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Undisclosed HIV infection and ART use in the Kenya AIDS Indicator Survey 2012: relevance to targets for HIV diagnosis and treatment in Kenya

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Abstract

Objectives: To assess the impact of undisclosed HIV infection and antiretroviral (ARV) therapy (ART) on national estimates of diagnosed HIV and ART coverage in Kenya.

Methods: HIV-positive dried blood spot samples from Kenya's second AIDS Indicator Survey were tested for an ARV biomarker by liquid chromatography-tandem mass spectrometry. Estimates of diagnosed HIV and ART use based on self-report were compared with those corrected for undisclosed HIV infection and ART use based on ARV testing. Multivariate analysis determined factors associated with undisclosed HIV infection and ART use among persons on ART.

Results: Among 559 HIV-positive samples, the ARV biomarker was detected in 42.5% (CI 37.4–47.7). ARV drugs were present in 90.7% (CI 86.1–95.2) reporting HIV-positive status and receiving ART, 66.7% (CI 59.9–73.4) reporting HIV-positive status irrespective of ART use, 21.0% (CI 13.4–28.6) reporting HIV-negative status, and 19.3% (CI 9.0–29.5) reporting no previous HIV test. After correcting for undisclosed HIV infection and ART use, diagnosed HIV increased from 46.9% to 57.2% and ART coverage increased from 31.8% to 42.8%. Undisclosed HIV infection on ART was associated with being aged 25–39 years and not visiting a health

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provider in the past year, while younger age and higher wealth was associated with undisclosed ART use.

Conclusion: Substantial levels of undisclosed HIV infection and ART use while on ART were observed, resulting in diagnosed HIV underestimated by 112,000 persons and ART coverage by 131,000 persons. Supplementing self-reported ART status with objective measures of ART use in national population-based sero-surveys can improve monitoring of treatment targets in countries.

Keywords

HIV diagnosis; antiretroviral therapy; viral load; self-reported data; HIV surveillance; sub-Saharan Africa; Kenya

Introduction

Reliable estimates of HIV diagnosis and access to antiretroviral (ARV) therapy (ART) among persons living with HIV (PLHIV) are needed to monitor progress towards fast-track targets set by the Joint United Nations Programme on HIV/AIDS (UNAIDS) to control the HIV pandemic by 2030 [1]. Nationally representative HIV sero-surveys provide insight on progress through collection of population-based information on HIV status and coverage of HIV services among HIV-infected persons. In combination with biomarkers, this allows for the assessment of trends in the continuum of care among PLHIV, from HIV diagnosis, linkage to care, ART initiation, to viral suppression. Robust estimates of these indicators, however, rely on participants answering questions related to HIV status and access to services accurately during an interview.

The Kenya AIDS Indicator Survey (KAIS) 2012 was a national sero-survey that linked information on demographics, behavior, and access to health services to HIV-related biomarkers to monitor the impact of the national HIV response. The criteria for ART initiation at the time of the survey included persons with CD4 counts ≥ 350 cells/mm³, or, irrespective of CD4 count, persons with WHO clinical stage 3/4 disease, persons with active tuberculosis co-infection, or persons with Hepatitis B virus co-infection with evidence of liver disease [3]. In 2012, the national ART program reported that 549,000 HIV-infected adults were receiving ART, representing 78% of ART-eligible adults living with HIV infection in Kenya [4].

In KAIS 2012, 23% of persons who reported HIV-positive status with no history of ART use were virally suppressed (unpublished data). This finding was surprising given that the control of viral replication in the absence of treatment is considered rare [5,6]. This phenomenon was documented in other epidemiological surveys and clinical trials that later confirmed that underreporting of ART use in these studies resulted in higher than expected levels of viral suppression among PLHIV who reported being treatment naïve [7–11]. The parallel finding in KAIS 2012 raised concerns that some respondents may have misreported their ART status resulting in an underestimate of ART coverage measured from the survey.

Testing HIV-positive blood for the presence of ARV metabolites provides a direct biomedical measure to improve estimates of ART coverage, and, by extension, estimates of

diagnosed HIV among PLHIV. Such data remain important for clinical trials that enroll participants based on no prior history of HIV treatment and population-based surveys that are designed to generalize levels of undiagnosed HIV, ART access, and viral suppression in the population. In this analysis we assess the level of undisclosed HIV infection and ART use among persons with the ARV biomarker in KAIS 2012 and impact on national estimates of coverage of diagnosed HIV and ART use.

Methods

KAIS 2012 was a nationally representative household survey of persons aged 18 months to 64 years [12,13]. Survey respondents were administered face-to-face interviews that collected information on demographics, sexual behavior, HIV testing history, HIV status, and receipt of health interventions, including ART for persons who reported HIV-positive status. Venous blood samples were collected in CD4 stabilization tubes which were used to prepare dried blood spot (DBS) cards in a field laboratory. Respondents were offered on-site rapid HIV testing based on national guidelines [14], and results were returned immediately with counselling by trained staff in a private area in the home.

Blood samples were transported to a central laboratory where DBS were tested for HIV-1 antibodies using Vironostika HIV-1/2 UNIF II Plus O enzyme immunoassay (EIA) (sensitivity/specificity=100%) and Murex HIV.1.2.0 EIA (sensitivity=100%; specificity=99.5%) [5–16]. CD4 counts were measured using the BD FACSCalibur flow cytometer (Becton Dickinson Biosciences, San Jose, CA). HIV-positive DBS were tested for HIV-1 RNA concentration (Abbott M2000 Real-Time HIV-1 Assay, Abbott Laboratories, Abbott Park, IL). Undetectable viral load was defined as HIV-1 RNA concentration <1,000 copies/mL. Remnant DBS samples were stored in –70°C freezers for future testing. Two years after survey completion, HIV-positive DBS were shipped to the University of Cape Town in South Africa where a qualitative ARV assay was applied to test for nevirapine (NVP), efavirenz (EFV), lamivudine (3TC), and lopinavir (LPV) using liquid chromatography-tandem mass spectrometry (LC/MS/MS) [17]. The assay's lower limit of detection (LLD) was 0.02 µg/mL. The number of days post ingestion to the LLD was 12–28 days for EFV, 8–9 days for NVP, 1.5 days for 3TC, and 1.5–2.5 days for LPV. Samples that fell above this threshold for any of the ARV drugs tested were classified as having the ARV biomarker present. Though validation studies assessing the performance of DBS on the qualitative assay have yet to be conducted, a validation study that compared the performance of quantitative measurement of ARV drug levels in plasma and DBS using LC/MS/MS found no major differences [18]. In 2012, the first-line standardized ARV regimen for Kenyan adults was tenofovir (TDF) + lamivudine (3TC) + efavirenz (EFV) or nevirapine (NVP) and second-line regimen was zidovudine (AZT) + 3TC + lopinavir/ritonavir (LPV/r) [3]. For pregnant women or patients intolerant to TDF, the recommended first-line regimen was AZT + 3TC + EFV/NVP.

Measures

The primary outcomes of interest were undisclosed HIV infection and undisclosed ART use while on ART. We categorized self-reported HIV status into five categories: HIV-positive,

HIV-negative, HIV-indeterminate, never tested for HIV, and unknown self-reported HIV status (i.e., persons who reported testing for HIV but did not provide a result). HIV-infected persons who reported HIV-positive status were classified as having disclosed HIV infection while HIV-infected persons with the ARV biomarker who reported HIV-negative, HIV-indeterminate, never tested for HIV, or had unknown self-reported status were classified as having undisclosed HIV infection while on ART. Persons who reported ART use, irrespective of ARV test results, were classified as having disclosed ART use. Respondents with the ARV biomarker who: 1) reported HIV-positive status with no history of ART use or 2) reported HIV-negative, HIV-indeterminate, never tested for HIV, or unknown self-reported status were classified as having undisclosed ART use while on ART.

Explanatory variables tested for potential associations with the outcomes of interest included demographic variables: sex, age, marital status, education, wealth, urban/rural residence, and region; behavioral variables: number of sexual partners in the past year, condom use, and knowledge of partner HIV status; and clinical variables: history of visiting a health provider in the past year, history of tuberculosis disease, undetectable viral load, and median CD4 count.

Analysis

We restricted the analysis to respondents aged 15–64 years who tested HIV-positive in the survey with sufficient volume of blood available in DBS for ARV testing. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of self-reported ART status compared to ARV biomarker results was assessed. The Rao-Scott χ^2 test was used to measure associations between categorical variables and outcomes of interest in bivariate analysis. Medians and interquartile ranges (IQR) were reported for continuous variables. The Wilcoxon rank sum test was used to measure the association between continuous variables and the outcome variables. We used PROC SURVEYLOGISTIC in SAS version 9.3 (SAS Institute, Inc., Cary NC) to determine independent and significant correlates of undisclosed HIV infection and ART use among persons on ART in multivariate logistic regression. The model included variables that were associated with the outcomes of interest in bivariate analysis at a p-value <0.2. Associations were considered statistically significant if the 95% confidence interval (CI) for the adjusted odds ratio (AOR) did not include 1.0. All estimates presented were weighted to account for sampling probability and survey nonresponse.

In a sub-analysis we compared national estimates of diagnosed HIV and ART coverage based on: 1) self-report; 2) self-report corrected for undisclosed HIV and ART use among persons on ART; and, 3) for comparison of ART coverage estimates only, treatment coverage based on national ART program data. We extrapolated national population counts of the number of diagnosed PLHIV and the number of PLHIV on ART by applying non-normalized survey weights based on the 2012 projected population data in the 2009 Kenya Population and Housing Census to the outcome variables [19].

For programmatic estimates of ART coverage, Spectrum version 5.31 (Avenir Health, Glastonbury, Connecticut) was used to project estimates of the number of PLHIV aged 15 years and older from 1970 to 2020 [2]. The number of adult ART patients in 2012 was based

on ARV drug dispensing data from Kenya's Logistics Management Information System. Programmatic ART coverage was calculated by dividing the number of adult ART patients by the projected number of adult PLHIV from Spectrum. Plausibility bounds around programmatic ART coverage were calculated using an uncertainty analysis which applied Monte Carlo simulations to estimate the impact of uncertainty in modeled HIV incidence and model assumptions [20,21]. A z-test was conducted to test for differences in ART coverage by estimation method.

Results

Overall, 648 of 11,626 respondents tested HIV-positive (Figure 1). Of those, 559 (86.3%) had sufficient volume available in stored DBS for ARV testing. No statistically significant differences in sex, age, urban/rural residence, region, marital status, education, or wealth were found among HIV-positive respondents with ARV test results compared to HIV-positive respondents without these results. Among the 559 individuals with ARV test results, 271 (47.7%; CI 41.8–53.6) reported HIV-positive status, 202 (35.9%; CI 31.0–40.9) reported HIV-negative status, 7 (1.0%; CI 0–2.0) reported HIV-indeterminate status, 18 (3.1%; CI 1.5–4.8) had unknown self-reported status, and 61 (12.2%; CI 8.9–15.6) reported that they had never tested for HIV. Among respondents who disclosed HIV infection (n=271), 186 (69.1%; CI 62.3–76.0) reported receiving ART.

Presence of the ARV biomarker

Among the 559 HIV-positive DBS tested for ARV drugs, at least one drug was detected in 235 specimens, representing 42.5% (CI 37.4–47.7) of HIV-positive persons. Among those, 3TC was detected in 94.5% (CI 91.3–97.8), NVP in 62.9% (CI 55.9–69.9), EFV in 34.0% (CI 27.1–40.9), and LPV in 3.9% (CI 0.8–7.0).

Among persons who disclosed HIV infection (n=271), 180 (66.7%; CI 59.9–73.4) had detectable ARVs (Figure 2) while those who disclosed both HIV infection and ART use (n=186) had ARVs detected in 168 (90.7%; CI 86.1–95.2). Among persons who disclosed HIV infection but did not disclose using ART (n=85), 12 (12.9%; CI 5.2–20.6) had ARVs detected.

A total of 202 HIV-infected persons reported HIV-negative status. Of those, 38 (21.0%; CI 13.4–28.6) had the ARV biomarker, and 26 (61.7%; CI 43.0–80.5) of those reported receiving their last HIV-negative result within the year preceding the survey. Among HIV-infected persons who reported never testing for HIV (n=61), 8 (12.8%; CI 3.3–22.3) had the ARV biomarker present. A minority of persons reported that their last HIV test was indeterminate (n=7) or reported an unknown HIV serostatus (n=18). Of those, the ARV biomarker was present in 13.4% (CI 0–41.1) and 46.5% (CI 20.4–72.7), respectively. Among all persons with the ARV biomarker (n=235), 18.3% (CI 12.7–24.0) did not disclose their HIV infection (n=55) and 6.0% (CI 2.5–9.5) did not disclose ART use despite disclosing HIV infection (n=12). Compared to results from ARV testing, the sensitivity of self-reported ART use was 71%, the specificity was 94%, the PPV was 90%, and the NPV was 82%.

Characteristics of persons on ART with undisclosed HIV infection

In bivariate analysis, male sex, younger age (15–24 years), living in urban residences, higher wealth, not visiting a health provider in the past year, and being virally suppressed were associated with undisclosed HIV infection while on ART at a p-value <0.1 (Table 1). In multivariate analysis, compared to HIV-infected persons who disclosed their HIV infection, persons aged 25–39 years (compared to aged 40–64 years: AOR 5.0; CI 1.1–22.0) and not visiting a health provider in the past year (AOR 6.1; CI 1.4–26.1) were associated with significantly higher adjusted odds of having undisclosed HIV infection while on ART.

Characteristics of persons on ART with undisclosed ART use and relevance to viral suppression

In bivariate analysis, undisclosed ART use was associated with younger age (aged 15–24 years), higher wealth, and not visiting a health provider in the past year at a p-value <1.0. In multivariate analysis, younger age (compared to aged 40–64 years: AOR 5.3; CI 1.4–19.8) and having higher wealth compared to lower wealth (AOR 3.1; CI 1.1–9.2) remained significantly associated with higher adjusted odds of undisclosed ART use while on ART.

Viral suppression ranged from 22.6% (CI 17.1–28.1) among HIV-infected persons who reported no prior history of ART use to 76.2% (CI 69.4–83.0) among those who reported taking ART (data not shown). After accounting for undisclosed ART use based on results of ARV testing, viral suppression decreased to 10.4% (CI 6.4–14.4) among persons not on ART and increased to 80.4% (CI 74.7–86.1) among those on ART.

National estimates HIV diagnosis and ART coverage

The percentage of persons with diagnosed HIV increased from 46.9% (CI 41.3–52.4) (305/648) based on self-report (population estimate: 558,000; CI 457,000–660,000) to 56.2% (CI 50.7–61.7) (360/648) (population estimate: 670,000; CI 561,000–779,000) after correcting for undisclosed HIV infection among persons on ART, representing an increase of 112,000 persons with diagnosed HIV. ART coverage increased from 31.8% (CI 27.1–36.5) (205/648) (population estimate: 379,000; CI 304,000–454,000) based on self-report to 42.8% (272/648, CI 37.9–47.8) (population estimate: 510,000; CI 425,000–596,000) after correcting for undisclosed ART use among persons on ART, equivalent to an additional 131,000 persons on ART. In 2012, the national ART program reported that programmatic ART coverage was 47% (CI 40–53) based on a numerator of 549,000 adult patients who received ART in health facilities that year and a projected denominator of 1,157,000 adult PLHIV based on the Spectrum model. Programmatic ART coverage was statistically different from ART coverage based on self-report (p<0.001) but similar to ART coverage adjusted for the ARV biomarker (p=0.315).

Discussion

We confirm that substantial misreporting occurred when HIV-infected respondents were asked to report their HIV and ART status in KAIS 2012. Only 71% of respondents with detectable ARVs reported a history of ART use, resulting in an underestimation of ART use by eleven percentage points and diagnosed HIV by nine percentage points. The impact of

this bias on population estimates was substantial, resulting in 131,000 persons on ART and 112,000 persons with diagnosed HIV who were left unaccounted for in national estimates of coverage based on self-report [22].

Over 90% of persons who reported ART use in the interview had evidence of at least one ARV drug in their blood, suggestive of high levels of treatment adherence among HIV-infected persons who acknowledged receiving ART. The percentage of individual ARV drugs that were detected were aligned with the expected coverage of these drugs in the national ART program. Approximately 95% of individuals with the ARV biomarker had evidence of 3TC, a drug recommended in both first- and second-line ART regimens for adults. Additionally, 96% of persons with the ARV biomarker were receiving NVP or EVF, also recommended as first-line therapy for adults. Approximately 16% of ART patients were expected to experience treatment failure after one year on treatment, requiring switch to second-line ART [22]. Though this estimate is higher than the percentage of second-line drug (LPV) detected in our sample, KAIS 2012 did not collect information on duration of ART use, treatment failure, and access to second-line therapy to confirm whether this level was lower than expected.

Programmatic ART coverage were robust when compared to ART coverage that accounted for undisclosed ART based on ARV testing in a national survey. This finding is reassuring considering that routine program data are often criticized for poor data quality, though they remain the main source of information used by LMIC to plan, monitor, and evaluate ART access.

Compared to the ARV biomarker, self-reported ART use had modest sensitivity and negative predictive value, which was likely influenced by social desirability bias. Our findings also confirmed that self-reported serostatus was impacted by this bias. The odds of undisclosed HIV infection while on ART was highest among younger persons and individuals who had not visited a health provider in the past year while the odds of undisclosed ART use while on ART was highest among persons who were young or wealthy. Interestingly, 6% of persons with detectable ARVs accurately disclosed their HIV infection but did not disclose ART use. These results were unexpected given that the perceived level of stigma associated with acknowledging HIV infection is assumed to be higher than that of acknowledging ART use, particularly in settings where treatment is heavily promoted and readily accessible for PLHIV.

Disclosure of sensitive health-related information is complex and may be influenced by a number of factors related to the respondent, interviewer, interview mode, and interview setting. Respondents may feel embarrassed or fear judgement when asked sensitive questions; they may want to please the interviewer and report behaviors they perceive to be more socially acceptable; they may feel that their responses will not be kept private and respond inaccurately to protect their anonymity; they may believe what they report; or they may have misunderstood the question. Additionally, the interviewer may have re-worded questions inaccurately or incorrectly coded responses. Self-administered questionnaires or computer-assisted self-interviews that remove the interviewer could yield higher rates of accurate responses to sensitive questions, though measurement of these indicators may need

to be simplified before considering this option. Nonetheless, every effort should be made to reduce reporting biases by ensuring that high-quality interviews that promote accurate reporting are delivered and that the mode of interview ensures that participants to feel at ease in their responses.

Estimated viral suppression in the absence of treatment decreased by over 50%, from 23% based on self-report to 10% after correction through ARV testing. A similar rate was reported in rural Uganda during a population-based health campaign in 2011, where 10% of persons who were not on ART were virally suppressed [23]. Though these rates are high for elite controllers [5, 6], they are not implausible given that the HIV epidemic in East Africa has existed for a long period resulting in more pressure to select those who have naturally lower viral loads as the duration of the HIV epidemic increases [24].

This analysis had the following limitations. Although estimates of ART coverage improved with inclusion of an ARV biomarker, true population ART coverage may still be underestimated. The parent drugs selected for ARV testing were based on the standardized treatment regimens available in public health facilities in Kenya. If a patient was on a regimen that did not include any of the four drugs tested, evidence of ART use would not have been captured. Additionally, given the short half-life of the ARV drugs tested, the ARV biomarker is an indicator of recent exposure to ARVs and could underestimate ART use if adherence was poor. While we found that ARV testing improved estimates of diagnosed HIV, a downward bias is still present by missing individuals who may be aware of their infection (but do not report it) and have not yet accessed ART. To understand the extent of this bias, 7% of persons with an HIV diagnosis in Kenya had not accessed care services in 2012, and of those in care, 22% had not yet accessed treatment. This limitation should be lessened in the future as treatment for all PLHIV is introduced irrespective of CD4 count [25]. Finally, we were unable to compare reported ART use with ARV biomarker results for HIV-infected persons who did not disclose HIV-positive status given that a history of ART use was collected only for persons who acknowledged that they were HIV-positive during the interview.

In conclusion, ARV testing in a national population-based sero-survey in Kenya confirmed that self-reported information on HIV-positive status and ART use should not be used alone for monitoring population-based trends in diagnosed HIV and ART coverage [26]. The change in viral suppression by ART status illustrates a further limitation of reliance on self-reported ART status. Not only did it result in an underestimate of diagnosed HIV and ART coverage at the population-level, the resulting misclassification at the individual-level can potentially bias associations between known status, ART use, and other explanatory factors. We were encouraged to find that routine ART program monitoring data used to estimate national ART coverage were valid. However, current program monitoring systems do not yet have the ability to directly link diagnosed HIV cases to their sentinel events in the cascade of care, limiting our understanding of the full impact of HIV prevention and treatment interventions in reducing HIV transmission on a population-level [27]. Until these systems are established and validated, population-based sero-surveys that include objective measures of ART use and biomarkers to measure viral suppression, serve as the best source of data for countries to monitor the reach and effectiveness of testing and treatment interventions on

achieving a successful treatment continuum. In settings where ARV testing is not feasible, self-reported data on ART use should continue to be collected but supplemented with information that can confirm treatment status, such as documentation of ART use in a health record. Triangulation of biological, epidemiological, and programmatic data remains an essential approach to generate best-supported estimates of treatment targets in a country.

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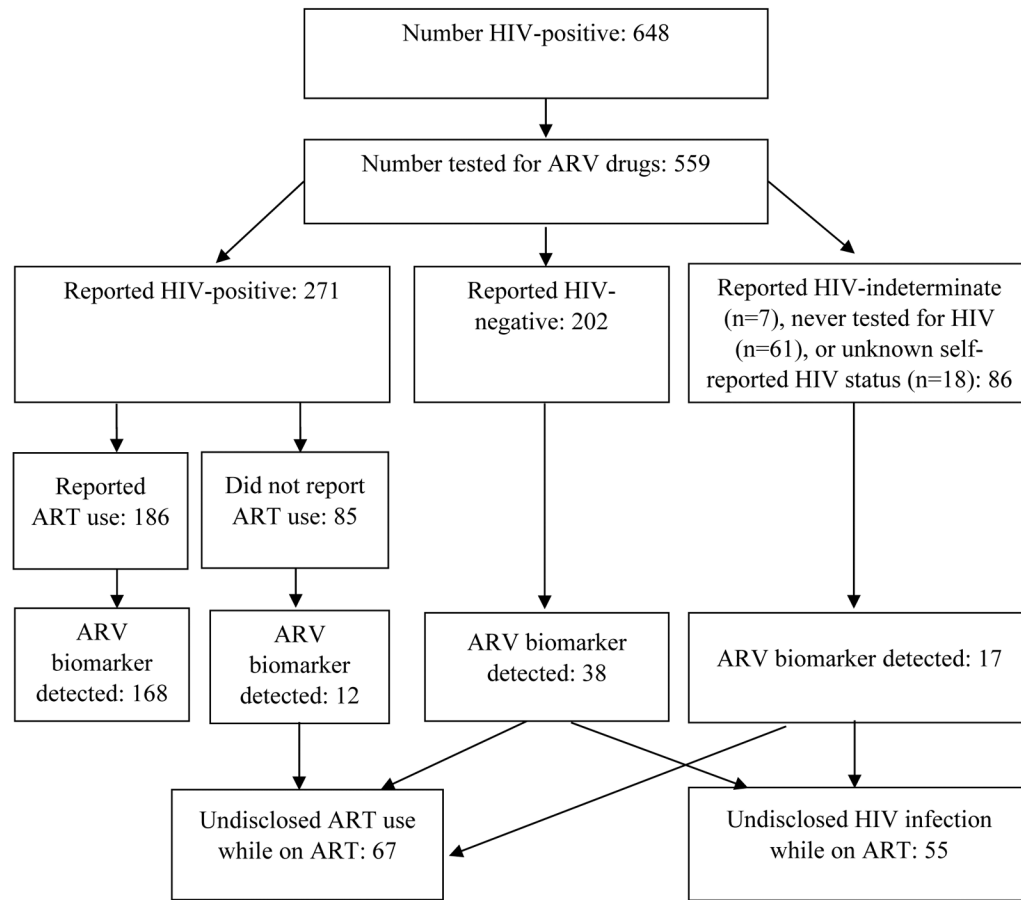


Figure 1. HIV-infected survey respondents aged 15–64 years by self-reported HIV status and detection of ARV biomarker, Kenya AIDS Indicator Survey 2012

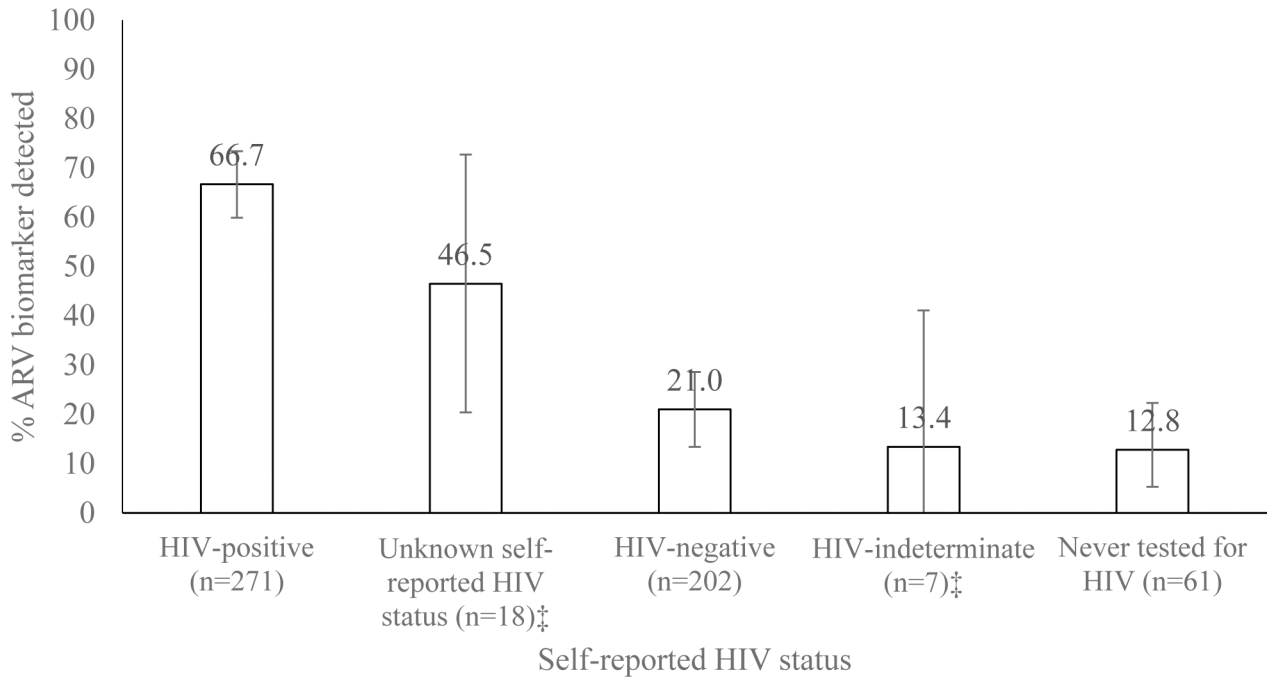


Figure 2. Percentage of HIV-infected respondents aged 15–64 years with the ARV biomarker by self-reported HIV status, Kenya AIDS Indicator Survey 2012[†]
[†]Analysis restricted to 559 HIV-positive dried blood spot samples available for ARV testing. Presented estimates include 95% confidence intervals.
[‡]Estimates unreliable due to denominator <25 observations and should be interpreted cautiously.

Table 1. Demographic, behavioral, and clinical characteristics of HIV-infected persons aged 15–64 years by HIV disclosure status, Kenya 2012

Demographic variables	Disclosed HIV infection (n=271)		Undisclosed HIV infection on ART (n=55)	Unadjusted odds ratio (95% CI)	p-value	Adjusted odds ratio (95% CI)
Sex						
Men	64	74.6 (63.1 – 86.0)	19	2.0 (1.0 – 4.0)	0.057	2.9 (0.8 – 10.5)
Women	207	85.2 (79.8 – 90.6)	36	1.0		1.0
Age category (years)						
15 – 24	15	55.3 (29.7 – 80.9)	8	4.1 (1.2 – 13.4)	0.051	8.8 (0.5 – 150.9)
25 – 39	131	84.0 (75.2 – 92.8)	23	1.0 (0.4 – 2.1)		5.0 (1.1 – 22.0)
40 – 64	125	83.4 (76.5 – 90.4)	24	1.0		1.0
Region						
Nairobi	24	79.1 (64.1 – 94.0)	6	20.9 (6.0 – 35.9)	0.139	1.0
Central	26	79.9 (62.0 – 97.8)	5	20.1 (2.2 – 38.0)		2.2 (0.1 – 40.0)
Coast	22	76.3 (59.9 – 92.7)	9	23.7 (7.3 – 40.1)		1.1 (0.03 – 40.0)
Eastern	33	71.1 (52.4 – 89.9)	12	28.9 (10.1 – 47.6)		5.2 (0.3 – 100.0)
Nyanza	111	89.0 (83.1 – 94.8)	13	11.0 (5.2 – 16.9)		0.7 (0.06 – 7.8)
Rift Valley	28	71.8 (51.1 – 92.5)	9	28.2 (7.5 – 48.9)		2.5 (0.3 – 22.5)
Western	27	95.7 (87.5 – 100)	1	4.3 (0.0 – 12.5)		0.8 (0.04 – 16.7)
Residence						
Rural	160	86.0 (79.7 – 92.2)	25	14.0 (7.8 – 20.3)	0.091	0.6 (0.1 – 2.7)
Urban	111	76.2 (66.1 – 86.3)	30	23.8 (13.7 – 33.9)		1.0
Educational level						
No primary	14	74.8 (50.2 – 99.4)	6	25.2 (0.6 – 49.8)	0.825	--
Incomplete primary	22	83.2 (67.1 – 99.4)	4	16.8 (0.6 – 32.9)		--
Primary and higher	235	81.8 (75.9 – 87.8)	45	18.2 (12.2 – 24.1)		--
Wealth index						

Demographic variables	Disclosed HIV infection (n=271)		Undisclosed HIV infection on ART (n=55)		Unadjusted odds ratio (95% CI)	p-value	Adjusted odds ratio (95% CI)
Lowest	42	90.4 (81.0 – 99.9)	7	9.6 (0.1 – 19.0)	0.8 (0.2 – 2.9)	0.003	0.8 (0.1 – 8.1)
Middle	133	88.5 (82.3 – 94.8)	17	11.5 (5.2 – 17.7)	1.0		1.0
Highest	96	70.1 (59.4 – 80.8)	31	29.9 (19.2 – 40.6)	3.3 (1.5 – 7.2)		4.6 (0.8 – 27.2)
Current Marital status							
Never married/cohabited	23	79.7 (57.3 – 100)	4	20.3 (0.0 – 42.7)	1.0	0.857	--
Ever married/cohabited	248	81.9 (75.7 – 88.0)	51	18.1 (12.0 – 24.3)	0.9 (0.2 – 3.9)		--
Behavioral variables							
Number of sex partners in past year							
0	86	85.8 (76.2 – 95.4)	11	14.2 (4.6 – 23.8)	1.0	0.559	--
1	156	79.5 (71.5 – 87.6)	37	20.5 (12.4 – 28.5)	1.6 (0.6 – 4.1)		--
2 or more	28	85.0 (71.8 – 98.3)	6	15.0 (1.7 – 28.2)	1.1 (0.3 – 3.8)		--
Used a condom with all partners in past year							
Yes	79	82.4 (73.3 – 91.5)	12	17.6 (8.5 – 26.7)	0.8 (0.4 – 1.8)	0.604	--
No	105	79.0 (69.2 – 88.9)	31	21.0 (11.1 – 30.8)	1.0		--
Knows HIV status of all partners in past year							
Yes	119	80.4 (70.7 – 90.2)	26	19.6 (9.8 – 29.3)	1.0 (0.4 – 2.3)	0.981	--
No	65	80.3 (71.1 – 89.5)	17	19.7 (10.5 – 28.9)	1.0		--
Clinical variables							
Visited health provider in past 12 months							
Yes	182	86.9 (81.2 – 92.5)	26	13.1 (7.5 – 18.8)	1.0		1.0
No	88	73.1 (61.9 – 84.4)	28	26.9 (15.6 – 38.1)	2.4 (1.2 – 5.1)	0.018	6.1 (1.4 – 26.1)
Diagnosed with tuberculosis (ever)							
Yes	55	84.6 (72.7 – 96.5)	7	15.4 (3.5 – 27.3)	0.8 (0.3 – 2.0)	0.614	--
No	209	81.2 (75.3 – 87.1)	46	18.8 (12.9 – 24.7)	1.0		--

Demographic variables	Disclosed HIV infection (n=271)		Undisclosed HIV infection on ART (n=55)		Unadjusted odds ratio (95% CI)	p-value	Adjusted odds ratio (95% CI)
HIV-1 RNA concentration [‡]							
Detectable RNA	107	87.9 (81.2 – 94.6)	15	12.1 (5.4 – 18.8)	1.0	0.039	1.0
Undetectable RNA	162	78.0 (70.7 – 85.2)	40	22.0 (14.8 – 29.3)	2.1 (1.0 – 4.1)		2.9 (0.6 – 14.7)
Median CD4+ T-cell count (IQR) (cells/mm ³)	145	550 (337 – 848)	27	437 (276 – 654)	--	0.345	--

[‡] Detectable RNA defined as HIV-1 RNA concentration ≥ 1,000 copies/mL. Undetectable RNA defined as HIV-1 RNA <1,000 copies/mL.

IQR = interquartile range.

Bolded adjusted odds ratios and 95% confidence intervals are those that are statistically significant.

Demographic, behavioral, and clinical characteristics of HIV-infected persons aged 15–64 years on ART by ART disclosure status, Kenya 2012

Table 2.

Demographic variables	Disclosed ART use (n=168)		Did not disclose ART use (n=67)	Unadjusted odds ratio (95% CI)	p-value	Adjusted odds ratio (95% CI)
Sex						
Male	45	65.0 (51.5 – 78.5)	23	1.7 (0.9 – 3.4)	0.107	1.8 (0.7 – 4.5)
Female	141	76.3 (68.9 – 83.7)	44	1.0		1.0
Age category (years)					0.016	
15–24	6	34.1 (9.0 – 59.2)	8	6.4 (1.8 – 22.8)		5.3 (1.4 – 19.8)
25–39	84	72.7 (61.0 – 84.4)	29	27.3 (15.6 – 39.0)		1.0 (0.4 – 2.4)
40–64	96	76.7 (68.5 – 85.0)	30	23.3 (15.0 – 31.5)		1.0
Region						
Nairobi	18	71.9 (52.6 – 91.2)	7	28.1 (8.8 – 47.4)	0.420	--
Central	19	74.6 (52.6 – 96.7)	5	25.4 (3.3 – 47.4)		--
Coast	17	63.0 (47.9 – 78.1)	11	37.0 (21.9 – 52.1)		--
Eastern	27	64.2 (45.1 – 83.3)	13	35.8 (16.7 – 54.9)		--
Nyanza	71	80.2 (71.0 – 89.4)	17	19.8 (10.6 – 29.0)		--
Rift Valley	18	62.8 (36.0 – 89.7)	9	37.2 (10.3 – 64.0)		--
Western	16	81.4 (64.0 – 98.9)	5	18.6 (1.1 – 36.0)		--
Residence						
Rural	105	76.5 (67.8 – 85.3)	33	23.5 (14.7 – 32.2)	0.206	--
Urban	81	67.2 (55.3 – 79.1)	34	32.8 (20.9 – 44.7)		--
Educational level						
No primary	12	72.0 (45.3 – 98.7)	6	28.0 (1.3 – 54.7)	0.999	--
Incomplete primary	14	72.9 (51.3 – 94.5)	6	27.1 (5.5 – 48.7)		--
Primary and higher	160	72.3 (64.6 – 80.1)	55	27.7 (19.9 – 35.4)		--
Wealth index						

	Disclosed ART use (n=168)		Did not disclose ART use (n=67)		Unadjusted odds ratio (95% CI)	p-value	Adjusted odds ratio (95% CI)
	n	% (95% CI)	n	% (95% CI)			
Low	29	81.2 (68.6 – 93.7)	10	18.8 (6.3 – 31.4)	1.0 (0.3 – 2.7)	0.015	0.9 (0.2 – 3.7)
Middle	87	80.5 (71.1 – 90.0)	22	19.5 (10.0 – 28.9)	1.0		1.0
High	70	60.0 (47.4 – 72.7)	35	40.0 (27.3 – 52.6)	2.8 (1.3 – 6.0)		3.1 (1.1 – 9.2)
Current marital status							
Never married/cohabited	15	68.9 (42.4 – 95.3)	6	31.1 (4.7 – 57.6)	1.0	0.787	--
Ever married/cohabiting	171	72.7 (64.8 – 80.5)	61	27.3 (19.5 – 35.2)	0.8 (0.2 – 3.2)		--
Behavioral variables							
Number of sex partners in past year							
0	65	80.2 (68.4 – 92.1)	13	19.8 (7.9 – 31.6)	1.0	0.431	--
1	103	68.9 (58.8 – 79.0)	46	31.1 (21.0 – 41.2)	1.83 (0.7 – 4.6)		--
2 or more	17	73.2 (53.6 – 92.8)	7	26.8 (7.2 – 46.4)	1.5 (0.4 – 5.0)		--
Used a condom with all partners in past year							
Yes	61	76.7 (65.9 – 87.6)	14	23.3 (12.4 – 34.1)	0.5 (0.2 – 1.2)	0.117	0.4 (0.2 – 1.2)
No	59	63.7 (50.0 – 77.3)	39	36.3 (22.7 – 50.0)			1.0
Knows HIV status of all partners in past year							
Yes	85	72.3 (60.5 – 84.2)	32	27.7 (15.8 – 39.5)	0.7 (0.3 – 1.4)	0.278	--
No	35	62.9 (49.5 – 76.3)	21	37.1 (23.7 – 50.5)	1.0		--
Clinical variables							
Visited health provider in past 12 months							
Yes	128	78.7 (70.9 – 86.5)	34	21.3 (13.5 – 29.1)	1.0	0.029	1.0
No	58	62.8 (49.7 – 75.9)	31	37.2 (24.1 – 50.3)	2.2 (1.1 – 4.4)		1.8 (0.8 – 4.4)
Diagnosed with tuberculosis (ever)							
Yes	52	81.8 (69.3 – 94.3)	9	18.2 (5.7 – 30.7)	0.5 (0.2 – 1.2)	0.123	0.7 (0.3 – 1.7)
No	129	69.4 (61.2 – 77.6)	56	30.6 (22.4 – 38.8)	1.0		1.0
HIV-1 RNA concentration [†]							

	Disclosed ART use (n=168)		Did not disclose ART use (n=67)		Unadjusted odds ratio (95% CI)	p-value	Adjusted odds ratio (95% CI)
	n	Median (IQR)	n	Median (IQR)			
Detectable RNA	45	72.4 (59.8 – 85.0)	18	27.6 (15.0 – 40.2)	1.0 (0.5 – 2.0)	0.998	--
Undetectable RNA	140	72.4 (64.4 – 80.4)	48	27.6 (19.6 – 35.6)	1.0		--
Median CD4+ T-cell count (IQR) (cells/mm ³)	104	533 (309– 754)	33	506 (299 – 654)	--	0.981	--

[†] Detectable RNA defined as HIV-1 RNA concentration ≥ 1,000 copies/mL. Undetectable RNA defined as HIV-1 RNA <1,000 copies/mL. IQR = interquartile range.

Bolded adjusted odds ratios and 95% confidence intervals are those that are statistically significant.