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Comparison of HIV Prevalence Estimates from Antenatal Care Surveillance and Population-Based Surveys in Sub-Saharan Africa

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ABSTRACT

Background: In countries with generalized epidemics, national estimates of HIV prevalence levels and trends in the adult population are generally derived indirectly from surveillance of pregnant women attending selected antenatal care (ANC) clinics. ANC data however, come from a subset of the population and may not represent the true population prevalence.

Objective: To compare HIV seroprevalence estimates obtained from ANC sentinel surveillance surveys in Ethiopia, Kenya, Malawi, Tanzania, and Uganda with those from population-based Demographic and Health Surveys (DHS) and AIDS Indicator Surveys (AIS).

Methods: Geographic information system (GIS) methods were used to map sentinel surveillance sites and DHS/AIS survey clusters within a 15 km radius of the ANC surveillance sites. National DHS/AIS HIV prevalence estimates for women were compared with national prevalence estimates from ANC surveillance. DHS/AIS HIV prevalence estimates for women residing within 15 km of ANC sites were compared to those from ANC surveillance. These comparisons were also stratified by current pregnancy status, experience of recent child birth, and receiving ANC for the last birth.

Results: In four of the five countries, national DHS/AIS estimates of HIV prevalence were lower than the ANC surveillance estimates. Comparing women in the catchment

areas of the ANC sites, the DHS/AIS estimates were similar to ANC surveillance estimates. ANC estimates were higher for younger women than DHS/AIS estimates for women in ANC catchment areas, but lower at older ages. In all cases, urban prevalence was higher than rural prevalence, but there were no consistent patterns by education.

Conclusions: ANC surveillance surveys tend to overestimate HIV prevalence compared to prevalence among women in the general population in DHS/AIS surveys. However, the ANC and DHS/AIS estimates are similar when restricted to women residing in catchment areas of ANC sites. Patterns by age and urban/rural residence suggest possible bias in the ANC estimates.

Key words: HIV, AIDS, prevalence, surveillance, estimates, surveys, sub-Saharan Africa

INTRODUCTION

The HIV/AIDS epidemic is one of the largest public health crises of the 21st century. While the epidemic has spread over the past two decades, a cure or vaccine for HIV has remained elusive. In 2006, UNAIDS estimated that about 40 million people were living with HIV infection worldwide (UNAIDS, 2006). The HIV prevalence estimates have come under increased scrutiny in recent years and some countries have revised their estimates downward as more reliable data have become available. For example, the number of HIV-infected people in India was revised downward from 5.7 million to 2.5 million in 2007. Similar downward adjustments in HIV prevalence estimates have also been made for several countries in sub-Saharan Africa. As a consequence, UNAIDS and WHO have recently lowered the global estimate of the number of HIV-infected people from 39.5 million in 2006 to 33.2 million in 2007 (UNAIDS/WHO/CDC, 2007). While some imprecision in the global total may not make a substantial difference in international attention to the epidemic or resource allocations, the extent of imprecision may vary greatly by country and may have major consequences for the local public health response. Reliable data on HIV prevalence in the general population are essential for an effective response to the epidemic and its consequences.

Since the late 1980s, country-specific HIV prevalence estimates in countries with generalized epidemics have been derived from data collected at health facilities providing antenatal care for pregnant women (WHO/UNAIDS, 2003). Pregnant women are considered to be a good proxy for the general population, and this population is accessible through routine antenatal care visits, where blood is generally collected for

other tests. However, HIV prevalence estimates based on pregnant women may be affected by biases which can lead to over-estimation of HIV prevalence among the general population (Boerma et al., 2003; Gregson et al., 2002). Pregnant women are an imprecise proxy for the general population if pregnancy occurs more frequently at younger ages, and among rural, poorer women. Pregnant women are sexually active and may have been exposed to HIV, unlike their non-sexually active peers. HIV-infected women may be physiologically less likely to become pregnant, which can lead to an underestimation among women of the same age in the general population. Furthermore, ANC coverage is not universal in all countries, the ANC surveillance sites often cover a limited, more urbanized geographic area, and finally the ANC surveillance data do not provide information on men (Gouws et al., 2008).

Given the increasing need for more precise data on the HIV epidemic, the population-based Demographic and Health Surveys (DHS) began to include HIV testing of adult women and men in 2001. Population-based surveys have many advantages: they provide representative estimates for both women and men, for geographic regions, and by age groups (Mishra et al., 2006). Population surveys offer another significant advantage: the linkage of HIV status with individual respondent and household characteristics. The linked surveys allow for the analysis of behavior, knowledge, and background characteristics as they relate to HIV status. Since 2001, some three dozen population-based surveys with HIV testing have been conducted or are being carried out under the Demographic and Health Surveys project (www.measuredhs.com).

WHO/UNAIDS have published annual estimates of HIV prevalence among adults age 15-49 since 1990. ANC data have been the primary source of HIV prevalence data used to model these population estimates. UNAIDS annual estimates have taken into account the newly available population-based data, which has led to the revision of current HIV prevalence estimates (UNAIDS, 2006; UNAIDS/WHO, 2007). In most cases where the revisions have been substantial, the prevalence estimates have been revised downward, with the notable exception of Uganda where the estimates have been revised upward.

The purpose of this analysis is to quantify and interpret the differences between HIV prevalence estimates obtained from ANC sentinel surveillance surveys and from DHS/AIS surveys in selected countries in sub-Saharan Africa. The results may be used to improve existing models and projections for HIV prevalence in the general population.

DATA AND METHODS

The population-based survey data used in this analysis are from three Demographic and Health Surveys (Ethiopia, Kenya, and Malawi) and two AIDS Indicator Surveys (Tanzania and Uganda), conducted during 2003 and 2005 (Kenya CBS, MOH, ORC Macro, 2004; Ethiopia CSA, ORC Macro, 2006; Uganda MOH, ORC Macro, 2006; Malawi NSO, ORC Macro, 2005; Tanzania TACAIDS, NBS, ORC Macro, 2005). The ANC surveillance data for these five countries were obtained from available ANC sentinel surveillance surveys, conducted during the same time period (MOH-Ethiopia,

2006, MOH-Malawi, 2005; Kenya MOH, 2004; Tanzania MOH, 2005; Musinguziet al., 2008). Sample sizes for all surveys are provided in Table 1.

Table 1. Comparisons of ANC and DHS/AIS survey samples of women age 15-49 in Ethiopia, Kenya, Malawi, Tanzania, and Uganda, 2003-05.

	DHS/AIS		ANC					
Country	Number of women tested & interviewed (unweighted)	Year	Number of women	Year	Number of DHS/AIS Clusters	Number of ANC sites	Number of DHS/AIS clusters within 15k catchment area of ANC sites	Number of women within 15k catchment area of ANC sites interviewed in DHS/AIS (unweighted)
Ethiopia	5,942	2005	28,247	2005	540	88	165	2,527
Kenya	3,273	2003	10,616	2003	400	40	153	1,745
Malawi	2,864	2004	8,953	2005	522	19	139	1,118
Tanzania	5,973	2003-04	17,813	2003-04	400	59	71	1,570
Uganda	9,376	2004-05	9,668	2005	417	19	111	2,817

Demographic and Health Surveys

The DHS/AIS surveys carried out in each of the five countries were designed to obtain national and regional estimates of HIV prevalence and associated socio-demographic and behavioral indicators among women and men. The DHS surveys follow a two stage selection process, where a random sample of clusters from the most recent national sample frame is first selected. In the second stage, all households are listed and the final systematic random sample of households is selected. During the main fieldwork, eligible women (age 15-49) and men (usually age 15-59) are selected for HIV testing. An individual is only considered absent after three callback visits. The DHS/AIS sample sizes take into account the estimated national HIV prevalence in each country, expected non-response rates for men and women, as well as design effects and expected confidence intervals.

To obtain reliable national estimates of HIV prevalence disaggregated by age and sex, and urban/rural residence, a representative sample of at least 3,000 households is required. If, on average, there is one eligible male and one eligible female in each sample household and if 10% of those eligible do not participate in the survey, this yields a final sample of approximately 5,400 tested adults. For a population with an estimated HIV prevalence of 5%, such a sample would provide a 95% confidence interval of 4.3% to 5.7% at the national level. Larger sample sizes are required if the prevalence of HIV is lower or if further disaggregation of HIV estimates is desired (Mishra et al., 2006).

Sample selection differed slightly in the surveys included in this analysis. In Ethiopia, half of the households were systematically selected for HIV testing; within these households all men age 15-59 and all women age 15-49 were tested. Similarly in Kenya, a systematic selection of half of the sample households were selected for HIV testing. Within those households, all men age 15-54 and all women age 15-49 were tested for HIV. In Malawi, one third of the sample households were selected for HIV testing; within those, all men age 15-54 and all women age 15-49 were tested. In Tanzania, all men and women age 15-49 were tested for HIV in all sample households. Finally, in Uganda, all men and women age 15-59 were tested for HIV in all sample households.

The interviews include questions on socio-economic and demographic characteristics, marriage, sexual activity and behaviors, reproductive health, and knowledge of HIV/AIDS. HIV testing was carried out on blood specimens from consenting individuals. The HIV test results were merged to the interview data after the

survey data had been double entered in CSPro and all personal identifiers were removed. Details of the specimen collection, laboratory testing, and ethical issues have been discussed elsewhere (Mishra et al., 2006).

The DHS/AIS surveys also routinely collect latitude and longitude coordinates for the communities where the survey respondents live (Montana and Spencer, 2004). One location is recorded for each primary sampling unit in the sample. In order to maintain confidentiality of the survey respondents, these locations are offset randomly by a maximum of two kilometers in urban areas, and five kilometers in rural areas. While the offsetting may introduce some bias in geographic analysis, the error is random and likely to be small. However, the geographic scale of this analysis is large enough that the offsetting is not expected to bias the results significantly.

Antenatal Care Surveillance Surveys

ANC surveillance systems have been in place for a number of years in all five countries included in this analysis. The latest round of available surveillance estimates were used for this analysis. The ANC surveillance sample sizes for the five countries included in this study range from 8,953 in Malawi to 28,247 in Ethiopia. The sample sizes reflect the total population size of the country. These data collection systems provide regular information to monitor HIV prevalence. ANC surveillance data from the five countries in this analysis followed the methodology described in the WHO guidelines (WHO/UNAIDS/CDC, 2003). The sampling design for ANC site selection was specific to each country's surveillance system, and the sites were distributed between urban and

rural areas. The number of surveillance sites in each country depended partly on the percentage of the general population who use ANC services, as well as the total population of the country. For example, in Ethiopia where ANC coverage is relatively low and the population is large and disparate, a total of 88 sites throughout the country participated in the ANC surveillance survey. In Malawi, with comparatively high ANC coverage and a small population, a total of 19 ANC sites were included in the surveillance survey.

Pregnant women who presented at the sentinel sites for their first prenatal visit were generally eligible for participation in the surveys. Women are selected consecutively until the target sample size – 200 to 400 – women is reached. At the end of a three-month period, the sampling ceases regardless of whether the target is reached. An exception was Ethiopia, where the target sample size was 250 for rural sites, and 400 for urban sites. Because of the low ANC coverage in the country, the data collection period was extended to 20 weeks for the rural sites, and those that were unlikely to meet the target number collaborated with satellite sites. In Uganda, target sample size ranged from 300 to 800 in 19 sites. In Kenya, target sample size ranged from 200 to 400 in 40 sites. In the ANC surveys, the participants were generally not informed of their inclusion in the surveillance sample. Participants had their blood samples taken routinely for other tests as part of their ANC visit, and the same samples were anonymized and used for HIV testing. Because the surveillance HIV test results were not linked to patient records, informed consent was not required according to the WHO guidelines (WHO/UNAIDS/CDC, 2003).

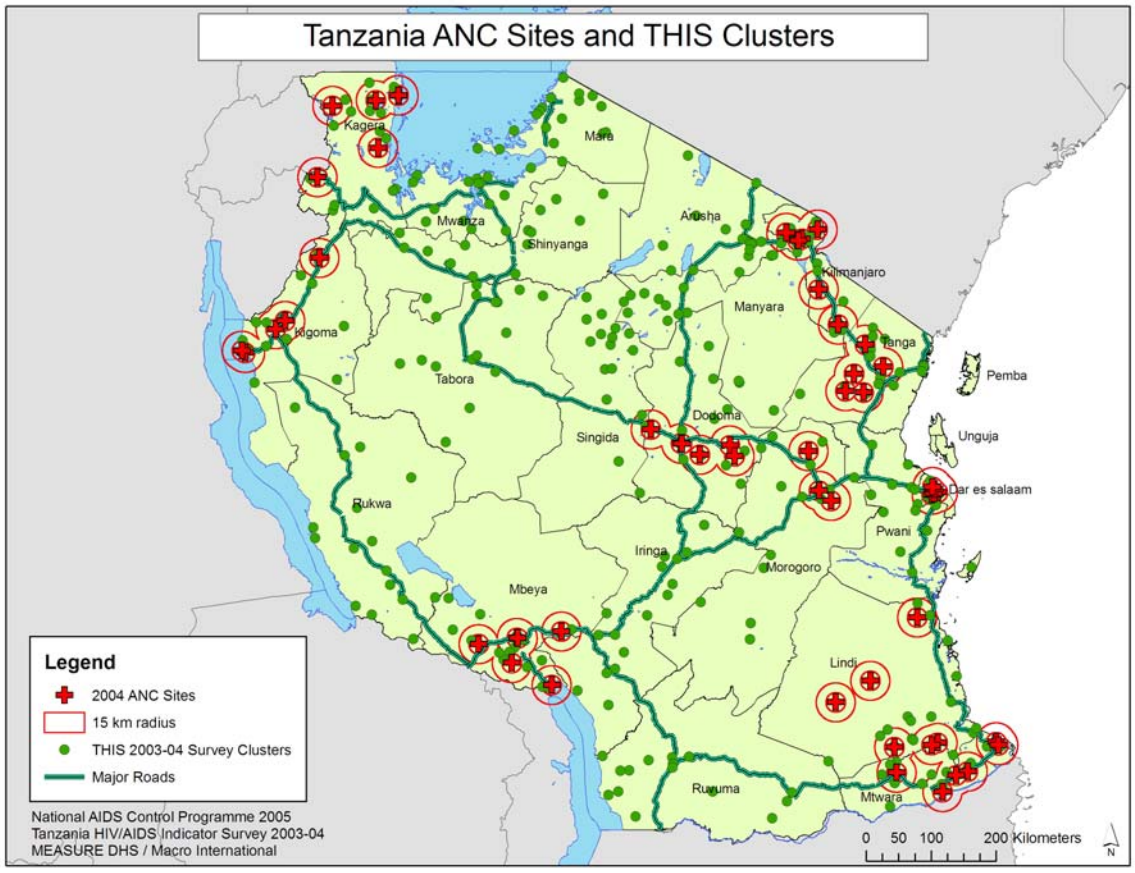
Geographic Information System Methods

A GIS-based methodology was used to identify the DHS/AIS clusters which were located within a reasonable distance of the ANC sites. Sample households within these clusters were expected to represent the catchment population of the ANC site.

A list of ANC surveillance facilities was obtained from the published sentinel surveillance reports for each country. Locations of the health facilities were georeferenced to the town or village where the site was located, or the facility itself. In Ethiopia, the locations of the health facilities were provided by the Ministry of Health. The locations of ANC sites in Tanzania were georeferenced to corresponding towns and villages from the WHO/HealthMapper database (version 4.2, WHO, 2006). Missing facilities were matched to town or village locations manually, or by obtaining GPS coordinates in collaboration with the National AIDS Control Programme. In Malawi, sentinel sites were matched to the facility GPS locations from the Ministry of Health Update of the Census of Health Facilities. In Uganda, the sentinel sites were located in the WHO/HealthMapper database (version 4.2, WHO, 2006) and were updated in collaboration with the Ministry of Health. The ANC sites in Kenya were georeferenced by matching the sentinel sites to the list of health facilities in the KEMRI/Wellcome Trust database and the WHO/Service Availability Mapping database. (KEMRI/Wellcome Trust, 2007; WHO, 2005). All coordinates were projected to corresponding Universal Transverse Mercator (UTM) zones for each country.

The georeferenced locations of the ANC surveillance sites were then plotted with the DHS/AIS cluster locations. The distance from each DHS/AIS cluster to the nearest ANC site was calculated in kilometers as Euclidian distance using ArcView 9.1 (ESRI 2006). For each ANC site, the DHS clusters within 15 km were identified. The 15 km radius was used as an approximation of the geographic catchment area of the ANC site. The DHS/AIS sample clusters typically follow the distribution of the population in the country. The distribution of ANC sites in Tanzania illustrates the common scenario whereby the ANC sites are unevenly distributed across the country, and are typically located near major roads or towns (Figure 1).

Figure 1. Tanzania HIV/AIDS Survey Clusters and ANC Surveillance Sites



After identifying the DHS/AIS clusters within 15 km of an ANC site in each country, HIV prevalence estimates for women age 15-49 residing in the 15 km catchment areas of ANC sites were compared with ANC surveillance estimates for women age 15-49. DHS/AIS survey estimates for women were tabulated by current pregnancy status, experience of birth in past three years, and whether attended ANC for the last birth. Comparisons were also made by broad age groups, urban/rural residence, and educational status.

HIV prevalence estimates for the ANC surveillance data were taken from published surveillance reports cited previously. These estimates represent the unadjusted average prevalence for the total ANC surveillance sample. Because the ANC surveillance sites are purposively selected, and represent convenience samples of pregnant ANC attenders without a known probability of selection, it is not possible to calculate standard errors or meaningful confidence intervals for these estimates. Other research has suggested that plausibility bounds could be considered instead of confidence intervals for ANC estimates; these bounds range from plus or minus 3-4 percent depending on the stage of the epidemic and the strength of the surveillance system (Grassly et al., 2004; Morgan et al., 2006). DHS/AIS estimates are presented with 95 percent confidence intervals for comparison purposes. An ANC estimate which falls within the 95 percent confidence interval of the DHS/AIS estimate is not considered to be significantly different from the DHS/AIS estimate.

RESULTS

In four of the five countries in this analysis, national DHS/AIS surveys estimated HIV prevalence among women age 15-49 to be lower compared to HIV prevalence based on ANC surveillance data (Table 2). In Ethiopia, the ANC estimate for women was about three-times the estimate obtained in the DHS. The ANC estimates were also higher for Malawi, Tanzania, and Kenya than the DHS/AIS estimates, but in Kenya the difference between the ANC and the DHS estimates was not statistically significant. In Uganda, the ANC surveillance survey estimated HIV prevalence among women at 6.0 percent, significantly lower than the DHS estimate at 7.5 percent. Comparing ANC and DHS/AIS estimates in urban and rural areas revealed similar patterns in that HIV prevalence was higher in urban areas in all countries in both data sources.

Table 2. Comparison of HIV prevalence among women age 15-49 in ANC sentinel surveillance and among women in DHS/AIS surveys who live in a community within 15km from the nearest ANC surveillance site, 2003-05

	HIV prevalence						
	All women in DHS/AIS surveys**; all women in ANC sentinel surveys						Women in DHS/AIS survey* who live in a community within 15km from the nearest ANC site
	Urban		Rural		Total		
Country	DHS/AIS	ANC	DHS/AIS	ANC	DHS/AIS	ANC	
Ethiopia	7.7 (6.4-9.0)	9.5	0.7 (0.4-0.9)	2.2	1.9 (1.5-2.2)	5.3	4.3 (3.4-5.3)
Kenya	12.3 (10.2-14.3)	11.0	7.5 (6.4-8.6)	8.9	8.7 (7.7-9.6)	9.4	9.8 (8.1-11.5)
Malawi	18.0 (14.1-21.9)	20.4	12.5 (11.2-13.8)	13.0	13.3 (12.1-14.6)	16.9	18.5 (15.7-21.3)
Tanzania	12.0 (10.4-13.6)	11.4	5.8 (5.1-6.5)	3.4	7.7 (7.0-8.4)	8.7	8.6 (7.0-10.2)
Uganda	12.8 (11.2-14.4)	7.6	6.5 (6.0-7.1)	5.3	7.5 (7.0-8.0)	6.0	8.0 (6.9-9.1)

(95% CI), *unweighted, **weighted

In all five countries, HIV prevalence was higher among women who lived in a community within 15 km of the nearest ANC surveillance site than among all women

included in the DHS/AIS survey, though this difference was only significant in Malawi and Ethiopia (Table 2). In three of the five countries, Kenya, Malawi, and Uganda, the DHS/AIS estimate of HIV prevalence among women in the ANC catchment areas was greater (though not significantly) than the estimate from the ANC surveillance surveys. In Tanzania, the AIS estimate in the 15 km catchment area of the ANC sites was about the same (8.6%) as the ANC estimate (8.7%). In the fifth country, Ethiopia, the DHS estimate in the ANC catchment areas was much closer (4.3%) to the ANC surveillance survey estimate (5.3%) than the DHS national estimate for all women (1.9%), though these differences were not significant.

In all five countries, women who were pregnant at the time of the DHS/AIS survey did not have significantly lower HIV prevalence than those who were not pregnant (Table 3). HIV prevalence was significantly lower among women who gave birth in the three years preceding the DHS/AIS survey than among those who did not in three countries – Malawi, Tanzania, and Uganda. However, there was no clear pattern in prevalence among women who received ANC for the last birth. In Ethiopia, HIV prevalence was significantly higher among women who gave birth in the last three years and received ANC for their last birth than among women who did not receive ANC or did not give birth in the last three years. On the contrary, in three countries – Malawi, Tanzania, and Uganda – this pattern was reversed, i.e., HIV prevalence was significantly lower among women who attended ANC for their last birth in the three years preceding the survey than among those who did not. There was no statistically significant difference for Kenya.

Table 3. Comparison of HIV prevalence among women age 15-49 in ANC sentinel surveillance and in DHS/AIS surveys by pregnancy status, recent birth experience, and receiving antenatal care for last birth, 2003-05

		DHS/AIS			
	ANC	All women (weighted)		Women who live in a community within 15km from the nearest ANC site (unweighted)	
	%	% (95%CI)	n	% (95%CI)	n
Ethiopia					
Total	5.3	1.86 (1.5-2.2)	5,736	4.34 (3.4-5.3)	1,911
Currently pregnant					
No		1.93 (1.6-2.3)	5,256	4.49 (3.5-5.4)	1,810
Yes		1.14 (0.2-2.1)	480	1.98 (0-4.7)	101
Gave birth in last 3 years					
No		1.96 (1.5-2.4)	3,308	4.74 (3.6-5.9)	1,417
Yes		1.73 (1.2-2.3)	2,428	3.24 (1.7-4.9)	494
Attended ANC for last birth in last 3 years					
No ANC/no birth in last 3 years		1.63 (1.3-2.0)	5,104	4.05 (3.1-5.0)	1,681
Birth in last 3 years with ANC		3.74 (2.2-5.2)	631	6.52 (3.3-9.7)	230
Kenya					
Total	9.4	8.68 (7.7-9.6)	3,151	9.76 (8.1-11.5)	1,178
Currently pregnant					
No		8.81 (7.8-9.8)	2,891	9.82 (8.1-11.5)	1,100
Yes		7.30 (4.2-10.4)	260	8.97 (2.5-15.5)	78
Gave birth in last 3 years					
No		8.82 (7.6-10.1)	1,961	9.96 (7.9-12.0)	823
Yes		8.46 (6.9-10.0)	1,190	9.30 (6.3-12.3)	355
Attended ANC for last birth in last 3 years					
No ANC/no birth in last 3 years		8.56 (7.4-9.7)	2,081	9.82 (7.8-11.8)	855
Birth in last 3 years with ANC		8.92 (7.2-10.6)	1,070	9.60 (6.4-12.8)	323
Malawi					
Total	16.9	13.32 (12.1-14.6)	2,686	18.48 (15.7-21.3)	736
Currently pregnant					
No		13.87 (12.5-15.2)	2,323	19.03 (16.0-22.1)	636
Yes		9.78 (6.8-12.8)	362	15.00 (7.9-22.0)	100
Gave birth in last 3 years					
No		16.55 (14.6-18.5)	1,282	23.08 (18.9-27.3)	390
Yes		10.37 (8.8-11.9)	1,404	13.29 (9.7-17.0)	346
Attended ANC for last birth in last 3 years					
No ANC/no birth in last 3 years		16.25 (14.3-18.2)	1,337	22.81 (18.7-26.9)	399
Birth in last 3 years with ANC		10.41 (8.8-12.0)	1,349	13.35 (9.7-17.0)	337
Tanzania					
Total	8.7	7.69 (7.0-8.4)	5,753	8.63 (7.0-10.2)	1,195
Currently pregnant					
No		7.80 (7.1-8.5)	5,210	8.42 (6.9-10.0)	1,117
Yes		6.77 (4.7-8.8)	533	11.69 (4.3-19.0)	77
Gave birth in last 3 years					
No		9.05 (8.1-10.0)	3,206	9.52 (7.5-11.6)	777
Yes		5.98 (5.1-6.9)	2,547	6.94 (4.5-9.4)	418
Attended ANC for last birth in last 3 years					
No ANC/no birth in last 3 years		8.72 (7.8-9.6)	3,558	9.47 (7.5-11.5)	813
Birth in last 3 years with ANC		6.03 (5.1-7.0)	2,195	6.81 (4.3-9.3)	382
Uganda					
Total	6.0	7.47 (7.0-8.0)	9,350	8.02 (6.9-9.1)	2,371
Currently pregnant					
No		7.66 (7.1-8.2)	8,250	7.95 (6.8-9.1)	2,125
Yes		6.47 (5.0-7.9)	1,068	8.66 (5.0-12.3)	231

Continued…

Table 3. Continued…

	ANC	DHS/AIS			
		All women (weighted)		Women who live in a community within 15km from the nearest ANC site (unweighted)	
	%	% (95%CI)	n	% (95%CI)	n
Gave birth in last 3 years					
No		8.48 (7.8-9.3)	4,854	9.20 (7.7-10.8)	1,392
Yes		6.37 (5.7-7.1)	4,496	6.23 (4.7-7.7)	979
Attended ANC for last birth in last 3 years					
No ANC/no birth in last 3 years		8.46 (7.8-9.3)	5,484	9.08 (7.7-10.6)	1,509
Birth in last 3 years with ANC		6.05 (5.3-6.8)	3,866	6.03 (4.4-7.6)	862

In Ethiopia and Tanzania, younger women (age 15-24) in the ANC catchment areas of DHS/AIS samples had significantly lower HIV prevalence than younger women in the ANC surveillance surveys (Table 4). This pattern reversed for older age groups, where women age 25 and older in the ANC catchment areas of DHS/AIS surveys had higher HIV prevalence than those in the ANC surveillance surveys. Among women age 35-49, HIV prevalence was significantly higher in Ethiopia, Tanzania, and Uganda in ANC surveillance sites. This finding suggests that women covered by ANC surveillance sites are not representative of all women even within the 15 km catchment areas of the surveillance sites. This differential age pattern in HIV prevalence between the two data sources is insignificant when a comparison is made with women from the DHS/AIS surveys that lived in the 15 km catchment areas of the ANC surveillance sites and received ANC for their last birth in the three years preceding the survey.

Table 4. Comparison of HIV prevalence among women age 15-49 from ANC sentinel surveillance and the DHS/AIS survey respondents residing within 15km of an ANC site who gave birth in last 3 years and attended ANC in a public facility by age, residence, and education, 2003-05 (unweighted)

	Ethiopia			Kenya			Malawi			Tanzania			Uganda		
	DHS/AIS 15km catchment area	Attended ANC DHS/AIS 15km catchment area	ANC	DHS/AIS 15km catchment area	Attended ANC DHS/AIS 15km catchment area	ANC	DHS/AIS 15km catchment area	Attended ANC DHS/AIS 15km catchment area	ANC	DHS/AIS 15km catchment area	Attended ANC DHS/AIS 15km catchment area	ANC	DHS/AIS 15km catchment area	Attended ANC DHS/AIS 15km catchment area	ANC
Total	4.3	6.5	5.3	9.8	9.6	9.4	18.5	13.4	16.9	8.6	6.8	8.7	8.0	6.0	6.0
	(3.4-5.3)	(3.3-9.7)		(8.1-11.5)	(6.4-12.8)		(15.7-21.3)	(9.7-17.0)		(7.0-10.2)	(4.3-9.3)		(6.9-9.1)	(4.4-7.6)	
Age															
15-24	2.5	7.7	5.6	5.8	6.4	NA	11.8	10.2	14.3	2.6	2.8	7.4	4.5	6.5	5.0
	(1.5-3.6)	(1.6-13.7)		(3.8-7.8)	(2.3-10.5)		(8.3-15.4)	(5.3-15.2)		(1.2-4.0)	(0.1-5.5)		(3.2-5.7)	(3.9-9.2)	
25-34	6.0	6.0	5.4	14.7	13.2	NA	24.7	16.8	21.2	12.9	9.4	11.0	11.4	6.6	7.9
	(4.0-8.1)	(1.6-10.3)		(11.2-18.3)	(7.6-18.8)		(19.2-30.2)	(10.5-23.1)		(9.6-16.1)	(5.1-13.8)		(9.2-13.6)	(4.2-9.0)	
35-49	6.0	5.7	3.3	10.4	7.7	NA	22.2	13.2	16.9	13.2	8.8	6.7	10.1	2.6	4.0
	(3.8-8.1)	(0-13.8)		(6.8-13.9)	(0-16.4)		(16.0-28.4)	(3.8-22.6)		(9.2-17.2)	(1.2-16.3)		(7.5-12.7)	(0-5.6)	
Residence															
Urban	5.9	7.4	9.5	12.5	14.2	11.0	20.6	19.5	18.3[a]	11.0	9.6	11.4	12.3	11.3	7.6
	(4.6-7.2)	(3.2-11.7)		(9.9-14.9)	(8.8-19.6)		(15.2-26.1)	(11.0-28.0)		(8.7-13.3)	(5.5-13.7)		(10.5-14.2)	(8.1-14.5)	
Rural	1.5	4.9	2.2	6.4	5.0	8.9	17.6	11.2	13.0	5.1	3.8	3.4	3.3	2.0	5.3
	(0.6-2.4)	(0.1-9.6)		(4.3-8.5)	(1.6-8.4)		(14.3-20.9)	(7.3-15.1)		(3.2-7.1)	(1.0-6.6)		(2.2-4.3)	(0.8-3.3)	
Education															
None	3.2	3.1	NA	5.8	NA	6.0	21.3	12.7	17.9	8.2	3.5	5.2	7.2	6.8	3.9
	(1.9-4.4)	(0-6.5)		(0.8-10.9)			(14.8-27.8)	(4.7-20.6)		(4.0-12.3)	(0-8.3)		(4.5-9.9)	(2.7-10.8)	
Primary	4.6	6.7	NA	11.7	11.4	10.6	17.2	12.3	16.1	9.0	7.2	9.3[b]	8.4	5.5	4.8
	(2.6-6.5)	(0-14.2)		(9.1-14.3)	(6.9-15.9)		(13.7-20.7)	(7.9-16.7)		(7.0-10.9)	(4.2-10.2)		(6.8-9.9)	(3.5-7.5)	
Secondary+	5.5	10.3	NA	8.0	7.9	9.2[c]	20.2	19.6	33.3	7.6	9.1	NA	7.8	6.7	6.1
	(3.8-7.1)	(3.8-16.9)		(5.6-10.5)	(2.9-12.9)		(13.1-27.2)	(7.7-31.5)		(3.9-11.4)	(0-19.4)		(6.0-9.7)	(3.4-10)	

[a]includes urban and semi-urban

[b]some education is the only category in the report

[c]prevalence for secondary+ computed by taking a weighted average of "secondary" and "higher" categories

The total ANC prevalence estimates are generally closer to the urban rather than the rural ANC estimates in Tanzania and Malawi, suggesting some over-representation of urban women in these ANC surveillance surveys. In both the ANC surveillance surveys and the ANC catchment areas of the DHS/AIS surveys, urban women have higher HIV prevalence than rural women, but there are no consistent patterns in the urban/rural differential between the two data sources. There are also no significant patterns within or between the two data sources by education categories.

DISCUSSION

The study found that in four of the five countries – Ethiopia, Kenya, Malawi, and Tanzania – the national DHS/AIS estimates were lower than the ANC surveillance estimates. In Uganda, where the epidemic is believed to have stabilized or leveled (Stoneburner and Low-Beer, 2004; Shafer et al., 2006) the ANC surveillance estimate was slightly lower than the DHS/AIS estimates.

In all five countries, HIV prevalence was higher among women who lived in a community within 15 km of the nearest ANC surveillance site than among all women included in the DHS/AIS survey. This may be because ANC sites tend to be disproportionately located near urban areas, where HIV prevalence is higher.

When the ANC surveillance estimates were compared with the DHS/AIS estimates for women residing in the 15 km catchment areas of the ANC surveillance sites, the DHS/AIS estimates were about the same or higher in four of the five countries;

in the fifth country, Ethiopia, the gap between the two estimates was considerably narrowed. This suggests that the two data sources compare rather well when the comparison is restricted to women living in the catchment areas of the ANC surveillance sites.

In all countries with available data, ANC estimates were higher for younger women (age 15-24) than the DHS/AIS estimates for younger women in the catchment areas, but lower at older ages. This finding suggests that women covered by ANC surveillance sites are not representative of all women even within the 15 km catchment areas of the surveillance sites. The total ANC prevalence estimates were generally closer to the urban ANC estimates, again reflecting a possible urban bias in the ANC surveillance estimates. The urban prevalence was higher than rural prevalence in all countries in both the ANC and the DHS/AIS surveys, but there were no consistent patterns in education differentials between the two data sources.

Some limitations of this analysis should be kept in mind when interpreting the findings. A major limitation is that the selection of DHS/AIS clusters within a 15 km radius around the ANC surveillance sites is based on the assumption that 15 km is a reasonable distance that most women would travel for ANC care, which may not reflect a true catchment area for an ANC site. A previous analysis of ANC attendees at sentinel surveillance sites in Uganda showed that these distances corresponded reasonably well with the actual administrative areas where clients were living (Musinguzi et al., 2008). For a more meaningful comparison, the catchment areas should be defined by examining the ANC client records for each surveillance site.

Another source of bias may be due to displacement of GPS coordinates of DHS/AIS clusters to protect confidentiality of survey participants. Yet because the displacement was random and the results from individual ANC catchment areas were aggregated up to the national level, any effect of such bias is expected to be small.

The DHS/AIS samples may also be biased due to differential non-response in the surveys, as well as due to exclusion of non-household population groups. An analysis of effects of non-response and exclusion of non-household population on national HIV prevalence estimates in the DHS/AIS surveys in several countries has shown that the impacts of such bias tend to be small and insignificant (Mishra et al., 2008).

Despite these limitations, the findings of this study suggest that HIV prevalence estimates derived from ANC sentinel surveillance surveys tend to overestimate HIV prevalence among women in the general population. However, the DHS/AIS estimates of HIV prevalence among women compare well with the ANC surveillance estimates when the comparison is restricted to women residing within the catchment areas of the ANC surveillance sites. Patterns by age and urban/rural residence point to possible sources of bias in the ANC estimates. The study reinforces the need to evaluate HIV prevalence estimates for potential sources of bias, and suggests that HIV prevalence data from population-based surveys can be used to calibrate estimates from clinic-based surveillance.

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