Burden of HIV Infection Among Children Aged 18 Months to 14 Years in Kenya: Results From a Nationally Representative Population-Based Cross-sectional Survey

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Background: In Kenya, mathematical models estimate that there are approximately 220,000 children aged less than 15 years infected with HIV. We analyzed data from the second Kenya AIDS Indicator Survey (KAIS 2012) to estimate the prevalence of HIV infection among children aged 18 months to 14 years.

Methods: KAIS 2012 was a nationally representative 2-stage cluster sample household survey. We studied children aged 18 months to 14 years whose parents or guardians answered questions pertaining to their children by interview. Blood specimens were collected for HIV serology and viral load measurement.

Results: We identified 5162 children who were eligible for the study. Blood was obtained for 3681 (71.3%) children. Among child participants, 16.4% had been tested for HIV infection in the past, and among children with parents or guardians who self-reported HIV-positive status, 52.9% had been tested for HIV infection. Twenty-eight (0.9%) children tested HIV-positive in the survey. Of these, 11 had been previously diagnosed with HIV infection before the survey. All 11 children were in HIV care and receiving cotrimoxazole; 8 were on antiretorivral therapy (ART). Among those on ART, 4 were virologically suppressed.

Conclusions: HIV causes a substantial burden of disease in the Kenyan pediatric population. Although most children who had been diagnosed with HIV before the survey were engaged in care and treatment, they represented less than half of HIV-infected children identified in the survey. Future efforts should focus on identifying infected children and getting them into care and on suppressive ART as early as possible.

Key Words: HIV, children, Kenya, antiretroviral therapy, testing

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INTRODUCTION

Pediatric HIV infection is a worldwide public health challenge that disproportionately affects children in the poorest parts of the world. The Joint United Nations Programme on HIV/AIDS estimated that at the end of 2011, 3.4 million children younger than 15 years were living with HIV and that 330,000 had been newly infected in the previous year[1,2]; 90% of these children were in sub-Saharan Africa.[2] Pediatric antiretroviral therapy (ART) coverage in low- and middle-income countries, although rapidly expanding, is relatively low. Worldwide, of the estimated 2 million HIV-infected children in need of ART, only 28% have access to ART, which is substantially lower than ART coverage in adults (58%).[2,3] In Africa, of the estimated 3.1 million children living with HIV at the end of 2010, 1.8 million (60%) were estimated to be eligible for ART, but only 387,500 (21%) were receiving it.[3]

In Kenya, an estimated 220,000 children younger than aged 15 years were living with HIV in 2012.[4] Despite efforts to scale-up prevention of mother-to-child transmission of HIV programs, almost 13,000 children were newly infected with HIV in 2011,[5] and there were an estimated 13,000 child deaths due to HIV/AIDS.[6] HIV is thought to cause 9% of all child mortality in Kenya,[7] and many children with severe opportunistic illnesses and undiagnosed HIV infection continue to present to public health care facilities, as has been described elsewhere in Africa.[8] Field experience has shown

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that where pediatric ART is available, the response to treatment of children in low-income countries is as good as that observed in developed countries.[9] Thus, many HIV-related deaths among children living with HIV could be prevented through earlier diagnosis of HIV infection and early initiation of ART. However, despite what is known regarding the benefits of ART, treatment scale-up in the pediatric population has been slower than among adults in Kenya. In 2011, mathematical models estimated that fewer than 1 (31.1%) in 3 children who needed ART was receiving it compared to 8 in 10 adults.[4]

There are a number of reasons for this shortfall. Fear of discrimination has been shown to negatively affect uptake to HIV infant testing and care[10–12]; a recent study in Zimbabwe, for instance, showed that 42% of the parents/guardians feared discrimination against their children as a result of HIV testing.[11] Other factors include lack of integration of antenatal prevention of mother-to-child transmission and pediatric HIV services, which limits the number of children accessing HIV testing in a timely manner; perceived and actual lack of expertise in the care of HIV-infected children; limited availability of some pediatric antiretroviral formulations; the complexities of using ART in the face of multiple co-morbidities (eg, tuberculosis, malaria, malnutrition); and insufficient pediatric health care resources to meet the demand.[13]

At the population level, HIV care and treatment comprise a cascade of interventions with coverage at each step dependent on coverage of the preceding step. This cascade involves diagnosis of HIV infection, linkage to care, determination of ART eligibility, initiation of ART, and successful suppression of viral replication. HIV testing is a critical first step in the cascade of HIV care, as well as the gateway to other prevention, treatment, and care interventions. However, to achieve access, reliable mechanisms must link individuals to needed services. Available evidence suggests considerable shortcomings with linkage and referral, including the lack of routine tracking mechanisms. As HIV diagnosis and treatment programs have scaled up in developing countries, attrition at each step in the cascade of HIV care has emerged as a critical concern limiting overall population-level impact for both adults and children.[14,15] This cascade is well characterized in developed countries,[16] but population-based estimates of pediatric HIV testing and care coverage are not available in most low-income countries, including Kenya.

The second Kenya AIDS Indicator Survey (KAIS 2012) was the first national survey in Kenya to collect HIV-specific data on children from 18 months to 14 years of age. KAIS 2012 allowed for estimation of HIV prevalence among this population and direct assessment of the cascade from diagnosis of HIV infection through suppression of viral replication.

METHODS

Study Design

KAIS 2012 was a nationally representative cross-sectional survey of HIV infection and associated risk behavior among persons aged 18 months to 64 years, conducted from October 2012 to February 2013. Details of the study are described elsewhere.[17] Briefly, a stratified 2-stage sampling design was used to select household clusters from a national household sampling frame, using systematic random sampling; subsequently, from the clusters, eligible households were selected using equal probability systematic sampling. Because of regional security concerns, the North Eastern region was not included in the sampling frame. Since half of the households selected in KAIS 2012 were required for the child sample, every other household was selected after random selection of the first household. These households were designated as child-eligible households. If a child-eligible household did not have an eligible child aged 18 months to 14 years, the next child-eligible household was visited until one with an eligible child was identified.

In this article, we consider all children who were aged 18 months to 14 years and resided in child-eligible households. Individual questionnaires were administered to consenting children's parents or guardians; we refer to this as the interview sample. In child-eligible households, we requested permission to draw blood from eligible children for HIV serology and, if HIV-positive, viral load measurement. We refer to this subsample as the serological sample. Questions pertaining to children aged 18 months to 14 years were embedded in the individual questionnaire for adult women and men and were answered by parents or guardians. These interviews collected information on demographics and HIV testing histories of children residing in the household. If a child was reported as HIV-positive by the parent or guardian, additional information on attendance at HIV clinics, current and past use of ART and cotrimoxazole use was collected. Parents or guardians of children in the serological sample were asked if the child had ever been tested for HIV, and if so, what the result of the test was.

Study Population

Our study population consisted of children aged 18 months to 14 years. Children were included if they were usual residents of the household or present in the household on the night before the survey and had their parent's or guardian's consent.

Measurements

The main outcome variable was HIV infection as determined by laboratory testing. Secondary outcomes among children with previously diagnosed HIV infection included attending an HIV clinic and receiving cotrimoxazole prophylaxis and ART. An additional outcome of interest was HIV RNA concentration among those who tested HIV-positive in the serological sample. We used an HIV RNA concentration threshold of <1000 copies per milliliter to define virologic suppression.

Laboratory Methods

We asked parents or guardians of eligible children for their verbal consent to collect a blood sample for biologic

testing and extended storage for future unspecified testing at the National HIV Reference Laboratory (NHRL) in Nairobi. At NHRL dried blood spot specimens were tested for HIV antibody using the Vironostika HIV-1/2 UNIF II plus O Enzyme Immunoassay (bioMérieux SA, Marcy l'Etoile, France) and confirmed using the Murex HIV.1.2.O HIV Enzyme Immunoassay (DiaSorin SpA, Saluggia, Italy). Repeat testing was done for discordant results, and, if results remained discordant, a final determination was made using polymerase chain reaction for HIV antigen (Cobas Amplicor HIV-1 Monitor Test, version 1.5; Roche Molecular Diagnostics, Pleasanton, CA). We tested all confirmed HIV-positive blood specimens for HIV RNA concentration (Abbott M2000 Real-Time HIV-1 Assay; Abbott Laboratories, Abbott Park, IL). Test results from the NHRL were not returned to study participants. Home-based HIV testing and counseling, using rapid tests according to the national HIV testing algorithm, was offered to all persons participating in the survey, including parents and guardians of participating children.

Statistical Analysis

We merged interview and laboratory data to produce a final survey dataset for cleaning and analysis. We weighted survey data to correct for unequal probability of selection and adjust for nonresponse. The analysis on the interview sample (ie, eligible children with available interview data from their parent or guardian) was restricted to describing sociodemographic and HIV testing characteristics. The analysis on the serological sample (ie, eligible children for whom we drew blood for HIV serology) included a description of sociodemographic characteristics, HIV testing characteristics, and for HIV-positive children, access to HIV care and treatment. We estimated point prevalences and 95% confidence intervals (CI). The Taylor Series Linearization method was used to compute variance estimates. For continuous variables, we calculated medians and interquartile ranges. Categorical factors associated with HIV infection were examined using the χ^2 test, and strength of associations were presented as odds ratios. We used non-normalized survey weights, based on the 2012 population projections from the 2009 national census, to estimate the national number and 95% CI of HIV-infected children aged 18 months to 14 years.[18] SAS version 9.3 (SAS Institute, Cary, NC) was used for statistical analyses. Because estimates based on small sample sizes are not reliable and cannot be generalized to the broader population, we do not present weighted estimates and 95% CI for indicators based on denominators of less than 30 observations. This includes indicators describing access to care and treatment among HIV-infected children.

Ethical Considerations

The KAIS 2012 protocol was approved by the Kenya Medical Research Institute Ethical Review Committee, the US Centers for Disease Control and Prevention Institutional Review Board, and the Committee on Human Research of the University of California, San Francisco. We obtained permission from parents or guardians to draw blood and assent from children aged 10 years or older. Home-based HIV testing and counseling was done in a private location within the household. The results of home-based testing were recorded by the counselor in a password-protected tablet computer using the unique identification number for the participant. Home-based HIV test results were disclosed to parents or guardians.

RESULTS

In total, there were 9189 KAIS 2012 households of which 4146 were child-eligible; 5162 of 9683 children in these households were found to be eligible. Of the 5162 eligible children, half (50.1%) were boys. The median age was 8.4 years (interquartile range, 4.8–11.7), and 25.4% were aged 18 months to 4 years (Table 1). For 7.4% of children (95% CI: 6.0 to 8.7), 1 parent had died, and for 1.3% of children (95% CI: 0.9 to 1.8), both parents had died. Overall 74.3% of children (95% CI: 71.2 to 77.4) resided in rural areas; the largest proportions were from the poorest (26.9%, 95% CI: 22.3 to 31.5) and second poorest (26.6%, 95% CI: 23.9 to 29.3) household wealth quintiles. Overall, 2.6% of children (95% CI: 1.7 to 3.5) had parents or guardians who reported an HIV-positive status.

Of the 5162 eligible children, 3681 (71.3%) children had consent obtained for the blood draw for HIV serology and viral load measurement in the NHRL (serological sample). Children who provided blood were comparable with those who did not provide blood with respect to most baseline characteristics assessed except for age ($P < 0.0001$), geographic region ($P < 0.0001$), and self-reported HIV status of the child's parent or guardian ($P = 0.0019$). Compared with children who did not provide blood, children who provided blood were more likely to be aged 10–14 years (42.0% vs. 31.6%); reside in Central (10.8% vs. 5.5%), Nyanza (17.9% vs. 11.2%) and Western (16.9% vs. 9.1%) regions; and have a parent or guardian who self-reported HIV-positive status (3.3% vs. 1.0%), respectively (Table 1). Among children in the serological sample, 16.9% (95% CI: 13.8% to 20.0%) had been tested for HIV before the survey.

Overall, 28 (0.9%, 95% CI: 0.5 to 1.3) children tested HIV-positive in the survey (Table 2). HIV prevalence among girls was 1.1% (95% CI: 0.4 to 1.7) compared with 0.7% (95% CI: 0.3 to 1.1) among boys. Children younger than 5 years of age had a HIV prevalence of 1.6% (95% CI: 0.5 to 2.7) and had significantly higher odds of being HIV-positive compared with older children aged 10–14 years (odds ratio, 2.9, 95% CI: 1.1 to 7.5). Children whose parents were dead (ie, 1 or both parents) had similar HIV prevalence (0.8%, 95% CI: 0 to 1.8) compared with children whose parents were alive (0.7%, 95% CI: 0.4 to 1.1). Children living in rural residences also had similar HIV prevalence compared with children living in urban residences (0.9%, 95% CI: 0.4 to 1.4 vs 0.8%, 95% CI: 0.1 to 1.6, respectively). High HIV prevalence was observed among children whose parent or guardian self-reported HIV-positive status (6.5%, 95% CI: 2.9 to 10.2) and among children who had been tested for HIV infection in the past (3.2%, 95% CI: 1.3 to 5.1).

Due to the small sample size of children with laboratory-confirmed HIV infection (N = 28), the following section

TABLE 1. Select Sociodemographic and Testing Characteristics Among Children Aged 18 Months to 14 Years, Kenya AIDS Indicator Survey 2012

	Interview Sample (N = 5162)		Interviewed With No Serology (N = 1481)		Interviewed With Serology—Serological Sample (N = 3681)	
Variable	Unweighted, n*	Weighted % (95% CI)	Unweighted, n*	Weighted % (95% CI)	Unweighted, n*	Weighted % (95% CI)
Sex						
Boy	2569	50.1 (48.5 to 51.7)	751	51.1 (48.5 to 53.6)	1818	49.7 (47.8 to 51.6)
Girl	2593	49.9 (48.3 to 51.5)	730	48.9 (46.4 to 51.5)	1863	50.3 (48.4 to 52.2)
Age category						
18 months to 4 yrs	1320	25.4 (24.0 to 26.7)	469	32.7 (29.8 to 35.6)	851	22.4 (20.9 to 24.0)
5–9 yrs	1888	35.6 (34.1 to 37.1)	539	35.7 (33.2 to 38.3)	1350	35.6 (33.7 to 37.4)
10–14 yrs	1954	39.0 (37.3 to 40.7)	474	31.6 (28.6 to 34.5)	1480	42.0 (39.9 to 44.0)
Orphan status						
Both parents dead	60	1.3 (0.9 to 1.8)	13	1.0 (0.4 to 1.6)	47	1.5 (0.9 to 2.0)
One parent dead	407	7.4 (6.0 to 8.7)	99	5.6 (3.9 to 7.2)	308	8.1 (6.5 to 9.8)
Both parents alive	4603	89.5 (88.0 to 91.1)	1343	91.9 (89.9 to 93.9)	3260	88.5 (86.6 to 90.4)
Unknown	92	1.8 (1.2 to 2.3)	26	1.5 (0.6 to 2.4)	66	1.9 (1.2 to 2.6)
Region						
Nairobi	366	6.2 (5.0 to 7.3)	170	9.7 (7.9 to 11.6)	196	4.7 (3.6 to 5.8)
Central	452	9.3 (7.8 to 10.7)	78	5.5 (3.8 to 7.3)	374	10.8 (8.9 to 12.7)
Coast	675	9.5 (7.2 to 11.9)	200	11.7 (7.1 to 16.4)	475	8.7 (6.3 to 11.0)
Eastern	1248	16.4 (13.8 to 19.0)	448	23.1 (18.3 to 27.9)	800	13.7 (11.2 to 16.1)
Nyanza	704	16.0 (13.2 to 18.7)	143	11.2 (8.0 to 14.4)	561	17.9 (14.2 to 21.6)
Rift Valley	927	28.0 (24.0 to 32.0)	299	29.6 (24.2 to 35.0)	628	27.4 (22.6 to 32.2)
Western	790	14.7 (12.7 to 16.6)	143	9.1 (7.1 to 11.2)	647	16.9 (14.4 to 19.4)
Residence						
Rural	3782	74.3 (71.2 to 77.4)	1009	71.4 (67.0 to 75.9)	2773	75.4 (71.7 to 79.2)
Urban	1380	25.7 (22.6 to 28.8)	472	28.6 (24.1 to 33.0)	908	24.6 (20.8 to 28.3)
Wealth index quintiles						
Poorest	1424	26.9 (22.3 to 31.5)	420	27.0 (20.9 to 33.0)	1004	26.8 (21.7 to 32.0)
Second	1333	26.6 (23.9 to 29.3)	324	23.9 (20.1 to 27.7)	1009	27.7 (24.6 to 30.8)
Middle	1098	22.1 (19.4 to 24.8)	305	21.5 (16.8 to 26.2)	795	22.5 (19.8 to 25.2)
Fourth	723	13.4 (11.2 to 15.7)	211	13.4 (10.0 to 16.8)	510	13.4 (11.1 to 15.7)
Richest	584	11.0 (8.9 to 13.0)	221	14.2 (10.8 to 17.7)	363	9.7 (7.5 to 11.8)
Self-reported HIV status of parent/guardian						
HIV-positive	93	2.6 (1.7 to 3.5)	14	1.0 (0.2 to 1.8)	79	3.3 (2.1 to 4.5)
HIV-negative	3611	97.4 (96.5 to 98.3)	1120	99.0 (98.2 to 99.8)	2491	96.7 (95.5 to 97.9)
HIV testing history of child of HIV-positive parent/guardian						
Child ever been tested	48	52.9 (39.5 to 66.2)	10	76.2 (55.6 to 96.7)	38	49.6 (35.7 to 63.5)
Child never been tested/don't know	45	47.1 (33.8 to 60.5)	4	23.8 (3.27 to 44.4)	41	50.4 (36.5 to 64.3)
Child tested before KAIS 2012						
Yes	742	16.4 (13.9 to 18.9)	205	15.2 (12.2 to 18.2)	537	16.9 (13.8 to 20.0)
No	3883	83.6 (81.1 to 86.1)	1185	84.8 (81.8 to 87.8)	2698	83.1 (80.0 to 86.2)

*Due to missing responses totals may vary between variables.

describes, in absolute numbers, select indicators in the cascade of care for HIV-positive children. Of the 28 children who were found to be HIV-infected in our sample, 11 had been previously diagnosed with HIV infection. Among these 11, all had attended an HIV clinic at least once before the survey and were currently taking daily cotrimoxazole. Eight were currently on ART and of those, 4 were virologically suppressed. Three of the 28 HIV-infected children were orphans with at least 1 parent who had died.

DISCUSSION

Our study provides the first population-based estimate of children living with HIV in Kenya. We found that the overall prevalence of HIV infection in children aged 18 months to 14 years was 0.9%, corresponding to an estimated 104,000 HIV-infected children in this age group. Previous estimates on the burden of HIV among children have been measured indirectly through mathematical modeling.[6,19] These models estimated that approximately 200,000 children

TABLE 2. HIV Prevalence Among Children Aged 18 Months to 14 Years and Associations With Select Sociodemographic, Testing, and Clinical Characteristics, Kenya AIDS Indicator Survey 2012

Variable	Unweighted, N*	Unweighted, n	Weighted % (95% CI)	Odds Ratio (95% CI)	*P*
Total	3681	28	0.9 (0.5 to 1.3)	—	—
Sex					
Boy	1818	14	0.7 (0.3 to 1.1)	1.0	—
Girl	1863	14	1.1 (0.4 to 1.7)	1.6 (0.7 to 3.5)	0.241
Age categories					
18 months to 4 years	851	9	1.6 (0.5 to 2.7)	2.91 (1.1 to 7.5)	0.028
5–9 years	1350	10	0.8 (0.1 to 1.4)	1.42 (0.5 to 3.8)	0.485
10–14 years	1480	9	0.6 (0.2 to 0.9)	1.0	—
Parent status					
One or both parents dead	355	3	0.8 (0.0 to 1.8)	1.1 (0.3 to 4.3)	0.914
Both parents alive	3260	20	0.7 (0.4 to 1.1)	1.0	—
Residence					
Rural	2773	21	0.9 (0.4 to 1.4)	1.1 (0.4 to 3.1)	0.896
Urban	908	7	0.8 (0.1 to 1.6)	1.0	—
Self-reported HIV status of parent/guardian†					
Parent/guardian is HIV-positive	237	15	6.5 (2.9 to 10.2)	17.4 (7.5 to 40.4)	<0.001
Parent/guardian is HIV-negative	2932	9	0.4 (0.1 to 0.7)	1.0	—
HIV testing history of child of HIV-positive parent/guardian					
Child ever tested	99	11	11.0 (3.8 to 18.2)	4.7 (1.4 to 16.4)	0.015
Child never tested	136	4	2.6 (0 to 5.32)	1.0	—
Child tested before KAIS 2012					
Yes	537	14	3.2 (1.3 to 5.1)	7.9 (3.3 to 18.8)	<0.001
No	2698	10	0.4 (0.1 to 0.7)	1.0	—
Child's reported HIV status					
HIV-positive	11	11	‡	—	—
HIV-negative	495	3	0.8 (0 to 1.8)	—	—

*Due to missing responses, totals vary between variables.
†Data missing for 392 children whose parent/guardian was not interviewed.
‡Estimate unreliable and suppressed due to small sample size.

younger than 15 years were living with HIV in 2010, of whom an estimated 158,000 required ART. Our survey identified fewer children living with HIV compared to these indirect estimates. Our estimates are likely to underestimate the true burden of pediatric HIV infection given that our survey sampled children who had already survived up to 18 months. Without ART, 30% HIV-infected children are expected to die by 1 year of age. This increases to 50% by the second year.[20] Thus, our estimation of the burden of pediatric HIV in Kenya omits a substantial number of children who die early if no intervention is provided. We also found variability in the burden of HIV among children, with a decrease in HIV prevalence with increasing age. This is consistent with the likely high mortality in the infected pediatric population in Africa from earlier birth cohorts.[20,21] Orphanhood was much lower than that reported in previous studies, which have estimated that about 45% of children with HIV infection will be orphaned,[22,23] but selective mortality among children and their parents may have led to our lower estimates. Another possibility is that the scale-up of ART for adults may have resulted in more parents surviving. Also the proportion of orphans in our study could be an underestimation considering that children whose parents' status was unknown may have been orphaned.

Only 16% of children were reported to have had a previous HIV test, and less than half of children with HIV-infected parents or guardians had ever been tested for HIV. Our study also confirmed that most children who were living with HIV remained undiagnosed and unable to access care and treatment. Although significant progress has been made in scaling up HIV testing for adults,[24] these findings highlight the need to improve testing strategies for children. The high proportion of undiagnosed HIV infection, particularly among those children whose parents or guardians were infected, underscores the magnitude of missed opportunities for diagnosis of HIV infection. Expansion of family testing strategies in facility and community-based settings can help to rapidly increase identification of HIV-infected children and link them into care.[25]

We were encouraged to find that all children in the sample who had been previously diagnosed with HIV infection had accessed HIV care and had started cotrimoxazole prophylaxis. Nonetheless, that only 8 of 28 children with laboratory-diagnosed HIV infection were receiving ART should be a cause for concern. In addition, only half of children who were currently on ART were virologically suppressed. This was lower than proportions reported in other studies in Kenya where the estimated proportion of children

who were able to achieve and maintain virologic suppression was around 70%.[25,26] Because we did not assess the duration of ART for these children, it is possible that some of these children may have initiated ART recently and therefore not yet achieved viral suppression.

Our study had several limitations. Although the majority of childhood infections are likely to occur in children younger than aged 18 months, we chose to survey only children from 18 months of age because of the complicated logistics of RNA testing in the field and returning results for these children after survey teams had left the cluster. Therefore, our estimates are not generalizable to all children. The details of medical histories were obtained from mothers and other caregivers, and we were unable to confirm these data by chart review, introducing the potential for recall bias. Finally, although this was a national household survey, we were only able to identify 28 HIV-infected children. Based on this small sample size, some of our estimates are imprecise and not generalizable to the broader population. Caution should therefore be used when interpreting reported indicators of care and treatment among HIV-infected children.

Despite these limitations, KAIS 2012 is the first survey to provide direct estimates of HIV-related indicators for children, information that program managers and policy makers can use immediately to inform pediatric programs for HIV prevention, care, and treatment. HIV causes a substantial burden of disease in the pediatric population in Kenya. Future efforts should focus on expanded testing of children to identify HIV-infected children and getting them into care and on suppressive ART as early as possible.

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