

RESEARCH ARTICLE

Comprehensive HIV/AIDS knowledge and HIV testing among men in sub-Saharan Africa: a multilevel modelling

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Abstract

This study investigated the association between comprehensive HIV/AIDS knowledge and HIV testing among men in sub-Saharan Africa (SSA). Data were taken from the most recent (2010–2019) Demographic and Health Survey men's recode files of 29 countries in SSA. A total of 104,398 men who had complete information on all the variables of interest were included in the study. The outcome variable was HIV testing. A multilevel logistic regression analysis was conducted to determine the association between comprehensive HIV/AIDS knowledge and HIV testing. The results of the fixed effects model were presented as adjusted odds ratios (AORs) with 95% confidence intervals (CIs). The average prevalences of HIV testing and comprehensive HIV/AIDS knowledge among men in SSA were 53.5% and 50.8% respectively. Rwanda and Niger recorded the highest (93.6%) and lowest prevalences (9.8%) respectively. The prevalence of comprehensive HIV/AIDS knowledge among men in the 29 countries was 50.8%, with the highest in Rwanda (76.4%) and the lowest in Benin (31.1%). Men who had no comprehensive HIV/AIDS knowledge were less likely to test for HIV compared with those who had comprehensive HIV/AIDS knowledge (AOR=0.59, CI: 0.57–0.60). Men who were older than 20 years, married or cohabiting, with at least secondary education, in the richest wealth quintile, exposed to mass media, used condoms and with multiple sexual partners were more likely to test for HIV. To improve HIV testing among men in SSA, this study recommends that policymakers and stakeholders step up comprehensive HIV/AIDS knowledge sensitization and education using effective tools such as mass media.

Keywords: HIV/AIDS; HIV testing; Sub-Saharan Africa

Introduction

HIV/AIDS remains a major public health threat despite the significant decline in AIDS-related deaths worldwide (Frank *et al.*, 2019). As of 2019, there were an estimated 38.0 million people worldwide living with HIV/AIDS, with the highest percentage in sub-Saharan Africa (SSA) (World Health Organization [WHO], 2020). Approximately 1.7 million new HIV infections and 690,000 AIDS-related deaths occurred in 2019 (WHO, 2020). A recent report on the impact

of the COVID-19 pandemic on antiretroviral therapy (ART) suggests a possible disruption in HIV/AIDS management, which is expected to increase AIDS-related deaths in the next year, mostly in SSA. This has resulted in the need to scale up HIV/AIDS-related interventions to help curb the pandemic in the face of the COVID-19 threat (Jewell *et al.*, 2020; WHO, 2020).

Globally, several interventions or programmes are being implemented to end the HIV/AIDS pandemic (Fauci & Lane, 2020). In 2016, for instance, the United Nations Political Declaration on HIV/AIDS set a global target of accelerating the fight against HIV and ending the AIDS pandemic by 2030 (United Nations General Assembly, 2016). Among the targets of the United Nations Program on HIV/AIDS (UNAIDS) is to achieve 95-95-95 by 2030 – that is, to diagnose at least 95% of people living with HIV, of whom at least 95% should be on treatment and out of which at least 95% should have achieved viral suppression by 2030 (Pandey & Galvani, 2019). However, a recent report shows that most countries are likely to miss the 2030 global target (Frank *et al.*, 2019), largely due to gaps in HIV testing and treatment initiation (UNAIDS, 2018). Early initiation of treatment significantly decreases viral load and its associated morbidity and mortality (Cohen *et al.*, 2011).

HIV counselling and testing is the first and most important step towards prevention and early initiation of treatment (Cohen *et al.*, 2011; Sharma *et al.*, 2015). However, it has been reported that about 9.4 million people living with HIV in 2017 did not know their status and a significant proportion of these people live in SSA (UNAIDS, 2018). Despite the significant improvement in voluntary HIV counselling, testing and HIV prevention measures, including the introduction of rapid diagnostic tests and self-tests (WHO, 2020), coverage remains low in most sub-Saharan African countries (Sharma *et al.*, 2015; Harichund *et al.*, 2019). Apart from discrimination, stigma and non-confidential testing environments (Bwambale *et al.*, 2008; Harichund & Moshabela, 2018), lack of comprehensive HIV/AIDS knowledge remains one of the major barriers to uptake of HIV testing in SSA (Aderemi *et al.*, 2014; Harichund & Moshabela, 2018). For example, in a cross-sectional survey to determine HIV testing uptake among youths in SSA, Asaolu *et al.* (2016) reported that having comprehensive HIV knowledge is associated with higher odds of being tested. Seidu *et al.* (2020) also reported that having comprehensive HIV/AIDS knowledge is associated with lower odds of self-reported sexually transmitted infections among sexually active men in SSA.

With the introduction of community and home-based HIV counselling and testing models, the uptake of HIV testing among males in SSA has been boosted (DiCarlo *et al.*, 2014; Hensen *et al.*, 2015). Available evidence suggests that most studies on comprehensive HIV/AIDS knowledge and testing in SSA have focused on women (e.g. Teshome *et al.*, 2016; Yaya *et al.*, 2016; Sheikh *et al.*, 2017; Darteh, 2020), students (e.g. Agha, 2012; Asante, 2013; Oljira *et al.*, 2013; Kejela *et al.*, 2015), youth or adolescents (e.g. Ziraba *et al.*, 2011; Asaolu *et al.*, 2016; Chikwari *et al.*, 2018) and men who have sex with men (e.g. Sorensen *et al.*, 2012). Thus, there is a paucity of literature on the association between comprehensive HIV/AIDS knowledge and testing among the general male population in SSA. Therefore, this study focuses generally on the association between comprehensive HIV/AIDS knowledge and HIV testing among men in SSA. Understanding the association between comprehensive HIV/AIDS knowledge and HIV testing is important in identifying targeted areas for HIV/AIDS education and testing strategies that could potentially increase HIV testing uptake among men in SSA and contribute to the realization of the global HIV/AIDS target of 95-95-95 by 2030.

Methods

Theoretical model

The study was guided by the Knowledge, Attitude and Practice (KAP) survey model adapted from Muleme *et al.* (2017). This model states that an individual's knowledge could be influenced by socio-demographic factors that affect their attitude, which then becomes an incentive or a

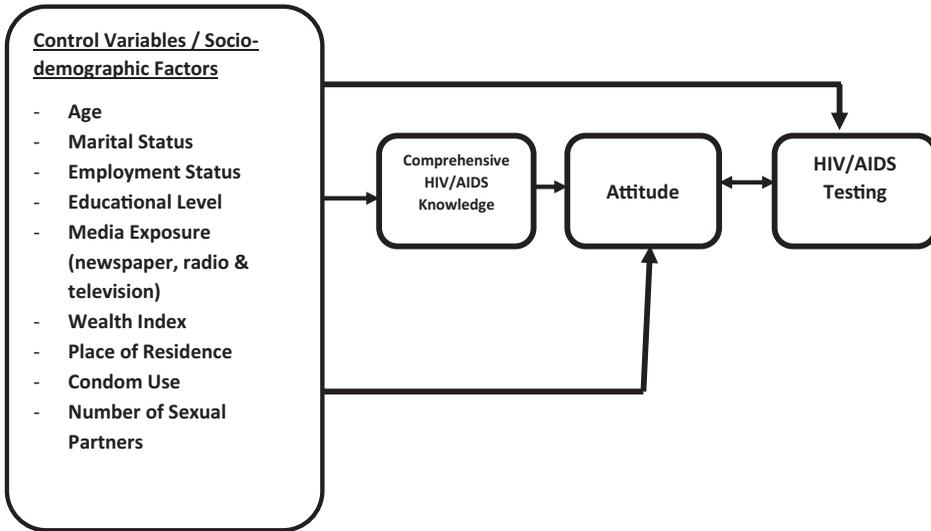


Figure 1. Knowledge, attitude and practice theoretical model; adapted from Muleme *et al.* (2017).

disincentive to practice (behaviour). The assumption here, based on previous studies (Asaolu *et al.*, 2016; Seidu *et al.*, 2020), was that those with comprehensive HIV/AIDS knowledge would be more likely to test for their HIV/AIDS status. Furthermore, it was recognized that comprehensive HIV/AIDS knowledge and testing could be influenced by socio-demographic factors, including age, marital status, employment status, educational level, exposure to newspapers, exposure to radio, exposure to television, wealth index, place of residence, condom use and multiple sexual partners, as reported in the literature (Ziraba *et al.*, 2011; Agha, 2012; Teshome *et al.*, 2016; Yaya *et al.*, 2016; Agegnehu *et al.*, 2020; Kefale *et al.*, 2020). Figure 1 shows the theoretical associations between the outcome, independent and control variables employed in the study.

Data source

The study used data from the most recent (2010–2019) Demographic and Health Surveys (DHS) of 29 sub-Saharan African countries – specifically, the men’s recode files. The DHS is a nationally representative survey conducted in over 85 low- and middle-income countries. It focuses on essential markers, including breastfeeding, fertility, family planning, immunization, HIV/AIDS, child health and nutrition (Corsi *et al.*, 2012). The survey employs a two-stage stratified sampling technique, which makes the data nationally representative. The study by Aliaga and Ruilin (2006) provides details of the sampling process. A total of 104,398 men who had complete information on all the variables of interest were included in the current study. The Strengthening the Reporting of Observational Studies in Epidemiology’ (STROBE) statement was consulted during the writing of the manuscript (Von Elm *et al.*, 2014). The dataset is freely available for download at: <https://dhsprogram.com/data/available-datasets.cfm>.

Definition of variables

Outcome variable

The outcome variable was HIV testing, which was derived from the question ‘Have you ever tested for HIV?’ Responses were ‘Yes’ and ‘No’, coded as ‘No’=0 and ‘Yes’=1.

Explanatory variable

Comprehensive HIV/AIDS knowledge was used as the main explanatory variable. This was defined as knowing that consistent use of condoms during sexual intercourse, and having just one uninfected faithful partner, can reduce the chance of getting an HIV infection; knowing that a healthy-looking person can have the AIDS virus; and rejecting the two most common local misconceptions about AIDS transmission or prevention (i.e. via mosquito bites or witchcraft/supernatural means). Comprehensive HIV knowledge was dichotomously coded 'Yes' = 1 and 'No' = 0. An index was created based on the correct answers to the preceding questions (Darteh, 2020; Frimpong *et al.*, 2021).

Control variables

Eleven control variables were considered in the study, broadly grouped into individual level and contextual level variables. The individual level variables included age, employment status, marital status, educational level, exposure to newspapers, exposure to radio, exposure to television, condom use and number of sexual partners. The contextual level factors included wealth quintile and type of place of residence. These variables were not determined *a priori*; instead, they were based on parsimony, theoretical relevance and practical significance with HIV testing (Yaya *et al.*, 2016; Agegnehu *et al.*, 2020; Kefale *et al.*, 2020).

Statistical analyses

The data were analysed with Stata version 14.0. The analysis was done in three steps. The first step was the graphical computation of the prevalence of HIV testing and comprehensive HIV/AIDS knowledge among men in SSA. The second step was a bivariate analysis, which calculated the proportions of HIV testing across the explanatory and control variables with their significance levels (Table 1). To check for a high correlation among the explanatory and control variables, a test for multicollinearity was carried out using the variance inflation factor (VIF) and the results showed no evidence of high collinearity (Mean VIF=1.41, Maximum VIF=1.69, and Minimum VIF=1.06).

All the variables that showed statistical significance from the Table 1 were moved to a multi-level logistic regression analysis. Five models were used to present the results (Model 0, Model I, Model II, Model III, Model IV). Model 0 was the empty model that had no explanatory or control variables. Model I had only the key explanatory variable. Model II had the individual-level control variables. Model III had the contextual-level control variables. Model IV had the explanatory variable and all the control variables. However, the results for Models 0, I and IV are presented. The multilevel logistic regression analysis comprised fixed effects and random effects (Austin & Merlo, 2017). The results of the fixed effects of the models were presented as Adjusted Odds Ratios (AORs) while the random effects were assessed with intra-cluster correlation (ICC) (Merlo *et al.*, 2016). Model comparison was done using the log-likelihood ratio (LLR) and Akaike's Information Criterion (AIC) test. The highest log-likelihood and the lowest AIC were used to determine the best-fit model (see Table 2). All frequency distributions were weighted (v005/1000000) while the survey command *svy* in Stata was used to adjust for the complex sampling structure of the data in the regression analyses.

Results

Figure 2 presents the prevalence of HIV testing among men in the 29 sub-Saharan African countries. On the average, the prevalence of HIV testing was 53.5% in SSA. Rwanda and Niger recorded the highest (93.6%) and lowest prevalences (9.8%) respectively. The prevalence of comprehensive HIV/AIDS knowledge among men in the 29 countries was 50.8%, with the highest in Rwanda (76.4%) and the lowest in Benin (31.1%) (Figure 3).

Table 1. Description of study sample

Country	Survey years	Weighted <i>n</i>	Weighted %
Burkina Faso	2010	4753	4.55
Benin	2017–18	4038	3.87
Burundi	2016–17	4205	4.03
Congo DR	2013–14	5097	4.88
Congo	2011–12	3558	3.41
Cote D'Ivoire	2011–12	2877	2.76
Cameroon	2011	4136	3.96
Ethiopia	2008	6309	6.04
Gabon	2012	3730	3.57
Ghana	2014	2701	2.59
Gambia	2013	1526	1.46
Guinea	2018	1611	1.54
Kenya	2014	8758	8.41
Comoros	2012	1302	1.03
Mali	2018	2523	2.42
Malawi	2015–16	5319	5.09
Mozambique	2015	3325	3.18
Niger	2013	1965	1.88
Namibia	2013	2701	2.59
Rwanda	2014–15	3612	3.47
Sierra Leone	2013	3665	3.51
Senegal	2010–11	1929	1.85
Chad	2014–15	1742	1.67
Togo	2013–14	2632	2.52
Uganda	2016	3419	3.28
Zambia	2018–19	8004	7.67
Zimbabwe	2015	5263	5.04

Table 2 presents the prevalences of HIV testing by the explanatory and control variables. The majority (62.5%) of men who had comprehensive knowledge of HIV/AIDS presented themselves for testing compared with only 44.3% of men who had no comprehensive HIV/AIDS knowledge. HIV testing was highest among men in the age group 30–34 (59.4%), those who were not working (54.3%) and who were cohabiting (55.6%). Men with secondary education (61.3%), the richest (65.6%), those residing in urban areas (59.7%), those exposed to newspapers almost every day (82.3%), those exposed to radio almost every day (81.4%), and those exposed to television almost every day (72.6%) had the highest proportions of HIV testing. Men who used condoms and those who had multiple sexual partners had slightly higher proportions testing for HIV (60.9% and 60.8% respectively).

Table 2. HIV testing by explanatory variables (*N*=104,398 weighted)

Variable	Weighted <i>n</i>	Weighted %	HIV testing	<i>p</i> -value
Comprehensive HIV/AIDS knowledge				<0.001
No	48,511	49.3	44.3	
Yes	55,887	50.7	62.5	
Age (years)				<0.001
15–19	7933	7.6	32.4	
20–24	15,357	14.7	51.5	
25–29	17,735	17.0	58.8	
30–34	16,721	16.0	59.4	
35–39	14,571	14.0	56.8	
40–44	12,050	11.5	56.2	
45–49	9314	8.9	52.0	
50–54	6703	6.4	51.1	
55+	4015	3.9	43.1	
Employment status				<0.001
Working	9319	8.9	45.3	
Not working	95,079	91.1	54.3	
Marital status				<0.001
Not married	25,774	24.7	47.4	
Married	61,909	59.3	55.2	
Cohabiting	12,645	12.1	55.6	
Other	4071	3.9	60.1	
Educational level				<0.001
No education	19,501	18.7	25.4	
Primary	32,773	31.4	57.9	
Secondary+	52,124	49.9	61.3	
Wealth Index				<0.001
Poorest	15,548	18.9	41.4	
Poorer	18,667	17.9	46.4	
Middle	20,084	19.2	51.2	
Richer	22,821	21.9	56.2	
Richest	27,277	26.1	65.6	
Place of residence				<0.001
Urban	43,232	41.4	59.7	
Rural	61,166	58.6	49.2	
Exposure to newspapers				<0.001
Not at all	64,469	61.8	45.5	

(Continued)

Table 2. (Continued)

Variable	Weighted <i>n</i>	Weighted %	HIV testing	<i>p</i> -value
Less than once a week	17,888	17.1	62.9	
At least once a week	20,563	19.7	68.4	
Almost every day	1478	1.4	82.3	
Exposure to radio				<0.001
Not at all	22,438	21.5	44.2	
Less than once a week	19,228	18.4	49.8	
At least once a week	58,371	55.9	56.3	
Almost every day	4361	4.2	81.4	
Exposure to television				<0.001
Not at all	44,382	42.5	45.9	
Less than once a week	18,223	17.5	43.4	
At least once a week	36,299	34.8	60.0	
Almost every day	5494	5.3	72.6	
Condom use				<0.001
No	80,541	77.1	51.3	
Yes	23,857	22.9	60.9	
Multiple sexual partners				<0.001
No	64,661	61.9	54.6	
Yes	39,737	38.1	61.8	

Multilevel logistic regression results on determinants of HIV testing among men in sub-Saharan Africa

Fixed effects results

Table 3 presents the multilevel logistic regression results on the determinants of HIV testing among men in SSA. Men who had no comprehensive HIV/AIDS knowledge were less likely to test for HIV compared with their counterparts who had comprehensive HIV/AIDS knowledge (AOR=0.59, CI: 0.57–0.60). With the covariates, age, employment status, marital status, educational level, wealth index, exposure to newspapers, exposure to radio, exposure to television, condom use, having multiple sexual partners, and place of residence were associated with HIV testing (Model IV).

Random effects results

The random effects results indicated a substantial variation in HIV testing among men in SSA across the PSUs without the explanatory and control variables, as shown in Model 0 ($\sigma^2=0.35$; 95% CI=0.30–0.41). The ICC value showed that about 10% (ICC=0.09) of the total variance was attributable to the clustering at the contextual level. The variations changed with the inclusion of key explanatory, individual and community level variables, and all explanatory variables. The AIC values showed variations in model fitness from one model to another. However, the final model, which had all the explanatory variables, was considered the best-fit model since it had the lowest AIC (Table 3).

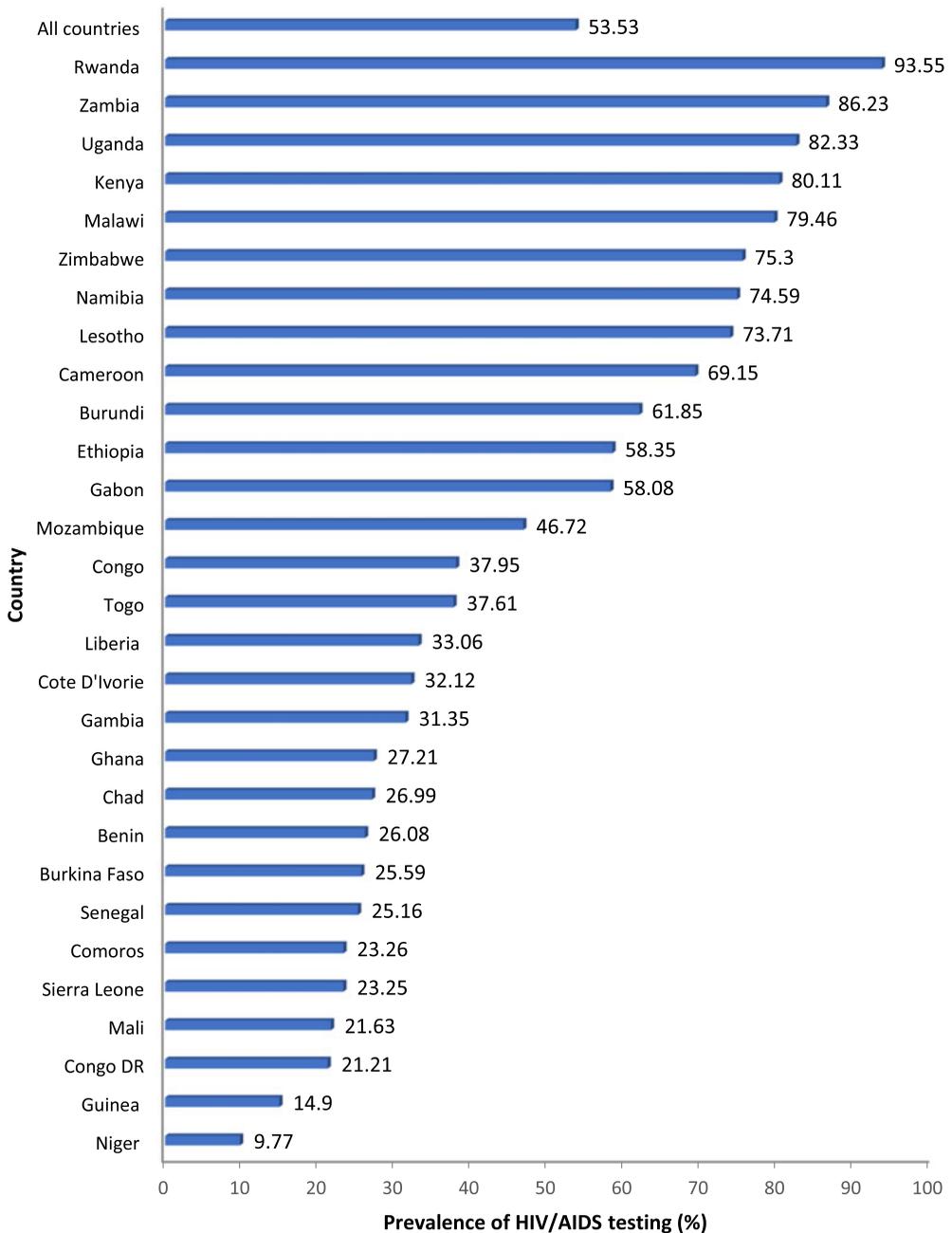


Figure 2. Prevalences of HIV testing among men in 29 countries in sub-Saharan Africa.

Discussion

This study investigated the association between comprehensive HIV and AIDS knowledge and HIV testing among men in 29 sub-Saharan African countries using DHS data. The prevalences of comprehensive HIV/AIDS knowledge and HIV testing among men in SSA were found to be 50.3% and 53.5%, respectively, which are lower than the UNAIDS target of 95% by 2030

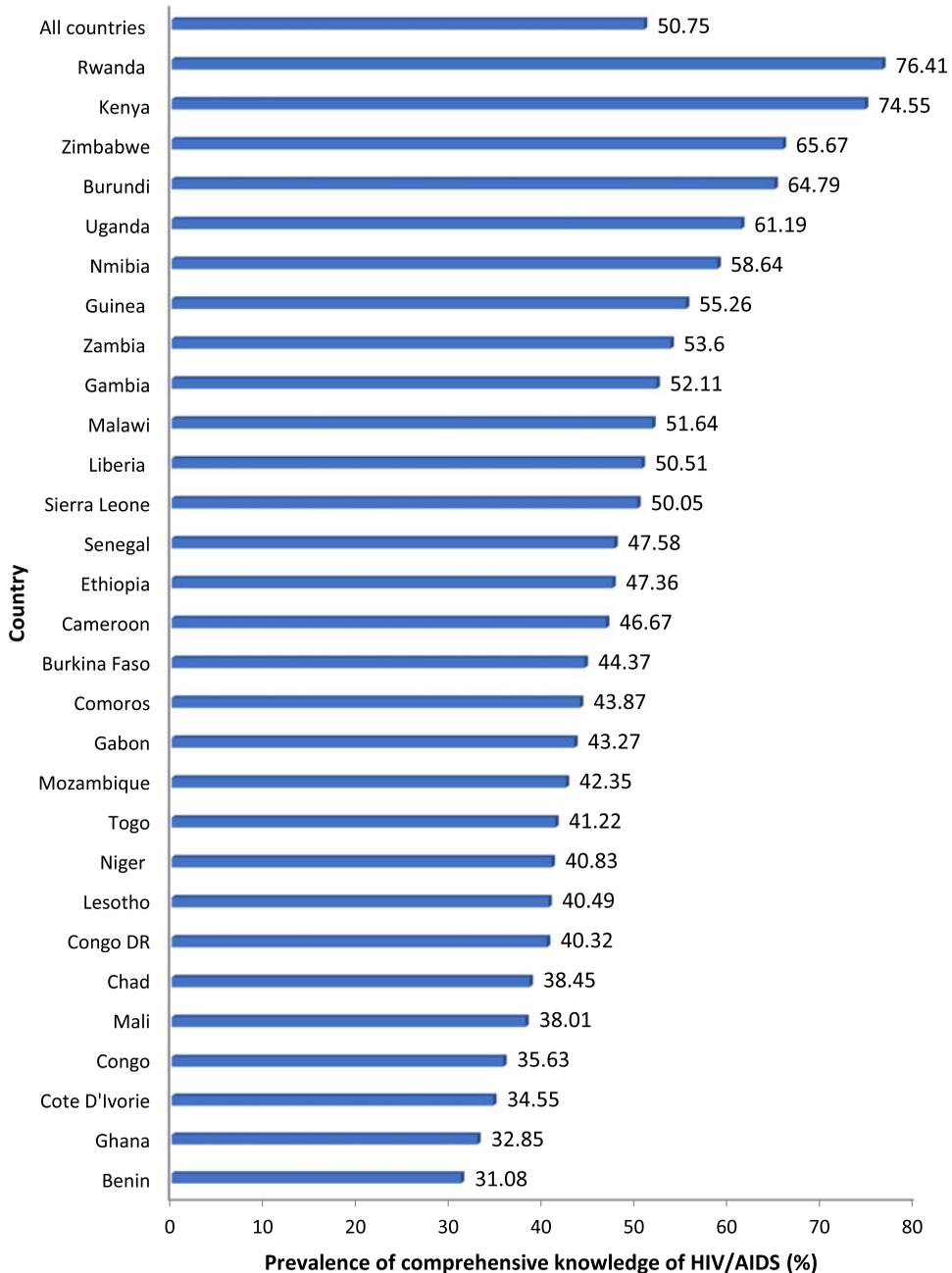


Figure 3. Prevalences of comprehensive knowledge of HIV/AIDS among men in 29 countries in sub-Saharan Africa.

(United Nations General Assembly, 2016). The study also found that comprehensive HIV/AIDS knowledge, age, employment status, marital status, educational level, wealth index, exposure to newspapers, exposure to radio, exposure to television, condom use, having multiple sexual partners and place of residence were associated with HIV testing.

The finding that Rwanda, Uganda, Kenya, and Malawi recording the highest prevalences of HIV testing among men in SSA, and Niger, Guinea, Congo DR, and Mali recorded the lowest

Table 3. Multilevel logistic regression results on the determinants of HIV testing among men in sub-Saharan Africa

Variable	Model 0	Model I	Model IV
Comprehensive HIV/AIDS knowledge			
No		0.47*** (0.46–0.48)	0.59*** (0.57–0.60)
Yes (Ref.)		1	
Age (years)			
15–19			0.39*** (0.36–0.42)
20–24			0.77*** (0.73–0.81)
25–29 (Ref.)			
30–34			1.01 (0.96–1.06)
35–39			0.91*** (0.82–0.91)
40–44			0.86*** (0.82–0.91)
45–49			0.77*** (0.73–0.82)
50–54			0.76*** (0.72–0.81)
55+			0.63*** (0.58–0.68)
Employment status			
Working			0.84*** (0.80–0.88)
Not working (Ref.)			
Marital status			
Not married			0.56*** (0.53–0.60)
Married (Ref.)			
Cohabiting			0.89*** (0.85–0.93)
Other			0.87*** (0.80–0.94)
Educational level			
No education			0.30*** (0.29–0.31)
Primary			1.08*** (1.05–1.12)
Secondary+ (Ref.)			
Exposure to newspapers			
Not at all (Ref.)			
Less than once a week			1.29*** (1.24–1.34)
At least once a week			1.44*** (1.38–1.50)
Almost every day			2.05*** (1.72–2.43)
Exposure to radio			
Not at all (Ref.)			
Less than once a week			1.00(0.96–1.05)
At least once a week			1.05***(1.01–1.09)
Almost every day			2.71*** (2.47–2.98)

(Continued)

Table 3. (Continued)

Variable	Model 0	Model I	Model IV
Exposure to television			
Not at all (Ref.)			
Less than once a week			1.14*** (1.10–1.19)
At least once a week			1.15*** (1.11–1.20)
Almost every day			1.39*** (1.27–1.51)
Condom use			
No (Ref.)			
Yes			1.87*** (1.80–1.95)
Multiple sexual partners			
No (Ref.)			
Yes			1.87*** (1.80–1.95)
Wealth Index			
Poorest			0.48*** (0.84–0.92)
Poorer			0.57*** (0.54–0.60)
Middle			0.64*** (0.61–0.67)
Richer			0.73*** (0.70–0.76)
Richest (Ref.)			
Place of residence			
Urban			0.84*** (0.81–0.87)
Rural (Ref.)			
Random effect result			
PSU variance (95% CI)	0.35 (0.30–0.41)	0.25 (0.21–0.30)	0.18 (0.15–0.21)
ICC	0.0953595	0.0710073	0.0508952
LR test	$\chi^2=1464.76$	$\chi^2=1095.34$	$\chi^2=769.02$ ***
Wald χ^2		3427.62	13802.05***
Model fitness			
Log-likelihood	-71,384.664	-69,646.259	-62,906.679
AIC	142,773.3	139,298.5	125,879.4
N	104,398	104,398	104,398
Number of clusters	1595	1595	1595

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Ref.=Reference category; PSU: Primary Sampling Unit; ICC=Intra-Class Correlation; AIC=Akaike's Information Criterion.

Model 0=empty model with no explanatory variables; Model I=model with only the key explanatory variable; Model IV=model with the key explanatory variable and the control variables.

prevalences, is consistent with the findings of a previous cross-sectional study in SSA (Staveteig *et al.*, 2013). The disparities in prevalence of HIV testing among countries in SSA could be the result of disparities in programmes adopted by each country to deal with HIV/AIDS. Rwanda for example, implemented an extensive HIV/AIDS comprehensive education programme in 1986 using the radio and public health educators (Allen *et al.*, 1991), and launched the 'treat all

programme' in the early 2000s, later restructured (in 2016) by the Rwandan Ministry of Health to make testing cheap and more easily accessible and put all those who tested positive on treatment immediately. These, coupled with previous successes that have seen over 99% of health facilities in Rwanda providing HIV testing services, have all contributed to the higher comprehensive HIV/AIDS Knowledge and HIV testing prevalence in Rwanda than in other countries, such as Congo DR; this is reported to be challenged with lack of HIV testing services and inadequate testing centres, which could be a plausible explanation for its low HIV testing (Carlos *et al.*, 2015; Nsanzimana *et al.*, 2015; UNAIDS, 2017).

In general, the reason for the increase in HIV testing among men in SSA from 22.8% reported by Staveteig *et al.* (2013) to 53.5% reported in the present study could be the general scaling up and implementation of the UNAIDS 90:90:90 programme in SSA, which sought to achieve by 2020 (90% of people living with HIV/AIDS knowing their status, 90% of people who know their status having access to antiretroviral therapy and at least 90% of people on treatment having a suppressed viral load) (Piot *et al.*, 2015; Maheu-Giroux *et al.*, 2019). Notwithstanding this, there is the need for SSA countries to further develop pragmatic health strategies (such as self-testing and mobile or workplace testing) and comprehensive education on the need to test for HIV/AIDS as this will help attain the United Nations goal of achieving 95-95-95 by the year 2030.

The literature suggests that comprehensive knowledge of HIV/AIDS leads to positive behavioural attitudes, which in turn lead to a reduced risk of infection (Seidu *et al.*, 2020). It is, therefore, not surprising to find that men who had no comprehensive HIV/AIDS knowledge also had lower odds of testing for HIV compared with their counterparts who had comprehensive knowledge, and this supports the findings of a previous study among youths in SSA by Asaolu *et al.* (2016).

Corroborating the findings of previous studies (Staveteig *et al.*, 2013; Asaolu *et al.*, 2016), this study found that men aged 15–19 years had lower odds of testing for HIV compared with those aged 25–29 years. A plausible reason for this could be that younger males are mostly dependent on their parents and may lack the decision-making power and the financial capability to go for HIV testing. Also, their unwillingness to go for testing may be as a result of fear, anxiety or stigma (Asante, 2013). Programmes to scale up HIV testing should therefore consider conducting periodic and mandatory HIV testing for younger men in educational settings.

This study found that those who were working had lower odds of testing for HIV, unlike the study by Kefale *et al.* (2020). A plausible reason for this finding could be that workers may have difficulty absenting themselves from work and find the time to spend at health centres or hospitals to test for HIV. Policymakers therefore need to intensify the provision of rapid diagnostic tests, self-test gadgets and mobile health vans to bring HIV testing to the doorstep of men, especially the working population in the sub-Saharan African region.

In support of findings of previous studies (Ziraba *et al.*, 2011; Agha, 2012), this study found that those who were not married had the lowest odds of testing for HIV. The common practice of premarital HIV testing in many sub-Saharan African countries could be the plausible reason behind this finding. Previous studies have highlighted how HIV testing is often made mandatory for people preparing to marry in some SSA countries, including Nigeria, Ethiopia, and Cameroon so most married men have already tested for HIV (Arulogun & Adefioye, 2010; Akoku *et al.*, 2018; Ahmed & Seid, 2020).

Findings from previous studies (Teshome *et al.*, 2016; Yaya *et al.*, 2016; Sheikh *et al.*, 2017; Agegnehu *et al.*, 2020) support the present finding that those with no education had the lowest odds of testing for HIV. A plausible reason for this is that people who are educated may have greater access to information on HIV testing, as well as how and where to get tested, than those who have no formal education (Agegnehu *et al.*, 2020; Kefale *et al.*, 2020). Another likely explanation is that individuals who have no education may lack the ability to understand the need to test for HIV (Kefale *et al.*, 2020). Also, people who are educated may possibly get their knowledge on HIV testing from school-based HIV/AIDS prevention programmes (Kefale *et al.*, 2020). There is the need to design public health interventions, such as creating more community health posts

and information centres where less-educated individuals could be educated on the virus and the lifetime and economic consequences of HIV/AIDS and the importance of testing for HIV.

Furthermore, corroborating other previous studies (Yaya *et al.*, 2016; Agegnehu *et al.*, 2020; Kefale *et al.*, 2020), the study found that men who were exposed to newspapers, radio, and television almost every day were more likely to test for HIV. A possible reason for this could be that those who are exposed to mass media may be exposed to educative contents that aids their understanding of HIV/AIDS, especially with its mode of acquisition and spread, available testing options and living with the virus (Kefale *et al.*, 2020). This highlights the importance of education through mass media as a tool to significantly improve the prevalence of HIV testing in sub-Saharan African countries. The finding that men who used condoms, and also men who had multiple sexual partners, were more likely to test for HIV supports the findings of a previous cross-sectional study in Mozambique by Agha (2012). A possible reason for this is that men who use condoms and have multiple sexual partners are aware that they may be more exposed to HIV/AIDS, and hence their willingness to go for an HIV test.

Akin to other previous studies (Agegnehu *et al.*, 2020), the study found that men in the poorest wealth quintile had the lowest odds of testing for HIV. A possible reason for this could be that poor individuals may not be able to afford the transport costs to and from health service centres for HIV testing since these are often located far away in sub-Saharan African countries (Agha, 2012). The scaling up of self-testing and the deployment of cheap rapid diagnostic/testing kits in all parts of SSA to enable individuals to conduct their own HIV test, coupled with strategies to either reduce transport costs or provide free transport to and from health service centres for HIV testing in sub-Saharan African countries, could be steps in the right direction to improve HIV testing among the poor individuals in the communities.

Research has shown that urban residents are more likely to have adequate knowledge of HIV/AIDS and have the self-efficacy to adhere to HIV/AIDS education and test for HIV (Yaya *et al.*, 2016; Kefale *et al.*, 2020). Surprisingly, the present study found that those residing in urban areas were less likely to test for HIV compared with those in rural areas. This finding contradicts the finding of previous studies (Yaya *et al.*, 2016; Kefale *et al.*, 2020). A possible reason for this could be the variations in geographical location, socio-cultural, and socioeconomic characteristics of the study areas.

The study had its strengths and limitations. Its main strength was its use of nationally representative data from 29 sub-Saharan African countries. The data collection technique and methodology employed by the DHS followed best practice by experienced and well-trained data collectors, resulting in a high response rate. The findings of this study can, therefore, be generalized to all men in SSA. Advanced statistical models that accounted for both individual and contextual factors were also employed. However, the study followed a cross-sectional study design and as such it was not possible to account for unobserved heterogeneity; causal interpretation cannot be deduced from the study findings. Also, the relationships established between the explanatory and dependent variables may vary over time.

In conclusion, after controlling for confounding factors, men in SSA with comprehensive knowledge of HIV/AIDS were found to be more likely to test for HIV compared with their counterparts who had no comprehensive knowledge of HIV/AIDS. To improve HIV testing among men in SSA as a crucial step towards the eradication of the virus and the attainment of the 95-95-95 by 2030 global target, this study recommends that policymakers and all stakeholders in SSA step up comprehensive HIV/AIDS knowledge education while ensuring that HIV testing services are cheap and easily accessible through the provision of self-testing kits and mobile or workplace testing programmes. Mass media could be key to facilitating this.

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