HIV testing and the results were presented using adjusted odd ratios (AORs) at 95% confidence intervals (CIs).

Results: The pooled prevalence of HIV testing among women of reproductive age in SSA was 56.1% (95% CI 53.7 to 58.4), with the highest coverage found in Zambia (86.9%) and the lowest in Chad (6.1%). Age (45–49 y; AOR 0.30 [95% CI 0.15 to 0.62]), women's education level (secondary; AOR 1.97 [95% CI 1.36 to 2.84]) and economic status (richest; AOR 2.78 [95% CI 1.40 to 5.51]) were some of the individual/household factors associated with HIV testing. Similarly, religion (no religion; AOR 0.58 [95% CI 0.34 to 0.97]), marital status (married; AOR 0.69 [95% CI 0.50 to 0.95]) and comprehensive knowledge of HIV (yes; AOR 2.01 [95% CI 1.53 to 2.64]) were significantly associated individual/household factors for HIV testing. Meanwhile, place of residence (rural; AOR 0.65 [95% CI 0.45 to 0.94]) was found to be a significant community-level factor.

Conclusion: More than half of married women in SSA have been tested for HIV, with between-country variations. Both individual/household factors were associated with HIV testing. Stakeholders should therefore consider all above-mentioned factors to plan an integrated approach to enhancing HIV testing through health education, sensitization, counselling and empowering older and married women, those with no formal education, those who do not have comprehensive HIV/AIDS knowledge and those in rural areas.

Keywords: AIDS, DHS, global health, HIV test, sub-Saharan Africa, women's health.

Introduction

Human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) remains one of the most significant public health and development threats globally. Approximately 38 million people are currently living with HIV/AIDS and tens of millions have died of AIDS-related causes since the beginning of the epidemic.[1] According to the 2020 Joint United Nations Programme on HIV and AIDS (UNAIDS) report, there were about 1.7 million new infections and 690 000 HIV/AIDS-related deaths in 2019.[2]

Sub-Saharan African are greatly affected by HIV/AIDS, as >50% of all new HIV infections occur in the region.[3,4] Recent reports suggest that sub-Saharan Africa (SSA) accounts for 76% of people infected with HIV across the globe.[5–7] In SSA, approximately 76% of all new HIV infections and 75% of all HIV/AIDS-related deaths were recorded in 2015.[5–7] There is evidence that young women are disproportionately impacted, as the 2022 Fact Sheet indicates that girls and young women 15–24 y of age are twice as likely to be living with HIV than young men.[8] The disproportionate impact of HIV infection on women is usually attributed to biological, social, cultural, economic and structural factors.[9] The possible reason for the high prevalence of HIV/AIDS among women could be due to gender-based violence and inadequate access and use of sexual and reproductive health services, including condoms.[10,11]

HIV testing services are a vital step towards HIV prevention, treatment, care and support.[12–16] In 2016, the United Nations declared an end to AIDS by the end of 2020.[13,14] The declaration endorsed the 90-90-90 targets.[13,14] UNAIDS subsequently scaled these targets to 95-95-95 and set achievement by 2025.[17] Using these targets, it is anticipated that 95% of women of reproductive age will have their HIV and sexual and reproductive health service needs met, and 95% of pregnant/breastfeeding women living with HIV should have suppressed viral loads and 95% of HIV-exposed children should be tested by 2025.[17]

Increasing access to and uptake of HIV testing is critical to achieving these targets.[13,14] HIV counselling and testing have been shown to be associated with reductions in transmission/acquisition behaviours for both HIV-infected and uninfected individuals.[18] Meanwhile, the coverage of HIV testing is low among men and women in SSA,[19,20] even though the services are available. Among women of reproductive age, a recent study in SSA revealed a pooled HIV test prevalence of 64.4%, ranging from 20.2% in the Democratic Republic of the Congo to 97.4% in Rwanda.[19]

Prior evidence showed that decision-making capacity and sociodemographic and socio-economic factors are highly predictive of HIV testing,[19,21,22] but few studies have investigated these factors in SSA.[5,19,21–22] More importantly, there is a paucity of evidence about individual, household and community factors associated with HIV testing among reproductive-age women in SSA. This is a significant gap in the literature considering the effect HIV/AIDS infection can have on couples and their children in the context of marriage. Thus this study aimed to examine the coverage of HIV testing among women of reproductive age in SSA and individual/household and community factors.

Methods

Study design and period

We conducted an analytic cross-sectional study involving secondary analysis of routine multicountry Demographic and Health Surveys (DHS) data. As illustrated in Table 1, the surveys were conducted between 2010 and 2020.

Study population

The study included women of reproductive age (15–49 y) who responded to questions relating to HIV.

Data source

We used data from the DHS of 28 SSA countries. The DHS is a nationally representative survey aimed at obtaining information on various demographic and health indicators, including HIV testing, across several low- and middle-income countries (LMICs). The DHS in the selected countries usually adopts a two-stage stratified cluster sampling technique. In the first stage, clusters, also known as enumeration areas (EAs), are selected using the probability proportional to size technique. In the second stage, a fixed number of households (usually 25–30) are selected using a systematic sampling technique from clusters that were already selected in the first stage. We included 28 SSA countries that have information on the outcome variable and all the key explanatory variables of interest in the study. The sample for the final analysis, after exclusions was 384 416, based on information from the individual recode (IR) file.[10,23,24] Table 1 provides detailed information on selected countries, the year of the survey and samples.

Study variables

Outcome variable

The outcome variable of interest was the uptake of HIV testing. In the survey, the question asked was, 'Have you ever been tested for HIV?' Responses in the affirmative were coded 1 and 'no' were coded 0.[19,24]

Explanatory variables

Based on previous studies,[5,14–22] we considered 15 explanatory variables that were likely to affect the outcome variable (HIV testing). We further grouped these variables into individual/household and community factors.

Individual/household factors

The individual explanatory factors were woman's age in years (15–19, 20–23, 24–28, 29–33, 34–38, 39–43, 44–48), woman's education level (no formal education, primary school, secondary school, higher), husband's education level (no formal education, primary school, secondary school, higher), marital status (not married, married), currently working (no, yes), number of children ever born (0, 1–2, 3–4, ≥5) and religion (Christian, Muslim, other, no religion). Other individual explanatory factors included

Table 1. Year of survey and weighted sample by country (N=384 416)

Country	Year of survey	Sampled population Weighted number	Weighted %
Angola	2015–16	14 379	3.7
Burkina Faso	2010	17 087	4.4
Benin	2017–18	15 928	4.1
Burundi	2016–17	17 269	4.5
Democratic Republic of the Congo	2013–14	18 692	4.9
Congo	2011–12	10 819	2.8
Côte d'Ivoire	2011–12	9937	2.6
Cameroon	2018–19	14 677	3.8
Ethiopia	2016	15 683	4.1
Gabon	2012	8422	2.2
Ghana	2014	9391	2.4
Gambia	2019–20	10 134	2.6
Guinea	2018	10 874	2.8
Kenya	2014	30 923	8.1
Comoros	2012	5329	1.4
Lesotho	2014	6621	1.7
Liberia	2019–20	9239	2.4
Mali	2018	10 519	2.7
Malawi	2015–16	24 562	6.4
Namibia	2013	9971	2.6
Rwanda	2014–15	13 477	3.5
Sierra Leone	2019	15 574	4.1
Senegal	2010–11	15 688	4.1
Chad	2014–15	17 634	4.6
Togo	2013–14	9443	2.5
Uganda	2016	18 506	4.8
Zambia	2018–19	13 683	3.6
Zimbabwe	2015	9955	2.6
Total	–	384 416	100.00

comprehensive HIV knowledge (no, yes), media exposure and economic status.

Media exposure was assessed in terms of frequency (no exposure, less than once a week, at least once a week) and coded 'yes' if the respondent read a newspaper or listened to the radio or watched television at least once every week and 'no' otherwise. The DHS uses information on ownership of family assets, e.g. supply of drinking water, kind of toilet facility, cooking fuel and possession of a television and refrigerator, to create a wealth index (poorest, poorer, middle, richer, richest).[26,27]

Community factors

Community explanatory variables included place of residence (urban, rural), distance to a health facility (big problem, not a big problem), community literacy level (low, medium, high), community socio-economic status (low, medium, high) and community media exposure (low, medium, high). The socio-economic status of respondents who reside in a given community was computed from occupation, wealth and education. We applied principal component analysis to estimate the number of women who were unemployed, uneducated and poor. A standardized score was derived with an average rating (0) and standard deviation.[1] The rankings were further categorized into tertile 1 (least disadvantaged), tertile 2 and tertile 3 (most disadvantaged), where a lower score (tertile 1) denoted higher socio-economic status and the highest score (tertile 3) denoted lower socio-economic status. Community literacy was derived from respondents who could read and write or not.

Statistical analyses

First, descriptive analysis, including frequencies and percentages of HIV testing, and all explanatory variables were estimated. This was followed by a Pearson χ^2 test of independence to select explanatory variables that had a significant association with HIV testing, using a p-value of <0.05. A multicollinearity test using variance inflation factor (VIF) was further conducted on all the explanatory variables and we found no evidence of collinearity (mean VIF 2.33, minimum VIF 1.03, maximum VIF 5.84). VIF

Table 2. Distribution of HIV testing across explanatory variables and bivariate multilevel logistic regression analysis results among reproductive-age women: evidence from 28 DHSs (N=384 416)

Variable	Frequency (weighted %)	HIV Testing (weighted %)	Correlation (95% CI)
Age (years)			
15–19 (ref)	82 700 (23.9)	23.0	
20–24	71 148 (21.2)	55.7	6.59 (5.19 to 8.38)***
25–29	66 507 (17.1)	64.9	11.45 (9.02 to 14.53)***
30–34	53 984 (12.5)	61.8	9.50 (7.41 to 12.20)***
35–39	45 851 (10.5)	55.9	7.28 (5.43 to 9.76)***
40–44	34 314 (8.6)	52.4	6.57 (5.01 to 8.63)***
45–49	27 605 (6.2)	36.1	2.96 (2.04 to 4.30)***
Women's education level			
No formal education (ref)	123 994 (22.1)	24.2	
Primary school	127 952 (34.8)	43.8	1.84 (1.59 to 2.14)***
Secondary school	116 952 (38.3)	62.7	2.55 (2.06 to 3.15)***
Higher	16 203 (4.8)	86.3	10.07 (5.99 to 16.91)***
Husband's education level			
No formal education (ref)	86 881 (13.4)	20.3	
Primary school	65 078 (29.2)	33.9	1.78 (1.32 to 2.41)***
Secondary school	70 322 (49.3)	73.9	5.49 (4.08 to 7.38)***
Higher	17 241 (8.1)	95.6	27.17 (14.39 to 51.29)***
Economic status			
Poorest (ref)	80 067 (16.9)	18.1	
Poorer	74 170 (17.6)	26.1	2.06 (1.63 to 2.60)***
Middle	73 417 (19.5)	54.7	5.34 (4.05 to 7.05)***
Richer	73 795 (22.5)	65.5	7.54 (5.60 to 10.14)***
Richest	82 652 (23.6)	66.5	7.32 (5.44 to 9.86)***
Currently working			
No (ref)	149 838 (34.9)	46.8	
Yes	217 448 (65.1)	49.7	2.02 (1.75 to 2.34)***
Place of residence			
Urban (ref)	143 743 (69.6)	60.5	
Rural	240 358 (30.4)	21.6	0.13 (0.11 to 0.17)***
Distance to health facility			
Big problem (ref)	140 313 (51.8)	43.4	
Not a big problem	214 671 (48.2)	54.4	1.28 (1.13 to 1.45)***
Marital status			
No (ref)	189 445 (89.2)	48.5	
Yes	194 656 (10.8)	50.1	1.82 (1.48 to 2.23)***
Media exposure			
No (ref)	123 114 (26.2)	22.7	
Yes	259 474 (73.8)	57.9	2.44 (2.08 to 2.85)***
Eve-born children			
0 (ref)	103 153 (24.9)	22.9	
1–2	115 453 (15.1)	64.9	16.25 (12.87 to 20.51)***
3–4	82 774 (34.5)	61.3	15.57 (12.76 to 19.00)***
≥5	82 901 (25.5)	47.4	10.62 (8.53 to 13.24)***
Religion			
Christian (ref)	249 065 (93.9)	49.6	
Muslim	112 438 (0.3)	38.0	0.56 (0.22 to 1.43)
Other	9988 (0.6)	44.4	1.05 (0.60 to 1.84)
No religion	7970 (5.2)	33.3	0.66 (0.49 to 0.88)**
Comprehensive HIV knowledge			
No (ref)	172 262 (55.9)	51.5	
Yes	161 350 (44.1)	69.7	1.82 (1.52 to 2.18)***

Table 2. *(Continued)*

Variable	Frequency (weighted %)	HIV Testing (weighted %)	Correlation (95% CI)
Community literacy level			
Low (ref)	131 368 (24.9)	20.9	
Medium	126 553 (32.2)	48.0	4.35 (3.31 to 5.72)***
High	127 202 (43.0)	65.3	9.99 (7.78 to 12.83)***
Community socio-economic status			
Low (ref)	190 643 (45.1)	29.4	
Medium	67 199 (7.3)	58.3	4.98 (3.80 to 6.51)***
High	127 281 (47.6)	65.5	6.17 (5.08 to 7.51)***
Community media exposure			
Low (ref)	130 243 (26.0)	19.2	
Medium	140 056 (25.4)	47.2	5.07 (3.88 to 6.62)***
High	114 824 (48.7)	65.2	10.57 (8.27 to 13.51)***

ref: reference group.
Statistically significant at *p<0.5, **p<0.1 and ***p<0.01.

values <10 are tolerable.[28,29] Finally, four different models were fitted using multilevel logistic regression (MLLR) to assess the association between individual/household and community factors and HIV testing. The first model, the null model (model 0), which had no explanatory variables, was fitted to show the variance in HIV testing attributed to the primary sampling units (PSUs). In the second model (model 1), only individual/household factors were fitted. The third model (model 2) included only community factors. The last model (model 3) comprised both the individual/household and community factors.

The four MLLR models included fixed and random effects.[30,31] The fixed effects (measures of association) showed the association between the explanatory variables and the outcome variable, and the random effects (measures of variations) showed the measure of variation in the outcome variable based on the EA. This is measured by the intracluster correlation (ICC).[32] The model fit of the regression models was assessed using Akaike's information criterion (AIC) deviance (−2 log-likelihood ratio), as the models were nested models.[33] The best model was the model with the least deviance and the highest log-likelihood ratio. Data processing and analysis were performed using Stata version 14.2 (StataCorp, College Station, TX, USA). The melogit command was used to run the MLLR models. We followed the Strengthening of Observational Studies in Epidemiology guidelines.[34]

Results

Sociodemographic characteristics and HIV testing coverage distribution

Table 2 shows the results for the characteristics and distribution of the respondents. A total of 384 416 reproductive-age women were included in the study. Of these, 23.9% were adolescents (15–19 y of age). More than one-fifth had no formal education (22.1%) and 34.9% were not currently employed. Approximately 30.4% of the participants resided in rural areas and more than half (51.8%) reported that they had a big challenge reaching a health facility (Table 2).

The prevalence of HIV testing by explanatory variables is shown in Table 2. We observed that HIV testing coverage varied across explanatory variables and subcategories. For example, HIV testing among women with higher education levels was 86.3%, while it was 24.2% for those with no formal education. Similarly, we observed a lower prevalence (20.3%) among those whose husbands had no formal education and a higher prevalence (95.6%) among those whose husbands had higher education levels. HIV testing was further found to be higher among urban residents (60.5%) and was lower among rural residents (21.6%). The prevalence of HIV testing ranged from 18.1% to 66.5% for women in the poorest and richest households (Table 2).

Coverage of HIV testing

The pooled result shows that 48.7% of women in the reproductive age groups had been tested for HIV. The highest coverage was observed in Zambia (86.9%), while the lowest coverage was found in Chad (6.1%) (Figure 1).

Regarding subregional distribution, the highest HIV testing coverage was observed in southern Africa (85.4%) followed by East Africa (67.8%), Central Africa (48.0%) and West Africa (30.4%) (Table 3).

Fixed effects (measure of association)

Table 4 shows the fixed effects of the individual and community factors associated with HIV testing among women of reproductive age. The odds of HIV testing were found to be lower among older women (age 45–49 y; adjusted odds ratio [AOR] 0.30 [95% confidence interval {CI} 0.15 to 0.62]) compared with those 15–19 y of age. We further observed higher odds of HIV testing among women who had secondary (AOR 1.97 [95% CI

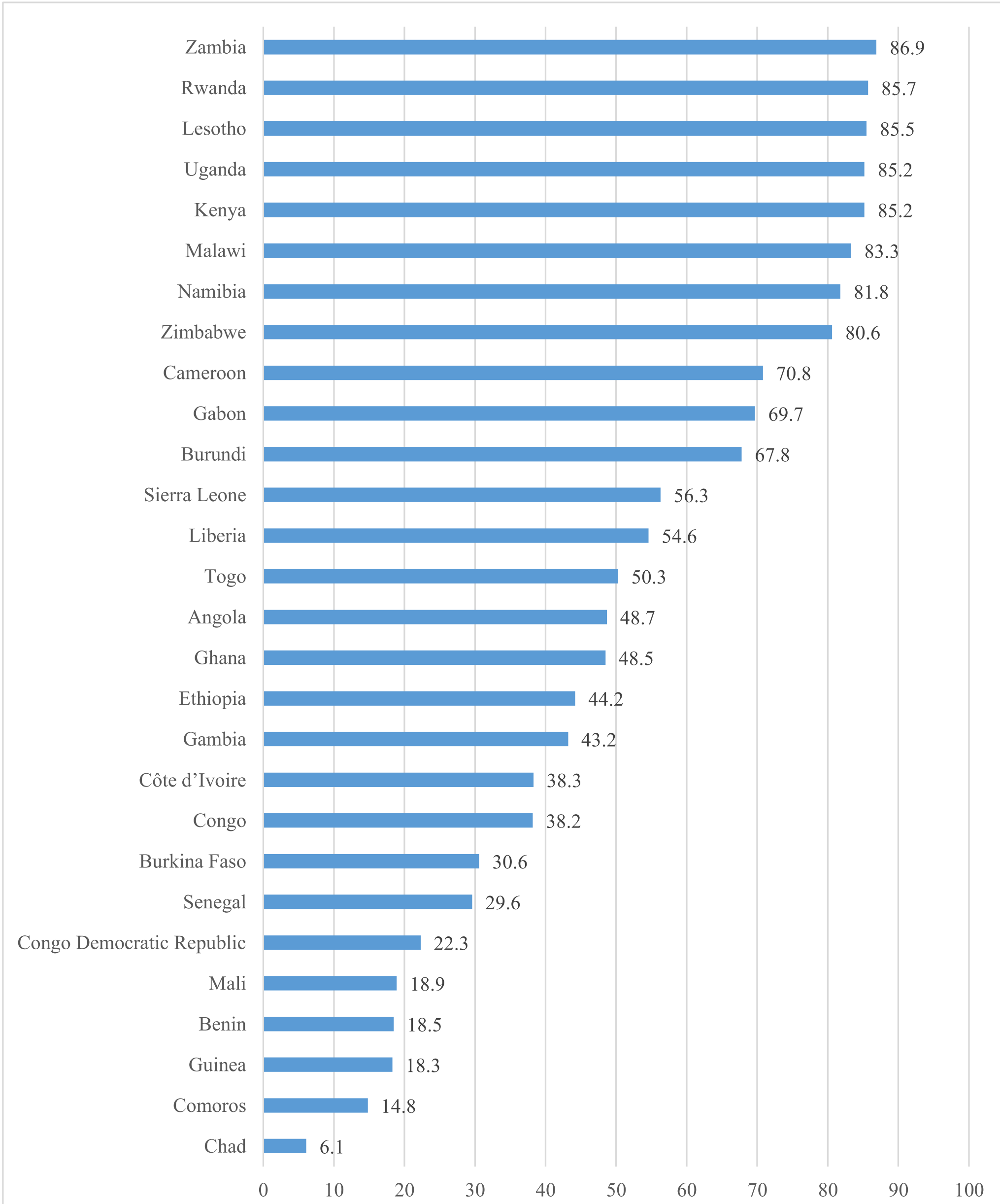

Figure 1. Coverage of HIV testing among reproductive-age women in SSA countries: evidence from 28 DHSs (N=384 416).

1.36 to 2.84]) and higher education (AOR 23.0 [95% CI 5.45 to 97.12]) compared with those with no formal education. Similarly, we found higher odds of HIV testing among women whose husbands had secondary (AOR 1.57 [95% CI 1.12 to 2.19]) and higher education (AOR 3.07 [95% CI 1.44 to 6.54]) compared with women whose husbands had no formal education.

The result also shows higher odds of HIV testing among women who were in the rich (AOR 2.79 [95% CI 1.58 to 4.91]) and richest (AOR 2.78 [95% CI 1.40 to 5.51]) households as compared with those in the poorest households. Moreover, higher odds of HIV testing was seen among women who had no religious affiliation (AOR 0.58 [95% CI 0.34 to 0.97]) compared with those who were Christian.

We found lower odds of HIV testing among women who were currently employed (AOR 0.70 [95% CI 0.55 to 0.89]) compared with those who were unemployed. Likewise, lower odds of HIV testing were noted among women who were married (AOR 0.69 [95% CI 0.50 to 0.95]) compared with unmarried women.

The odds of HIV testing were found to be higher among women with 1–2 (AOR 3.18 [95% CI 1.71 to 5.88]), 3–4 (AOR 3.64 [95% CI 1.98 to 6.68]) and $\geq$5 children (AOR 4.75 [95% CI 2.56 to 8.80]) compared with those with no children. We found the likelihood of HIV testing to be higher among women with a comprehensive knowledge of HIV (AOR 2.01 [95% CI 1.53 to 2.64]) compared with those with no comprehensive HIV knowledge. Regarding community predictors, we found lower odds of HIV

Table 3. Subregional coverage of HIV testing among reproductive-age women: evidence from 28 DHSs (N=384 416)

Sub-regions	Included countries	Pooled subregional coverage, % (95% CI)
West Africa	Burkina Faso	30.4 (28.9 to 31.9)
	Benin	
	Côte d'Ivoire	
	Gambia	
	Ghana	
	Guinea	
	Liberia	
	Mali	
	Senegal	
	Sierra-Leone	
	Togo	
Central Africa	Angola	48.7 (47.2 to 50.2)
	Congo	
	Democratic Republic of the Congo	
	Cameroon	
	Gabon	
	Chad	
East Africa	Burundi	67.8 (66.8 to 68.9)
	Ethiopia	
	Kenya	
	Comoros	
	Malawi	
	Rwanda	
	Uganda	
	Zambia	
	Zimbabwe	
Southern Africa	Namibia	85.4 (84.2 to 86.6)
	Lesotho	

testing among women who reside in rural areas (AOR 0.65 [95% CI 0.45 to 0.94]) compared with those in urban areas (Table 4).

Random effects (measures of variation)

The random effects models of the individual/household and community factors of HIV testing are shown in Table 5. We observed in the null model a significant variation in the likelihood of HIV testing across the clusters (σ^2=2.08 [95% CI 1.75 to 2.48]). Approximately 41% of the total variance in HIV testing was attributed to between-cluster variations (ICC=0.35). The ICC estimate in the empty model (41%) decreased by 11% in model 1 (ICC=30%) then decreased by 7% in model 2 (ICC=23%), but increased by 6% in model 3 (ICC=29%). These estimates showed that the variations in the likelihood of HIV testing can be attributed to the variances in the clustering in the PSUs. Model fitness was checked by the AIC, deviance and log-likelihood ratio. The best model was the model with the lowest AIC and deviance value (the highest log-likelihood ratio), model 3, which included both individual/household and community factors (Table 5).

Discussion

We examined the coverage of HIV testing in SSA and the individual/household and community factors using data from the most recent DHS. The pooled results showed that 48.7% (95% CI 47.2 to 50.2) of reproductive-age women had been tested for HIV, ranging from 6.1% in Chad to 86.9% in Zambia. The estimate in our study was lower than what was observed in a recent study,[19] where a prevalence of 64.4% was reported. The discrepancy in estimates may be attributed to the distinct target populations, as the previous study focused on married and cohabiting women.[19]

Regarding the individual/household factors, we found the likelihood of HIV testing to be lower among older women, which is consistent with prior findings in SSA.[19,34] This outcome may be attributed to the low level of sexual activity among older women compared with younger women.[19,35] Women with higher education levels had a greater chance of being tested for HIV than those with no formal education. This finding is in line with prior studies conducted in Burkina Faso,[35] Ethiopia[14] and Nigeria.[37] Other studies also found women with higher education levels to have better comprehensive knowledge about HIV/AIDS.[38] It has been shown that women with higher educational attainment have the capability to access healthcare services due to financial and social empowerment.[6,39] There is also evidence that education empowers women to make health decisions,[6,11,40] especially visiting health facilities.[14,39] Formal education also promotes healthcare-seeking behaviour,[39–41] which can lead to an improved quality of life.[11,41]

We found higher odds of HIV testing among women whose husbands had attended secondary and higher education compared with women whose husbands had no formal education. Our finding is consistent with a study in four African countries that shows that among both men and women, secondary education is associated with a 3-fold increase in the prevalence of HIV testing.[42]

Other studies conducted in SSA where voluntary counselling and testing (VCT) was associated with knowledge of HIV and education,[43,44] and an analysis of survey data from 13 countries of SSA, showed that prior to the availability of treatment, VCT was associated with secondary education.[45]

Consistent with previous studies in SSA,[19] the number of children a woman has was found to be associated with HIV testing, where women with more children had higher odds of testing for HIV compared with those with no children. This finding can be attributed to the fact that women have access to healthcare services during pregnancy, delivery or postpartum.[19,47,48] The result also shows higher odds of HIV testing among women who were in the rich and richest households as compared with those who were in the poorest households. Socio-economic inequalities in the uptake of HIV testing have persisted despite the massive scale-up of HIV testing in SSA. People living in the richest households were around three times as likely as those in the poorest households to have been tested for HIV.[48] This is probably because women from wealthier households have higher odds of a comprehensive knowledge of HIV as compared with those who are from poor families.[37]

Socio-economic status often determines access to HIV testing and treatment partly due to structural factors, including poverty, lack of employment opportunities, limited healthcare

Table 4. Multilevel multivariable binary logistic regression results for predictors of HIV testing among reproductive-age women: evidence from 28 DHSs (N=384 416)

Variables	Model 1, AOR (95% CI)	Model 2, AOR (95% CI)	Model 3, AOR (95% CI)
Age (years)			
15–19 (ref)			
20–24	1.26 (0.84 to 1.88)		1.25 (0.84 to 1.86)
25–29	1.67 (0.99 to 2.80)		1.64 (0.97 to 2.75)
30–34	1.46 (0.80 to 2.65)		1.42 (0.78 to 2.60)
35–39	0.81 (0.39 to 1.67)		0.78 (0.37 to 1.62)
40–44	0.78 (0.42 to 1.46)		0.74 (0.39 to 1.39)
45–49	0.31 (0.15 to 0.62)**		0.30 (0.15 to 0.62)**
Women's education level			
No formal education (ref)			
Primary school	1.36 (1.06 to 1.75)*		1.26 (0.99 to 1.62)
Secondary school	2.17 (1.51 to 3.14)***		1.97 (1.36 to 2.84)***
Higher	26.30 (6.28 to 110.15)****		23.01 (5.45 to 97.19)***
Husband's education level			
No formal education (ref)			
Primary school	1.12 (0.79 to 1.58)		1.08 (0.76 to 1.53)
Secondary school	1.65 (1.19 to 2.30)**		1.57 (1.12 to 2.19)**
Higher	3.30 (1.53 to 7.10)**		3.07 (1.44 to 6.54)**
Economic status			
Poorest (ref)			
Poorer	1.49 (1.05 to 2.10)*		1.14 (0.78 to 1.66)
Middle	3.76 (2.49 to 5.65)***		1.81 (1.10 to 2.98)*
Richer	7.27 (4.67 to 11.32)***		2.79 (1.58 to 4.91)***
Richest	7.88 (4.52 to 13.74)***		2.78 (1.40 to 5.51)**
Media exposure			
No (ref)			
Yes	1.46 (1.14 to 1.87)**		1.40 (1.08 to 1.81)**
Ever-born children			
0 (ref)			
1–2	3.16 (1.73 to 5.77)***		3.18 (1.71 to 5.88)***
3–4	3.67 (2.03 to 6.62)***		3.64 (1.98 to 6.68)***
≥5	4.76 (2.61 to 8.66)***		4.75 (2.56 to 8.80)***
Currently working			
No (ref)			
Yes	0.67 (0.53 to 0.85)**		0.70 (0.55 to 0.89)**
Marital status			
No (ref)			
Yes	0.67 (0.49 to 0.92)*		0.69 (0.50 to 0.95)*
Religion			
Christian (ref)			
Muslim	0.44 (0.10 to 1.93)		0.39 (0.08 to 1.86)
Other	1.26 (0.60 to 2.68)		1.27 (0.59 to 2.76)
No religion	0.58 (0.34 to 1.00)		0.58 (0.34 to 0.97)*
Comprehensive HIV knowledge			
No (ref)			
Yes	2.09 (1.60 to 2.74)***		2.01 (1.53 to 2.64)***
Place of residence			
Urban (ref)			
Rural		0.49 (0.37 to 0.64)***	0.65 (0.45 to 0.94)*
Distance to health facility			
Big problem (ref)			
Not a big problem		1.19 (1.05 to 1.34)**	1.06 (0.87 to 1.30)

Table 4. *(Continued)*

Variables	Model 1, AOR (95% CI)	Model 2, AOR (95% CI)	Model 3, AOR (95% CI)
Community literacy level			
Low (ref)			
Medium		1.80 (1.32 to 2.46)***	1.45 (0.98 to 2.15)
High		2.08 (1.44 to 3.01)***	1.61 (0.96 to 2.69)
Community socio-economic status			
Low (ref)			
Moderate		1.42 (1.10 to 1.83)**	1.43 (0.90 to 2.29)
High		1.35 (1.05 to 1.74)*	1.34 (0.87 to 2.06)
Community media exposure			
Low (ref)			
Moderate		2.08 (1.54 to 2.82)***	1.35 (0.88 to 2.05)
High		2.55 (1.76 to 3.70)***	1.70 (0.96 to 2.99)

ref: reference group.
Statistically significant at *p<0.5, **p<0.1 and ***p<0.01.

Table 5. Random effects for factors of HIV testing among reproductive-age women: evidence from 28 DHSs (N=384 416)

Random effect	Model 0	Model 1	Model 2	Model 3
PSU variance (95% CI)	2.08 (1.75 to 2.48)	1.12 (0.83 to 1.53)	0.79 (0.61 to 1.02)	1.06 (0.77 to 1.46)
ICC	0.41	0.30	0.23	0.29
Likelihood ratio test	2985.20	321.39	1210.71	310.26
Wald χ^2	Reference	500.21 (p<0.001)	479.59 (p<0.001)	547.44 (p<0.001)
Model fitness				
Log-likelihood	−8574.36	−2282.53	−8359.04	−2256.72
Deviance (−LLR)	17 148.36	4565.06	16 718.08	4513.44
AIC	17 152.74	4621.07	16 738.09	4585.44
Total observations	384 101	384 101	384 101	384 101

access and limited transportation infrastructure, which have been highlighted as both independent and interactive contributors to healthcare engagement in HIV-positive women.[49]

We found lower odds of HIV testing among women who were currently employed as compared with those who were not currently employed. This finding is inconsistent with prior studies documenting that although the type of employment matters, employed women are more likely to engage in HIV medical care, including HIV testing, timely linkage to HIV care, retention in HIV care and HIV medication adherence.[50,51] However, even though further studies are needed to examine the mechanism, our lower odds of HIV testing among currently employed women might probably be due to a relatively busy work schedule. Thus some women might not get permission from their employer and might have no time to wait for test results.

We also found that lower odds of HIV testing were seen among women who were married as compared with unmarried women. This finding is inconsistent with a prior study conducted among African Americans.[52] However, other literature documented that divorced and separated individuals were more likely to have been tested for HIV than married individuals.[53,54] Divorced and separated individuals were more than four times as likely to die of HIV/AIDS than married individuals. Single or never-married persons were 13 times more likely to die of HIV/AIDS than their married counterparts.[55,56]

Because of their wider sexual network, single/never married and divorced/separated persons have a high risk of acquiring HIV/AIDS and subsequently dying from it.[57] Marriage seems to confer a form of social control,[55,58] which in effect works to limit the number of sexual partners a spouse has. Behaviour change communications should target individuals at high risk (single and divorced) to get them to seek HIV testing, the cornerstone for HIV prevention.[51]

Furthermore, we found religion to be associated with HIV testing. We observed lower odds of HIV testing among women with no religious affiliation than Christians. One mixed methods study examined HIV/sexually transmitted infection testing in association with the influence of religion on behaviour.[59] That study found a positive/protective association, where encouragement from church members to get tested for HIV was significantly greater than encouragement from family and friends. Also, people exposed to religious teachings on HIV and stigma were more likely to get tested for HIV.[60] Several mechanisms were present in those studies, including behavioural norms, social support and organization, social influence and education. In one study,[59] 87% of participants said it was important for their church to talk about testing for HIV and 77% reported that the church should offer HIV testing.[60]

In this study, we found higher odds of HIV testing among women with comprehensive HIV knowledge compared with those with no comprehensive knowledge. This finding corroborates several prior studies in Africa,[61–65] and socio-economic status, including wealth, employment and urban residence, have been implicated,[52] as women with higher social status may have a good understanding of the benefits of HIV testing.[65] Knowledge is essential in preventing and controlling HIV,[38,52] as such knowledge increases self-awareness about risk factors associated with transmission.[63] A recent meta-analysis of 60 studies showed that HIV knowledge ranked among the most common factors selected by researchers when studying HIV testing behaviours and revealed that HIV knowledge was positively correlated with HIV testing.[64,66]

Finally, we found lower odds of HIV testing among women who resided in rural areas compared with their counterparts in urban areas, as seen in another study in SSA.[19] The possible reason for this finding is partly attributable to the concentration of health facilities in urban centers.[67] Moreover, rural residents face unique challenges, such as distance to care, a lack of healthcare facilities and healthcare providers with HIV/AIDS expertise, limited availability of supportive or ancillary services, stigma and discrimination and limited educational and economic infrastructure.[68]

Strengths and limitations of this study

A key strength of this study is that we used nationally representative surveys from several countries in SSA to investigate HIV testing coverage and its associated individual and community predictors. Thus we believe our findings are generalizable to other countries in SSA. Nonetheless, the study has the following limitations. First, a cause–effect relationship cannot be established due to the cross-sectional nature of the study. Second, the DHS relies on self-reported data, which may be prone to recall bias. Lastly, due to data availability and constraints, we used surveys that were conducted at different time points in the selected countries.

Conclusions

Overall, more than half of the women of reproductive age had been tested for HIV. However, country and subregional differences were observed in this study. The likelihood of HIV testing was lower in older married women but higher in women with at least a primary education, those with comprehensive HIV/AIDS knowledge and those who lived in urban areas. Stakeholders should therefore consider an integrated approach to enhance HIV testing by empowering older women, those with no formal education, those who do not have comprehensive HIV/AIDS knowledge and those in urban areas through health education, sensitization and counselling. More importantly, it is expedient for these to be considered while being cognizant of within- and across-country variations.

Authors' contributions: SY and BZ contributed to the conception and design of the study, interpreted the data, prepared the manuscript and led the research. NKA, BOA, EKA, EB, GAT and AS helped with data analysis, provided technical support in the interpretation of results and critically reviewed the manuscript for intellectual content. SY had final responsibility to submit the article. All authors read and revised drafts of the article and approved the final version.

Acknowledgements: We acknowledge the Demographic and Health Surveys Programme for making the DHS data available and we thank the women who participated in the surveys.

Funding: None.

Competing interests: None declared.

Ethical approval: Not required.

Data availability: The datasets generated and/or analysed during the current study are available from http://dhsprogram.com/data/available-datasets.cfm.

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