

# Antiretroviral Treatment Scale-up Among Persons Living With HIV in Kenya: Results From a Nationally Representative Survey

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**Background:** In 2007, 29% of HIV-infected Kenyans in need of antiretroviral therapy (ART), based on an immunologic criterion of CD4  $\leq$ 350 cells per microliter, were receiving ART. Since then, substantial treatment scale-up has occurred in the country. We analyzed data from the second Kenya AIDS Indicator Survey (KAIS 2012) to assess progress of treatment scale-up in Kenya.

**Methods:** KAIS 2012 was a nationally representative survey of persons aged 18 months to 64 years that collected information on HIV status, care, and treatment. ART eligibility was defined based on 2 standards: (1) 2011 Kenya eligibility criteria for ART initiation: CD4  $\leq$ 350 cells per microliter or co-infection with active tuberculosis and (2) 2013 World Health Organization (WHO) eligibility criteria for ART initiation: CD4  $\leq$ 500 cells per microliter, co-

infection with active tuberculosis, currently pregnant or breastfeeding, and infected partners in serodiscordant relationships. Blood specimens were tested for HIV antibodies and HIV-positive specimens tested for CD4 cell counts.

**Results:** Among 13,720 adults and adolescents aged 15–64 years, 11,626 provided a blood sample, and 648 were HIV infected. Overall, 58.8% [95% confidence interval (CI): 52.0 to 65.5] were eligible for treatment using the 2011 Kenya eligibility criteria and 77.4% (95% CI: 72.4 to 82.4) using the 2013 WHO eligibility criteria. Coverage of ART was 60.5% (95% CI: 50.8 to 70.2) using the 2011 Kenya eligibility criteria and 45.9% (95% CI: 37.7 to 54.2) using the 2013 WHO eligibility criteria.

**Conclusions:** ART coverage has increased from 29% in 2007 to 61% in 2012. If Kenya adopts the 2013 WHO guidelines for ART initiation, need for ART increases by an additional 19 percentage points and current coverage decreases by an additional 15 percentage points, representing an additional 214,000 persons who will need to be reached.

**Key Words:** HIV, antiretroviral therapy, CD4, Kenya, HIV/AIDS

(*J Acquir Immune Defic Syndr* 2014;66:S116–S122)

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KAIS 2012 was supported by the National AIDS and STI Control Programme (NAS COP), Kenya National Bureau of Statistics (KNBS), National Public Health Laboratory Services (NPHLS), National AIDS Control Council (NACC), National Council for Population and Development (NCPD), Kenya Medical Research Institute (KEMRI), US Centers for Disease Control and Prevention (CDC/Kenya, CDC/Atlanta), United States Agency for International Development (USAID/Kenya), University of California, San Francisco (UCSF), Joint United Nations Team on HIV/AIDS, Japan International Cooperation Agency (JICA), Elizabeth Glaser Pediatric AIDS Foundation (EGPAF), Liverpool Voluntary Counselling and Testing (LVCT), African Medical and Research Foundation (AMREF), World Bank, and Global Fund. This publication was made possible by support from the US President's Emergency Plan for AIDS Relief through cooperative agreements (#PS001805, GH000069, and PS001814) from the US Centers for Disease Control and Prevention, Division of Global HIV/AIDS. This work was also funded in part by support from the Global Fund, World Bank, and the Joint United Nations Team for HIV/AIDS.

The authors have no conflicts of interest to disclose.

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the US Centers for Disease Control and Prevention and the Government of Kenya.

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that aims to reduce HIV transmission, morbidity, and mortality in part through increasing the number of treatment-eligible persons receiving ART.<sup>10</sup> Efforts to expand HIV testing have resulted in a substantial increase in the percentage of Kenyan adults and adolescents who have ever been tested, from 36.6% in 2007 to 70.1% in 2012.<sup>11</sup> Subsequently, the number of adults who have received ART has increased almost 3-fold during the same period, from 184,000 in 2007 to 525,000 by year-end 2012.<sup>12</sup> In 2013, the World Health Organization (WHO) released new guidance on the use of ART to treat and prevent HIV infection.<sup>13</sup> This guidance recommends raising the immunologic threshold for ART initiation from CD4  $\leq$ 350 cells per microliter to CD4  $\leq$ 500 cells per microliter and, in addition to the 2011 Kenyan eligibility criteria for ART initiation, recommends ART for HIV-infected women who are pregnant or breastfeeding and HIV-infected persons in serodiscordant relationships, irrespective of CD4 cell count. Kenya plans to integrate these new criteria in its next national strategic plan for HIV care and treatment in 2014. Although not currently eligible for treatment under the Kenya or WHO guidance, it is anticipated that persons with CD4  $>$ 500 cells per microliter will ultimately require treatment in the future.

The second Kenya AIDS Indicator Survey (KAIS 2012) was a nationally representative survey of adults and children aged 18 months to 64 years residing in Kenya that collected information on HIV diagnosis, care, and treatment and tested participants for HIV antibodies and CD4 cell counts. We used data from HIV-infected adults and adolescents aged 15–64 years to estimate the need for ART and coverage of ART using different eligibility criteria for ART initiation.

## METHODS

### Study Design and Population

The methods used in KAIS 2012 have been previously described.<sup>14</sup> Briefly, a cross-sectional household survey of adults and children aged 18 months to 64 years was conducted from October 2012 to February 2013 using a stratified 2-stage cluster sample to identify households and within households, eligible residents. The North Eastern region was not surveyed because of regional insecurity. This analysis was restricted to subjects aged 15–64 years with a confirmed HIV-positive test result from central laboratory testing in Nairobi.

### Data Collection Methods

Participants were interviewed face-to-face regarding household and demographic characteristics, HIV testing history, and use of HIV-related care for persons known to be HIV infected. Information was collected on tablet computers (Mirus Innovations, Mississauga, Ontario, Canada) and transmitted electronically to a central database in Nairobi. Blood was obtained and tested at the National HIV Reference Laboratory for HIV antibodies using the Vironostika HIV-1/2 UNIF II Plus O Enzyme Immunoassay (bioMérieux, Marcy d'Etoile, France) as the screening assay and the Murex HIV.1.2.O HIV Enzyme Immunoassay (DiaSorin, SpA, Saluggia, Italy) as the confirmatory assay. HIV-positive specimens were further tested for CD4 cell count using the BD

FACSCalibur flow cytometer (Becton Dickinson BioSciences, San Jose, CA). Due to hemolysis, 54.0% of HIV-positive specimens were not available for CD4 cell count testing at the National HIV Reference Laboratory.

### Measures

We used self-reported data from the interview to determine each HIV-infected participant's knowledge of his or her HIV infection, current HIV care clinic attendance (defined as having attended the clinic in the past six months), current treatment for tuberculosis co-infection, and current ART usage. We classified participants into 4 categories: (1) those who were unaware of their HIV infection (ie, self-reported being HIV uninfected or not having been previously tested); (2) those who were aware of their infection (ie, self-reported being diagnosed before the survey), currently receiving care, and currently receiving ART; (3) those who were aware of their infection and currently receiving care but not currently receiving ART; and (4) those who were aware of their infection but not currently receiving care or ART. Participants who reported that they were not currently attending an HIV care clinic but were currently receiving ART were classified as currently receiving care and ART.

We measured eligibility for ART using 2 eligibility standards: (1) the 2011 Kenya eligibility criteria for ART initiation and (2) the 2013 WHO eligibility criteria for ART initiation. The Kenya criteria were based on the 2011 National Guidelines for ART, which recommend treatment for persons with CD4  $\leq$ 350 cells per microliter or, irrespective of CD4 cell count, persons with active tuberculosis co-infection and persons with chronic Hepatitis B virus co-infection requiring therapy.<sup>9</sup> The WHO criteria were based on the 2013 WHO recommendations on priority populations to initiate ART, including persons with CD4  $\leq$ 500 cells per microliter, or irrespective of CD4 cell count, persons with active tuberculosis co-infection, persons with chronic Hepatitis B virus co-infection requiring therapy, women who were pregnant or breastfeeding, and partners of HIV-infected partners in serodiscordant relationships.<sup>13</sup> We used self-reported data on current treatment for tuberculosis as a proxy for active co-infection with tuberculosis. Because persons who were currently receiving ART will continue to need ART in the future, they were included in denominator for determining need for ART. Clinical staging information and Hepatitis B virus status were not collected in KAIS 2012 and therefore were not used for determining eligibility.

### Analysis

All analyses were performed in SAS version 9.3 (SAS Institute Inc., Cary, NC) using the SURVEYFREQ procedure to take into account the stratified cluster design of the survey. Estimates were weighted to account for sampling probability and adjust for nonresponse. Statistical significance for cross-tabulations was assessed using the Rao-Scott  $\chi^2$  test. To estimate the number of adults and adolescents living with HIV, we applied non-normalized survey weights to the outcome variable of HIV infection and rounded estimates to the nearest 1000. Non-normalized weights were based on the 2012 projected

population data in the 2009 Kenya Population and Housing Census<sup>15</sup> and adjusted for missing CD4 results when CD4 testing was not performed.

ART need and coverage were calculated using the 2011 Kenya eligibility criteria for ART initiation and the 2013 WHO eligibility criteria for ART initiation. We also estimated coverage assuming that all infected persons were in need of ART. To determine unmet need for ART, we subtracted the number of persons currently receiving ART from the total number of persons eligible for ART. Population estimates for eligibility, coverage, and unmet need were calculated by multiplying each stratum with the estimated number of adults and adolescents living with HIV. For population estimates, we excluded respondents whose eligibility could not be classified because a CD4 cell count test was not conducted.

## Ethical Considerations

This study was approved by the Kenya Medical Research Institute's Ethical Review Committee, the US Centers for Disease Control and Prevention's Institutional Review Board, and the Committee on Human Research of the University of California, San Francisco.

## RESULTS

We surveyed 13,720 participants and collected blood specimens from 11,626 (84.7%). Of these, 648 (5.6%) were found to be HIV infected. A greater proportion of HIV infections were observed in women [62.1%, 95% confidence intervals (CI): 57.7 to 66.5], persons aged 40 years and above (40.2%, 95% CI: 36.4 to 44.1), persons who had not been educated beyond primary school (45.6%, 95% CI: 40.9 to 50.2), and persons who were married or cohabited (61.1%, 95% CI: 56.1 to 66.2) compared to persons of other demographic and marital groups (Table 1).

Among HIV-infected participants, 53.1% (95% CI: 47.6 to 58.7) were unaware of their infection;<sup>11</sup> 31.8% (95% CI: 27.1 to 36.5) were aware of their infection, currently in care, and receiving ART; 9.9% (95% CI: 7.2 to 12.5) were aware of the infection and currently in care but not receiving ART; and 5.2% (95% CI: 3.0 to 7.4) knew they were infected but were not currently receiving care (Table 2). There were significant differences in the proportions of HIV care and treatment status categories by sex, age, educational attainment, and current marital status. The proportion of persons aged 15–19 years who were in care and receiving ART (14.1%, 95% CI: 9.1 to 19.0) was low relative to other age groups (30–39 years: 33.4%, 95% CI: 26.0 to 40.9 and 40 years and above: 43.3%, 95% CI 36.2 to 50.5). The proportion of widows in care and receiving ART (49.9%, 95% CI 39.9 to 57.7) was higher compared to persons who were married or cohabiting (31.4%, 95% CI: 25.1 to 37.7) or in other marital status categories (21.0%, 95% CI: 13.0 to 28.2). There were few differences in the demographic characteristic among persons who were not on ART, regardless of whether they were in care.

Using the 2011 Kenya eligibility criteria for ART initiation, 58.8% (95% CI: 52.0 to 65.5) or an estimated 674,000 (95% CI: 553,000 to 794,000) HIV-infected persons were eligible for ART (Table 3). Of those, 60.5% (95% CI: 50.8

to 70.2) or an estimated 407,000 (95% CI: 312,000 to 503,000) persons were currently receiving ART; 7.0% (95% CI: 2.0 to 12.1) were aware of their infection and in care but not receiving ART; 4.1% (95% CI: 0.0 to 8.8) were aware of their infection but not in care and not receiving ART; and 28.4% (95% CI: 19.9 to 36.9) were unaware of their infection and not receiving ART. Therefore, 39.5% of persons who were in need of ART, or an estimated 267,000 persons, were not receiving treatment. Using the 2013 WHO eligibility criteria for ART initiation, 77.4% (95% CI: 72.4 to 82.4) or an estimated 880,000 (95% CI: 766,000 to 1,009,000) HIV-infected persons were eligible for treatment. Among those eligible for ART, 45.9% (95% CI: 37.7 to 54.2) were receiving ART; 10.0% (95% CI: 5.5 to 14.5) were aware of their infection and in care but not receiving ART; 4.8% (95% CI: 0.0 to 8.9) were aware of their infection but not in care and not receiving ART; and 39.3% (95% CI: 31.7 to 46.9) were unaware of their infection and not receiving ART.

**TABLE 1.** Characteristics of HIV-Infected Persons, Kenya AIDS Indicator Survey 2012

Characteristic	HIV Infected, Unweighted, N* (Unweighted %)	Weighted % (95% CI)
Overall	648 (100)	100.0
Sex		
Men	193 (29.8)	37.9 (33.5 to 42.3)
Women	455 (70.2)	62.1 (57.7 to 66.5)
Age group, yrs		
15–29	187 (28.9)	29.0 (25.0 to 33.1)
30–39	205 (31.6)	30.7 (26.3 to 35.2)
40 and above	256 (39.5)	40.2 (36.4 to 44.1)
Highest educational attainment		
Primary or less	312 (48.1)	45.6 (40.9 to 50.2)
Secondary/vocational	158 (24.4)	25.4 (21.1 to 29.7)
Post-secondary	177 (27.3)	29.1 (24.2 to 33.9)
Marital status		
Married/cohabiting	385 (59.4)	61.1 (56.1 to 66.2)
Ever widowed	106 (16.4)	15.4 (11.9 to 18.9)
Other	157 (24.2)	23.5 (19.5 to 27.4)
Region		
Nairobi	67 (10.3)	9.6 (7.0 to 12.2)
Central	60 (9.3)	8.8 (6.2 to 11.4)
Coast	66 (10.2)	6.9 (4.8 to 9.1)
Eastern	75 (11.6)	10.1 (6.4 to 13.7)
Nyanza	242 (37.3)	37.7 (30.8 to 44.5)
Rift Valley	79 (12.2)	17.6 (12.8 to 22.4)
Western	59 (9.1)	9.2 (5.3 to 13.2)
Residence		
Rural	373 (57.6)	56.8 (50.4 to 63.2)
Urban	275 (42.4)	43.2 (36.8 to 49.6)
Wealth index		
Poorest	97 (15.0)	14.2 (10.5 to 17.9)
Second	153 (23.6)	24.2 (18.9 to 29.6)
Middle	137 (21.1)	21.2 (16.8 to 25.6)
Fourth	159 (24.5)	23.5 (18.7 to 28.2)
Richest	102 (15.7)	16.9 (12.8 to 21.0)

\*Due to missing responses, totals vary between variables.

**TABLE 2.** Characteristics of HIV-Infected Persons by Awareness of HIV Infection and Status of HIV Care and Treatment, Kenya AIDS Indicator Survey 2012

Characteristic	Total HIV+ Unweighted, N*	Aware of HIV Infection					
		In Care and on ART		In Care and Not on ART		Not in care	
		Unweighted, n*	Weighted % (95% CI)	Unweighted, n*	Weighted % (95% CI)	Unweighted, n*	Weighted % (95% CI)
Total	648	205	31.8 (27.1 to 36.5)	69	9.9 (7.2 to 12.5)	31	5.2 (3.0 to 7.4)
Sex							
Men	193	51	27.0 (19.6 to 34.4)	12	5.4 (2.2 to 8.6)	10	5.6 (2.0 to 9.2)
Women	455	154	34.7 (29.7 to 39.7)	57	12.6 (9.1 to 16.1)	21	4.9 (2.9 to 7.0)
Age, yrs							
15–29	187	29	14.1 (9.1 to 19.0)	18	9.6 (5.0 to 14.1)	10	5.7 (1.9 to 9.5)
30–39	205	70	33.4 (26.0 to 40.9)	30	14.1 (8.8 to 19.5)	8	4.7 (1.5 to 7.9)
40 and above	256	106	43.3 (36.2 to 50.5)	21	6.8 (3.6 to 10.0)	13	5.2 (1.8 to 8.6)
Highest educational attainment							
Primary or less	312	92	29.6 (23.4 to 35.8)	36	10.9 (7.1 to 14.8)	12	4.0 (1.7 to 6.3)
Secondary/vocational	158	40	24.2 (16.6 to 31.8)	19	11.6 (6.7 to 16.6)	9	7.4 (1.5 to 13.3)
Post-secondary	177	73	41.8 (33.3 to 50.3)	14	6.6 (3.3 to 10.0)	10	5.2 (1.7 to 8.7)
Marital status							
Married/cohabiting	385	118	31.4 (25.1 to 37.7)	38	9.1 (5.8 to 12.4)	19	5.3 (2.4 to 8.2)
Ever widowed	106	54	49.8 (39.9 to 59.7)	17	16.7 (8.7 to 24.7)	7	6.8 (1.7 to 11.9)
Other	157	33	21.0 (13.8 to 28.2)	14	7.4 (3.4 to 11.4)	5	3.8 (0.6 to 7.0)
Region							
Nairobi	67	19	28.2 (16.9 to 39.4)	7	9.9 (3.5 to 16.2)	1	2.0 (0.0 to 5.9)
Central	60	21	33.3 (19.2 to 47.5)	5	6.7 (1.6 to 11.9)	2	3.6 (0.0 to 9.0)
Coast	66	18	28.1 (17.1 to 39.1)	6	10.4 (2.9 to 17.9)	2	2.4 (0.0 to 5.4)
Eastern	75	27	36.5 (21.7 to 51.2)	5	7.6 (0.0 to 15.4)	2	2.3 (0.0 to 6.7)
Nyanza	242	84	34.0 (26.9 to 41.0)	30	11.5 (6.5 to 16.5)	12	4.9 (1.6 to 8.1)
Rift Valley	79	19	27.3 (11.9 to 42.7)	5	6.1 (0.1 to 12.0)	8	10.6 (2.3 to 18.8)
Western	59	17	31.3 (16.2 to 46.5)	11	15.5 (5.9 to 25.1)	4	6.5 (1.0 to 11.9)
Residence							
Rural	373	118	32.9 (26.0 to 39.9)	44	10.7 (7.0 to 14.4)	19	5.4 (2.4 to 8.3)
Urban	275	87	30.3 (24.4 to 36.2)	25	8.8 (4.8 to 12.7)	12	5.0 (1.8 to 8.2)
Wealth index							
Poorest	97	31	36.6 (24.8 to 48.4)	9	8.1 (2.1 to 14.1)	6	6.1 (1.2 to 11.1)
Second	153	52	35.4 (23.9 to 46.9)	21	12.5 (6.9 to 18.0)	5	2.4 (0.2 to 4.6)
Middle	137	43	33.4 (24.3 to 42.6)	17	12.0 (6.0 to 18.0)	9	7.8 (3.1 to 12.5)
Fourth	159	52	28.7 (19.7 to 37.6)	13	7.8 (3.3 to 12.3)	9	7.5 (1.4 to 13.6)
Richest	102	27	24.9 (16.4 to 33.4)	9	7.8 (2.7 to 12.8)	2	2.0 (0.0 to 4.7)

\*Due to missing responses, totals vary between variables.

This corresponds to 54.1% of ART-eligible persons under the 2013 WHO eligibility criteria, or an estimated 481,000 persons, who were not receiving ART. Taking into account the unmet need for ART using the 2011 Kenya eligibility criteria, this represents an additional 214,000 persons who will need to be reached under the 2013 WHO eligibility criteria for ART initiation.

Assuming universal coverage, all HIV-infected persons would be eligible for ART. Among those, 35.5% (95% CI: 28.6 to 42.5) were currently receiving ART; 11.6% (95% CI: 7.4 to 15.7) were aware of their infection and currently in care but not receiving ART; 5.3% (95% CI: 1.9 to 8.8) were aware of their infection but not in care and not receiving ART; and

47.6% (95% CI: 40.4 to 54.8) were unaware of their infection and not receiving ART. Therefore, if all HIV-infected persons were eligible for ART, an additional 473,000 persons on top of those already in need for ART under the 2011 Kenya eligibility criteria would need to be reached.

## DISCUSSION

In this nationally representative sample of adults and adolescents aged 15–64 years, we estimated that among Kenyans aged 15–64 years who were living with HIV in 2012, 59% were eligible for ART, of whom 61% were receiving it. These data represent a major milestone in the scale-up

**TABLE 3.** Estimates of ART Need and Coverage Among HIV-Infected Adults, by Treatment and Care Status and Treatment Eligibility Criteria, Kenya AIDS Indicator Survey 2012§

	2011 Kenya Treatment Guidelines*			2013 WHO Treatment Guidelines†		
	Unweighted, N	Weighted % (95% CI)	Population Size (95% CI)	Unweighted, N	Weighted % (95% CI)	Population Size (95% CI)
<b>ART eligibility among HIV infected</b>						
Yes	174	58.8 (52.0 to 65.5)	674,000 (553,000 to 794,000)	234	77.4 (72.4 to 82.4)	888,000 (766,000 to 1,009,000)
No	136	41.2 (34.5 to 48.0)	473,000 (388,000 to 558,000)	76	22.6 (17.6 to 27.6)	259,000 (196,000 to 322,000)
Total HIV infected	310	—	1,147,000 (1,014,000 to 1,279,000)	310	—	1,147,000 (1,014,000 to 1,279,000)
<b>Coverage of ART among persons eligible for ART</b>						
In care, on ART	109	60.5 (50.8 to 70.2)	407,000 (312,000 to 503,000)	109	45.9 (37.7 to 54.2)	407,000 (308,000 to 507,000)
Aware, in care, not on ART	12	7.0 (2.0 to 12.1)	47,000 (14,000 to 81,000)	22	10.0 (5.5 to 14.5)	89,000 (49,000 to 129,000)
Aware, not in care	3	4.1 (0.0 to 8.8)	27,000 (0 to 60,000)	7	4.8 (0.8 to 8.9)	43,000 (7,000 to 79,000)
Unaware	50	28.4 (19.9 to 36.9)	191,000 (131,000 to 252,000)	96	39.3 (31.7 to 46.9)	349,000 (278,000 to 419,000)
Total eligible for ART‡	174	—	674,000 (553,000 to 558,000)	234	—	888,000 (781,000 to 994,000)

	Universal Coverage		
	Unweighted, N	Weighted % (95% CI)	Population Size (95% CI)
<b>ART eligibility among HIV infected</b>			
Yes	310	100	1,147,000 (1,014,000 to 1,279,000)
No	—	—	—
Population estimated HIV infected	—	—	1,147,000 (1,014,000 to 1,279,000)
<b>Coverage of ART among persons eligible for ART</b>			
In care, on ART	109	35.5 (28.6 to 42.5)	407,000 (304,000 to 511,000)
Aware, in care, not on ART	35	11.6 (7.4 to 15.7)	132,000 (85,000 to 180,000)
Aware, not in care	12	5.3 (1.9 to 8.8)	61,000 (21,000 to 101,000)
Unaware	154	47.6 (40.4 to 54.8)	546,000 (451,000 to 640,000)
Total eligible for ART‡	310	—	1,147,000 (1,014,000 to 1,279,000)

\*Based on the 2011 Kenya treatment guidelines, KAIS 2012 defined ART eligibility as persons ever on ART regardless of CD4 count, persons not on ART who had a CD4 ≤ 350 cells per microliter, and persons currently on tuberculosis medication regardless of CD4 count.

†Based on the 2013 WHO treatment guidelines, KAIS 2012 defined ART eligibility as all persons eligible according to current Kenya guidelines plus persons not on ART and who had a CD4 ≤ 500 cells per microliter, women who were pregnant or breastfeeding regardless of CD4 count, and infected partners in a serodiscordant relationship regardless of CD4 count.

‡Number may not add up to total eligible because of rounding.

§Estimates calculated for individuals with available CD4 cell count results.

of the national ART program over the past 5 years, from an ART coverage rate of 29% in 2007 to 61% in 2012 among treatment-eligible persons.<sup>8</sup>

By year-end 2012, routinely collected service delivery data from health facilities indicated that approximately 525,000 Kenyan adults were receiving ART.<sup>12</sup> Although our population estimate of ART coverage in KAIS 2012 was lower, the upper bound of our estimate (ie, 503,000 persons) fell within range of the programmatic estimate. We also expect our estimates of ART coverage in a national household survey to be an underestimate of the true value in the population, given the likely impact of social desirability bias on the accuracy of self-reported responses for sensitive ques-

tions, such as HIV status and HIV care and treatment experience.

As Kenya moves towards adopting the 2013 WHO guidance for initiating ART, the need for ART will increase by an additional 19 percentage points and current coverage will decrease by an additional 15 percentage points, representing approximately 214,000 additional persons who will need to be reached beyond current need. Although these numbers reflect anticipated treatment needs in Kenya, ultimately all currently infected persons and persons who later acquire infection will likely need to receive lifelong treatment. Funding treatment in the context of diminishing donor funds presents a challenge for Kenya.<sup>16</sup>

Despite progress in treatment scale-up, more than 50% of HIV-infected adults and adolescents were unaware of their infection, and that a greater proportion of men than women were unaware of their infection.<sup>11</sup> Given that the majority of infections are transmitted from persons who are unaware of their infection, in the absence of marked increases in HIV diagnosis and treatment to maintain viral suppression, Kenya will face substantial ongoing HIV transmission.<sup>17,18</sup>

Although these findings are concerning, the fact that the proportion of persons who are aware of their infection has increased substantially since 2007 suggests that efforts to expand HIV testing through provider-initiated and home-based testing and counseling are making a difference.<sup>11</sup> The lower proportion of women who were unaware of their infection is likely due to the success of opt-out testing provided through the prevention of mother-to-child transmission of HIV programs where rates of test acceptance are very high.<sup>19</sup>

We found that a high proportion of diagnosed persons were receiving care and that 7% of persons in care who met the Kenya eligibility criteria for initiating ART were not receiving ART. Although the proportion may seem relatively low, this represents an estimated 47,000 persons in care who require ART. This gap may be due, at least in part, to prioritization of health care services for persons receiving treatment over the pre-ART population in care.<sup>20–24</sup>

There are important limitations to consider when interpreting the results of this analysis. Security concerns resulted in not sampling the North Eastern region, and our findings may not be completely representative of the entire country. However, in KAIS 2007, the North Eastern region had the lowest HIV prevalence (0.8%) and lowest number of survey participants (2% of total national sample) compared to other regions.<sup>8</sup> Therefore, exclusion of this region in KAIS 2012 did not substantially impact the generalizability of these results for the country. Hemolysis of transported blood specimens resulted in the loss of 54% of HIV-positive samples eligible for CD4 testing. There were no differences in sex, age, residence, and geographic region between HIV-infected persons with and without CD4 test results; therefore, we believe that any bias from this loss to be minimal. Our study relied on self-report of HIV infection and use of HIV care and treatment services. Concern over disclosure of HIV status may have over-estimated the proportion of persons with undiagnosed HIV infection, leading to underreporting of previously received treatment and care services, resulting in underestimation of ART coverage in our study. Finally, we had no objective measures of clinical indicators for ART and Hepatitis B virus infection and for this reason relied only on immunologic criterion and self-reported data on current treatment for tuberculosis disease, current pregnancy, and current breastfeeding status to determine need for ART. As such, our estimates of treatment-eligible persons may be underestimated.

Despite these limitations, as a national population-based survey, our study is reasonably representative and provides data not available elsewhere with which we were able to obtain estimates of coverage and unmet need for treatment. Efforts to increase the proportion of infected persons who are aware of their infection is critical because knowledge of one's infection

leads to reduced risk behavior, provides the opportunity to identify additional infections by disclosing infection status to partners, and is the first step in accessing ART. Once in care, more infected persons must initiate and sustain ART to reduce HIV transmission. Our conservative estimate of the number of persons in need of treatment should be used to obtain direct resources for ART clinics and support services to maximize retention and compliance with care and treatment. Finally, continued monitoring of HIV prevalence, testing, care use, and care outcomes is needed to evaluate the success of expanded efforts and to determine future needs.

## ACKNOWLEDGMENTS

The authors would like to thank George Rutherford and Rennatus Mdofo for reviewing and providing input on the manuscript and the KAIS Study Group for their contribution to the design of the survey and collection of the data set: Willis Akhwale, Sehin Birhanu, John Bore, Angela Broad, Robert Buluma, Thomas Gachuki, Jennifer Galbraith, Anthony Gichangi, Beth Gikonyo, Margaret Gitau, Joshua Gitonga, Mike Grasso, Malayah Harper, Andrew Imbwaga, Muthoni Junghae, Mutua Kakinyi, Samuel Mwangi Kamiru, Nicholas Owenje Kandege, Lucy Kanyara, Yasuyo Kawamura, Timothy Kellogg, George Kichamu, Andrea Kim, Lucy Kimondo, Davies Kimanga, Elija Kinyanjui, Stephen Kipkerich, Danson Kimutai Koske, Boniface O. K'Oyugi, Veronica Lee, Serenita Lewis, William Maina, Ernest Makokha, Agneta Mbithi, Joy Mirjahangir, Ibrahim Mohamed, Rex Mpanzje, Silas Mulwa, Nicolas Muraguri, Patrick Murithi, Lilly Muthoni, James Muttunga, Jane Mwangi, Mary Mwangi, Sophie Mwanyumba, Francis Ndichu, Anne Ng'ang'a, James Ng'ang'a, John Gitahi Ng'ang'a, Lucy Ng'ang'a, Carol Ngare, Bernadette Ng'eno, Inviolata Njeri, David Njogu, Bernard Obasi, Macdonald Obudho, Edwin Ochieng, Linus Odawo, Jacob Odhiambo, Caleb Ogada, Samuel Ogola, David Ojaka, James Kwach Ojwang, George Okumu, Patricia Oluoch, Tom Oluoch, Kenneth Ochieng Omondi, Osborn Otieno, Yakubu Owolabi, Bharat Parekh, George Rutherford, Sandra Schwarcz, Shahnaaz Sharrif, Victor Ssempijja, Lydia Tabuke, Yuko Takenaka, Mamo Umuro, Brian Eugene Wakhutu, Wanjiru Waruiru, Celia Wandera, John Wanyungu, Anthony Waruru, Paul Waweru, Larry Westerman, and Kelly Winter.

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