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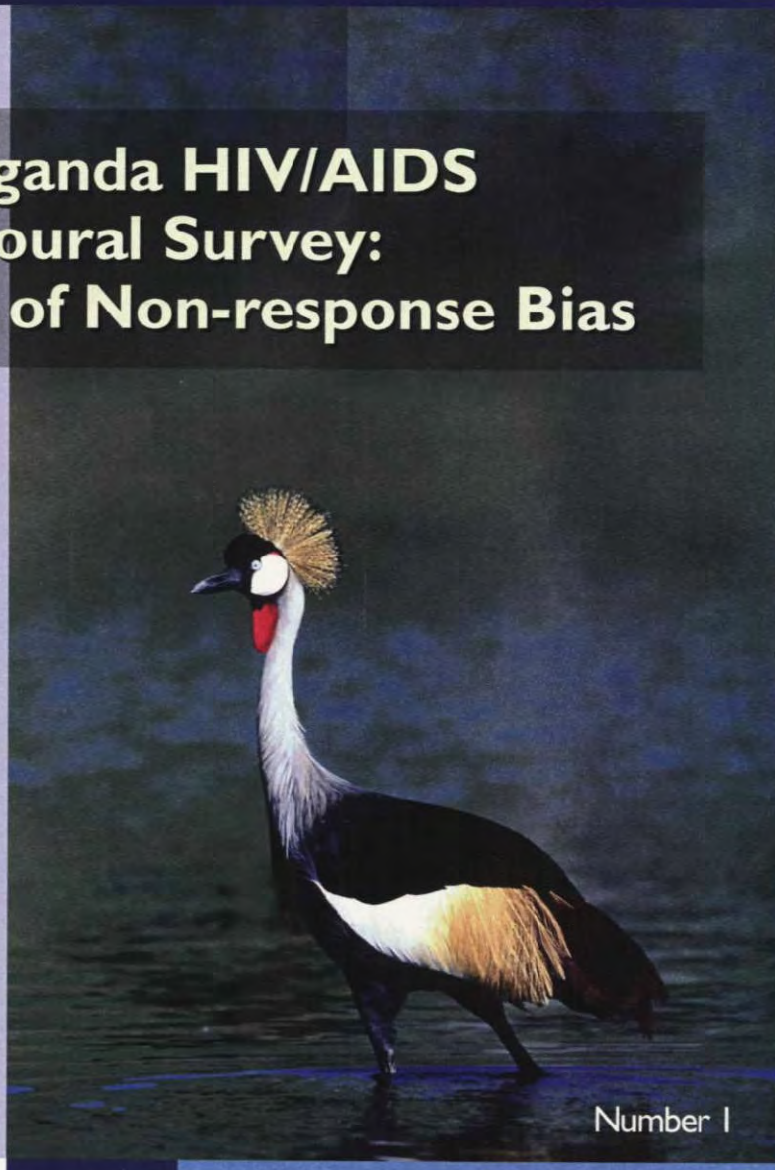

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Based on further analysis of the 2004-05 Uganda HIV/AIDS Sero-Behavioural Survey

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The 2004–05 Uganda HIV/AIDS Sero-Behavioural Survey: Methods and Impact of Non-response Bias

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ABSTRACT

Objectives: To describe the methods used in the 2004–05 Uganda HIV/AIDS Sero-Behavioural Survey (UHSBS), a nationally-representative, population-based survey that collected data on behavioral, social, and demographic indicators, and tested blood samples for HIV, syphilis, herpes simplex virus type 2 (HSV-2), and hepatitis B virus (HBV). We evaluated prevalence estimates for HIV, syphilis, and HSV-2 for potential bias due to non-response in the survey.

Methods: The survey collected information from 9,529 households in 417 sample enumeration areas. A total of 9,905 men and 11,454 women aged 15–59 years were eligible for individual interviews and blood sample collection. Testing for biomarkers was conducted using standard testing and quality-control procedures. The test results for individuals were anonymously linked to questionnaire information through bar codes. We predicted prevalence of HIV, syphilis, and HSV-2 among non-tested adults based on multivariate statistical models for those who were interviewed and tested, using a common set of predictor variables.

Results: Of the eligible men and women, individual questionnaires were completed for 89% of men and 95% of women, and blood specimens were collected for 84% of men and 90% of women. Results indicate that non-tested adults have a slightly lower predicted prevalence of HIV, syphilis, and HSV-2 than those tested. The overall effect of non-response bias on observed prevalence estimates was small and did not substantially change estimates.

Conclusions: The UHSBS was a large population-based survey that provided nationally-representative data on the prevalence of HIV, syphilis, HSV-2, HBV, and associated characteristics and risk factors. These data are useful for identifying higher-risk and vulnerable populations and for informing prevention, care, and treatment programs.

KEY WORDS: HIV, AIDS, syphilis, herpes simplex virus, hepatitis B, prevalence, non-response bias, survey, Uganda

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INTRODUCTION

Uganda has experienced a severe HIV/AIDS epidemic for more than two decades. During this period, an estimated two million people have been infected by HIV, of whom about one million have died due to complications of AIDS.[1] Syphilis, herpes, and hepatitis B are also severe public health problems in Uganda.[2–5] Reliable data on the distribution of these infections in the general population are essential for planning an effective response to these epidemics and their consequences, but national data for Uganda have not been available.

The 2004–05 Uganda HIV/AIDS Sero-Behavioural Survey (UHSBS), a nationally-representative, population-based survey, was designed to obtain national and sub-national data on the prevalence of HIV, syphilis, herpes simplex virus type 2 (HSV-2), and hepatitis B virus (HBV), and their social, behavioral, and demographic variations in the country.[6] The overall goal of the survey was to provide program managers and policymakers involved in HIV/AIDS programs with strategic information needed to monitor and evaluate existing programs and to effectively design new strategies for combating the epidemic in Uganda.

In this paper, we describe the survey methodology and laboratory procedures used in the UHSBS. A major challenge for surveys is bias due to non-response, both from refusal and absence. We discuss the response rates in the survey and evaluate how non-response in the survey may have biased the estimates of HIV, syphilis, and HSV-2 seroprevalence.

SURVEY METHODS

The survey protocol was cleared by the Uganda National Council of Science and Technology and the U.S. Centers for Disease Control and Prevention (CDC), and approved by the Institutional Review Boards of the Uganda Virus Research Institute (UVRI) and ORC Macro.

Sample design

The UHSBS covered a nationally-representative probability sample of households throughout Uganda. The survey utilized a two-stage sample design. The first stage involved selecting sample points or clusters from a list of enumeration areas covered in the 2002 Population Census. A total of 417 clusters (74 urban and 343 rural) were selected. The second stage of selection involved systematic sampling of households from the census list of households in each cluster. A total of 10,425 households were selected, 25 households per cluster.

The sample was constructed to allow separate estimates for key indicators for nine regions, consisting of Kampala, the capital city, and eight regions created by grouping the (then) 56 districts in Uganda.[1] To allow a sufficient number of cases in each region, the sample was allocated more or less equally across all nine regionsv. Since the sample was not allocated in proportion to the population size of each region, the UHSBS sample is not self-weighting at the national level. Consequently, weighting factors need to be applied to the data to produce nationally-representative results.[2]

All adults aged 15–59 years residing in the selected households (either usual residents or visitors present in the household on the night before the survey) were eligible for both individual interview

[1] The districts included in each region are as follows Central Kalangala, Kiboga, Luwero, Masaka, Mpigi, Mubende, Nakasongola, Rakai, Sembabule, and Wakiso, East Central Bugiri, Iganga, Jinja, Kamuli, Kayunga, Mayuge, and Mukono, Eastern Busia, Kapchorwa, Mbale, Pallisa, Sironko, and Tororo; Northeast Kaberamaido, Katakwi, Kotido, Kumi, Moroto, Nakapiripirit, and Soroti; North Central. Apac, Gulu, Kitgum, Lira, and Pader, West Nile. Adjumani, Arua, Moyo, Nebbi, and Yumbe; Western. Bundibugyo, Hoima, Kabarole, Kamwenge, Kasese, Kibaale, Kyenjojo, and Masindi, Southwest· Bushenyi, Kabale, Kanungu, Kisoro, Mbarara, Ntungamo, and Rukungiri.

[2] Weights are adjustment factors applied to each case in tabulations to adjust for differences in probabilities of selection and interview In UHSBS, there are several types of weights Household weight for a particular household is calculated as the inverse of the household selection probability multiplied by the inverse of the household response rate. Individual weight for a respondent is its household weight multiplied by the inverse of the individual response rate. Blood testing weight for a respondent is its household weight multiplied by the inverse of individual response rate for blood draw The weights are standardized (each weight separately) so that the sum of the standardized weights equals the sum of the cases over the entire sample In the analysis and tabulations, the weights are used as follows: 1. For any household-level analysis, household weight is used; 2 For any individual-level analysis not including HIV, syphilis, HSV-2, or HBV result, individual weight is used; 3. For any individual-level analysis including any biomarker result, blood testing weight is used, 4. For any couple-level analysis not including any biomarker result, individual weight for men is used; and 5 For any couple-level analysis including any biomarker result, blood testing weight for men is used

and blood specimen collection for subsequent testing for HIV, syphilis, and HSV-2. All children <5 years were eligible for HIV testing. Additionally, one-in-three systematically-selected adult specimens were tested for HBV.

Survey questionnaires

Social, behavioral, and demographic data were collected using two questionnaires, a household questionnaire and an individual questionnaire. The household questionnaire was used to list all household members and identify men and women eligible for individual interviews. The household questionnaire also collected information about each household member, such as age, sex, education, and relationship to the household head; household amenities and ownership of durable assets, such as source of water, type of toilet facility, and ownership of mosquito nets. It also gathered information about care and support for orphans and vulnerable children, chronically ill adults, and any household members who died in last 12 months.

The individual questionnaire was used to collect information from all men and women aged 15–59 in the households with completed interviews. The individual questionnaire collected information on individual's background characteristics, reproduction, marriage and sexual activity, knowledge and attitudes towards HIV/AIDS, and knowledge and prevalence of other sexually transmitted infections.

The interviews were conducted in the local language of the respondents after translating the questionnaires from English into six local languages: Ateso-Karamajong, Luganda, Lugbara, Luo, Runyankole-Rukiga, and Runyoro-Rutoro.

Training and fieldwork

One hundred and eighty-six fieldworkers (18 supervisors, 122 interviewers, and 46 laboratory technicians) were trained by senior UHSBS staff from the Ministry of Health, UVRI, CDC, and ORC Macro. The training of interviewers and supervisors consisted of an overview of the survey, its objectives, techniques of interviewing, field procedures, a detailed description of all sections of the household and individual questionnaires, mock interviews between pairs of trainees, and three tests. The trainees also reviewed the questionnaires, and conducted three days of practice

interviews. Trainees appointed as regional and team supervisors received additional half-day of special training.

The laboratory technicians were trained on blood draw procedures (for both venous and capillary blood), specimen processing in the field lab, storage and transportation of specimens, syphilis testing, lab safety procedures, labeling of samples, consent administration, and field practice. The nurse-interviewers were also trained on how to administer syphilis treatment. The course content of the counselors and lab persons on the VCT teams in each region consisted of general introduction to the survey, understanding the survey protocols, and how to use rapid HIV test kits.

The questionnaires and all other aspects of the survey were pre-tested in June 2004, using five teams that completed 300 individual interviews in various local languages. The lessons learned from the pretest were used to finalize the questionnaires and logistical arrangements for the survey.

Prior to the start of fieldwork, numerous advocacy and community mobilization activities, including media campaigns, were conducted to promote awareness of the survey and encourage participation. Some of these activities continued throughout the survey period to encourage participation.

The UHSBS staff coordinated and supervised fieldwork activities, assisted by occasional visits by staff from ORC Macro and the World Health Organization. To ensure quality, the nine survey regions were divided into four zones, each supervised by a team of two zonal supervisors, one for the questionnaires and the other for the biomarkers. Eighteen teams carried out data collection for the survey. Each team consisted of one supervisor, two female interviewers, two male interviewers, two laboratory technicians, and one driver. Data collection took place over a five-month period, from 14 August 2004 to the end of January 2005.

Blood specimen collection and field testing for syphilis

Blood specimens were collected using standard field procedures.[7] All men and women aged 15–59 who were interviewed were asked to voluntarily provide a venous blood sample for subsequent testing for HIV, syphilis, HSV-2, and hepatitis B. To obtain informed consent for blood draw, the laboratory technician explained the procedure, the confidentiality of the data, the tests to be

performed as well as the fact that the blood sample would be stored for future unspecified tests. In addition, the respondents were informed that they could obtain their syphilis results the following day if they wanted, that those testing positive for syphilis could be treated, and that the other test results could not be linked or made available to the respondent. The respondents were given an opportunity to ask any questions about the survey that may help them decide whether or not they wanted to participate. The interviewer recorded the respondent's decision on the questionnaire and signed the questionnaire affirming that he/she had read the statement.

For those who consented, the laboratory technician drew a venous blood sample in a 4.5 ml EDTA Vacutainer tube. If respondents refused the venous blood draw, they were given an option to provide a dried blood spot sample on a filter paper card from a finger prick using a single-use, spring-loaded, sterile lancet. For all children <5 years only blood spot samples were collected. For children <5 years and youth aged 15–17 years, consent was sought from their parents or guardians to take blood sample. Blood tubes and filter paper dried blood spot samples were labeled with a bar-coded identification label, which was also pasted on the household questionnaire on the line number for that respondent and on various other laboratory forms.

Before starting work in a given area, each team made arrangements to establish a temporary field laboratory, usually setting up their mobile equipment in a spare room in a laboratory attached to a hospital or health center. Each team carried cold boxes, centrifuges, a generator, a liquid nitrogen tank, and routine laboratory supplies such as pipettes, gloves, and test tubes. In the temporary field laboratory, a number of procedures were carried out on the blood samples. For specimens from adults, the laboratory technicians first made a back-up dried blood spot from the venous blood sample. They then centrifuged the blood and transferred the plasma to microvials, labeled with the same bar code identification. A small aliquot was removed and tested for syphilis using the rapid plasma reagin (RPR) card test, and results were recorded on a preprinted laboratory results form. Packed blood cells remaining in the EDTA Vacutainer tubes were transferred to microvials labeled with the bar code for long-term storage. Microvials containing plasma and packed blood cells were stored in liquid nitrogen tanks and their location within the tank recorded on a preprinted specimen inventory form. All dried blood spot samples were air-dried overnight in plastic boxes and stored at ambient temperature in lots of 20 separated by glassine paper in zipper-locked bags containing desiccants. Specimens were periodically collected from the field and taken to the Uganda Virus

Research Institute (UVRI). Recharged liquid nitrogen tanks and resupplies were also provided to the teams.

Syphilis results were provided in privacy to the respondents the following day at home for those who provided a venous blood sample and who indicated that they would like to get their results. Respondents testing positive for syphilis were treated with a single injection of benzathine penicillin (2.4 M IU). Anyone who indicated being allergic to penicillin was treated with erythromycin tablets (500 mg QID PO for 14 days) in line with national treatment guidelines.

Laboratory testing

Laboratory testing of the serum specimens was carried out at the HIV Reference Lab (HRL) at UVRI. Specimens were checked against the specimen shipping forms and were then registered electronically using a bar code reader. Each specimen was assigned a unique laboratory number during the registration process, and laboratory testing and storage in the repository were carried out against that number.

Plasma specimens from the venous blood draw were tested with a two HIV EIA parallel testing algorithm—Murex 1.2.0 (Abbott) and Vironostica Uniform II Plus O (Biomerieux)—in accordance with WHO guidelines, with repeat testing for specimens with equivocal or discordant results on the two assays. Western blot was carried out to resolve specimens with repeatedly discordant results using WHO interpretative criteria. For quality control, all positive specimens and 5% of negative specimens were re-tested at the CDC laboratory at UVRI using the same testing algorithm; specimens with discordant results were resolved by repeating the testing algorithm. Samples with discrepant results between the two laboratories were sent to Nakasero Blood Bank for 'tie-breaker' testing.

Dried blood spot specimens were tested for HIV by eluting serum from 6 mm discs punched from the blood spots, and using the same parallel testing algorithm described above for plasma specimens. Specimens from children less than 18 months of age with a positive or ambiguous result were further tested for HIV DNA using a polymerase chain reaction (PCR) test (Roche HIV DNA 1.5 kit).

All plasma specimens, regardless of the field result, were screened with the rapid plasma reagin (RPR) test at a dilution of 1:8. Reactive specimens were titrated at doubling dilutions and reported as positive after review by a second reader. All specimens positive on RPR and 10% of negative specimens were also tested with the *Treponemal pallidum* haemaglutination assay (TPHA) test. For quality control, all positive specimens and 5% of negative specimens were tested using this algorithm. Specimens with discordant results were resolved by repeat testing on the same assays or were reported as indeterminate. All positive specimens and 5% of the negative specimens were retested at the CDC laboratory at UVRI.

Plasma specimens were tested on an HSV-2 EIA (Kalon Biological HSV Type 2 IgG indirect EIA). Specimens with equivocal results were tested again and because there is no reliable confirmatory assay, those that remained equivocal were reported as 'indeterminate.' For quality control, 5% of positive specimens and 5% of negative specimens were re-tested and specimens with discordant results were reported as indeterminate. Positive specimens and 5% of the negative specimens were retested at the CDC laboratory at UVRI.

Testing for hepatitis B was performed on a systematic one-in-three nationally-representative sub-sample of the 6,035 specimens from adults, using an anti-HBcAb EIA. Only the specimens positive for anti-HBcAb were subsequently tested for HBsAg by EIA. For quality control, 5% of positive specimens and 5% of negative specimens were retested at the CDC laboratory at UVRI. Specimens with discordant results between the two labs were resolved by repeat testing; specimens remaining discordant after repeat testing were reported as 'indeterminate.' Specimens positive for anti-HBcAb indicate overall prevalence of lifetime HBV infection (resolved, chronic, and active); specimens positive for both anti-HBcAb and HBsAg indicate chronic active HBV infection; specimens positive on anti-HBcAb but negative on HBsAg indicate past infection that has been cleared; and specimens negative on anti-HBcAb indicate that a participant was never infected with HBV.

Vouchers for voluntary counseling and testing (VCT)

Respondents who agreed to provide a venous blood sample were offered the opportunity to get the results of the syphilis test that was performed in the field laboratory. However, respondents were not offered the results of any of the other tests, including HIV.

To assist respondents who wanted to know their HIV status, a voucher was provided for a free VCT visit, along with an educational pamphlet about available services and benefits of testing. The vouchers could either be used at a nearby health facility or at an outreach point established by the UHSBS project. Facilities that did not already offer VCT services were provided with rapid HIV test kits, necessary training, and other supplies and forms needed to provide VCT services during the survey period. A VCT supervisor was appointed in each district. Within each of the identified facilities, two counselors and a laboratory person were enrolled to assist with the survey. These teams were responsible for making VCT services available at the facilities and, in cases in which the selected sample cluster was located far from the facility, for providing outreach VCT services in locations close to the cluster.

Data processing

The processing of the UHSBS questionnaires began shortly after the fieldwork commenced. Data were entered using ORC Macro's CSPro computer program. All data were entered twice (100% verification). The concurrent processing of the data was a distinct advantage for data quality because UHSBS staff was able to advise field teams of errors detected during data entry. The data entry and editing phase of the survey was completed in early March 2005.

The UHSBS protocol allowed for merging individual laboratory test results for HIV, syphilis, HSV-2, and HBV with the socio-demographic and behavioral data collected in the questionnaires, provided that the confidentiality of the participants was protected. To that end, stringent laboratory procedures were employed to ensure complete confidentiality of blood specimens. Laboratory test results were linked to data from the questionnaires using bar codes only after the cluster and household codes had been scrambled and after the files containing the original identity codes and the back page of the household questionnaire that contained the bar code labels had been destroyed.

Home-based counseling and testing study

After the data collection for the main UHSBS was completed, a smaller study was implemented to test the feasibility of providing respondents with their HIV results at home. The study was implemented in 33 clusters outside of the original 417 selected for the main survey, with 11

clusters each in three regions, namely, West Nile, Western, and Central. Six of the 18 teams used for the main survey were selected to implement the home-based study.

The home-based survey was implemented similarly to the main UHSBS except that adult respondents in the survey were told that they could get their HIV results the following day if they wanted them. To provide the HIV results and counseling at home, four counselors and one more laboratory technician were added to each team. The extra laboratory technician performed rapid HIV tests in the field laboratory on the plasma samples in accordance with the national VCT guidelines. The technician also carried out syphilis testing. The counselors provided HIV test results to the respondents the following day. HIV results could not be provided for children because they had only provided dried blood spot samples.

In eight of the 33 clusters covered in the home-based study, a qualitative study was implemented to explore issues regarding acceptance and potential consequences of providing home-based VCT for the respondent or for the family. Results from the home-based study and the companion qualitative study are reported elsewhere in this volume.[8,9]

Analysis of non-response bias

To estimate the extent of non-response bias and its potential impact on the observed HIV, syphilis, and HSV-2 rates, all eligible respondents were divided into four groups: (1) interviewed and tested; (2) not interviewed but tested; (3) interviewed, not-tested; and (4) not-interviewed, not-tested.

Prevalence of HIV, syphilis, and HSV-2 in the two non-tested groups (3 and 4) was predicted based on multivariate statistical models for those who were interviewed and tested using a common set of predictor variables. A logistic regression model was used to calculate predicted prevalence separately for the "not-interviewed, not-tested" and "interviewed, not-tested" groups. Predictions for the "not-interviewed, not-tested" group are based on a limited set of variables (only from the household questionnaire), but predictions for the "interviewed, not-tested" group additionally use several individual socio-demographic and behavioral characteristics of the respondents, as collected in the survey. All models were run separately for HIV, syphilis, and HSV-2, and separately for men, women, and total (men and women combined).

For each of the three biomarkers, variables for predicting prevalence in the "not-interviewed, not-tested" group included age, education, wealth index, residence, and geographic region. Additional variables for predicting HIV, syphilis, and HSV-2 prevalence in the "interviewed, not-tested" group included: marital union; childbirth in last five years (women only); occupation; media exposure; ethnicity; religion; circumcision (men only); years in current place of residence; knowledge of preventive behaviors (abstinence, being faithful, and condom use); woman's ability to negotiate safe sex with spouse; age at first sex; condom use at last sex in last 12 months; alcohol use at last sex in last 12 months; number of sex partners in last 12 months; and higher-risk sex (sex with a non-marital, non-cohabiting partner) in last 12 months. Additional variables for HIV included: stigmatizing attitudes towards people living with HIV/AIDS; skin cutting or tattooing; use of medical injections; contact with blood; blood transfusion; and STI or STI symptoms in the last 12 months. All models for men and women combined exclude childbirth in last five years and circumcision variables, but include a variable for respondent's sex.

Multivariate analyses used STATA version 8.0. Adjusted prevalence for each biomarker was calculated as a weighted average of observed prevalence in the "interviewed, tested" group and predicted prevalence in the two non-tested groups. Sampling weights were applied in accordance with standard survey procedures. We use blood testing sampling weights for the tested, individual sampling weights for the "interviewed, not-tested", and household sampling weights for the "not-interviewed, not-tested" groups, respectively.

RESULTS

Non-response rates

A total of 10,437 households were selected in the sample, of which 9,842 (94%) were found to be occupied at the time of the fieldwork. The shortfall was largely a result of structures that were vacant or destroyed. Of existing households, 9,529 had participants living in them who were interviewed, yielding a household response rate of 97% (Table 1).

In the households with completed interviews, a total of 9,905 men and 11,454 women aged 15–59 were identified as eligible for individual interview and blood specimen collection. Of the eligible men and women, individual questionnaires were completed for 89% (8,830) of men and 95% (10,826) of women, and blood specimens were collected for 84% (8,356) of men and 90% (10,298) of women. Overall response rate was 92% for individual interview and 87% for blood specimen collection. Overall response rates for HIV, syphilis, and HSV-2 were 87%, 84%, and 84%, respectively. An individual was only considered absent after three callback visits.

The principal reason for non-response for blood specimen collection was non-availability of eligible respondents at home despite repeated visits to the household. The lower response rate for men reflects more frequent and longer absence of men from the households. Of the 16% non-response rate among men, about two-thirds was due to non-interview, while the non-response rate for women was about the same for the interviewed and not interviewed women (5% each) (Table 2). For men, absence was a more important reason for non-response (8%) than refusal (5%). On the contrary, for women, refusal was a somewhat more important reason for non-response (5%) than absence (4%).

Non-response for blood draw was substantially higher in urban areas (23%) than in rural areas (10%). Non-response due to both refusal and absence was higher in urban areas than in rural areas. Non-response was considerably higher among more educated and richer respondents. Men and women with secondary or higher education and those belonging to the richest 20% households had considerably higher non-response rates for blood draw than less-educated and poorer respondents (Figure 1).

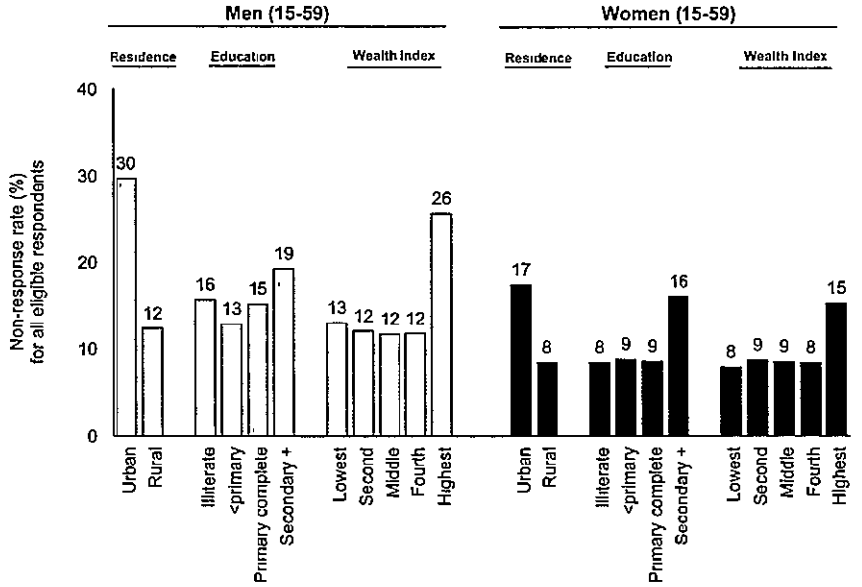
Table 1 Response rates for household and individual interview, and percent who gave blood and percent tested for HIV, syphilis, and herpes simplex virus (HSV-2), by sex and urban/rural residence, Uganda HIV/AIDS Sero-Behavioural Survey, 2004–2005

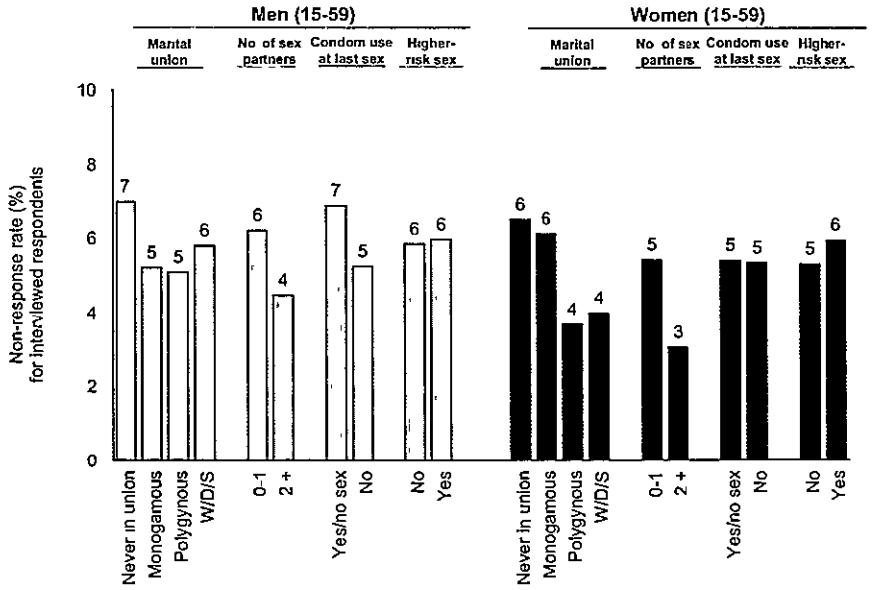
Sex/residence	Number of households selected and occupied	Percent households interviewed	Number eligible for individual interview and testing	Percent interviewed	Percent who gave blood	Percent tested for HIV	Percent tested for syphilis	Percent tested for herpes simplex virus
Male								
Urban	–	–	1,852	79.0	70.3	69.7	66.1	66.5
Rural	–	–	8,053	91.5	87.6	87.0	84.9	85.5
Total	–	–	9,905	89.2	84.4	83.8	81.4	81.9
Female								
Urban	–	–	2,117	90 4	82.6	82.2	75.1	75.3
Rural	–	–	9,337	95 5	91 6	90 9	88 4	89 0
Total	–	–	11,454	94.5	89.9	89 3	85 9	86 4
Total								
Urban	1,742	95.6	3,969	85.1	76.9	76 4	70 9	71 2
Rural	8,100	97 1	17,390	93 6	89.7	89.1	86 8	87.4
Total	9,842	96 8	21,359	92 0	87 3	86 7	83 8	84 3

Table 2 Non-response for giving blood specimen by interview status and reason for not giving blood, by sex and urban/rural residence, Uganda HIV/AIDS Sero-Behavioural Survey, 2004–2005

Sex/residence	Non-response rate	Interview status		Reason for non-response		
		Interviewed	Not interviewed	Refused	Absent	Other/ missing
Male						
Urban	29 7	8 8	21 0	9.5	16 3	3.9
Rural	12 4	4 4	8 0	4 4	6 5	1 5
Total	15 6	5 2	10 4	5 3	8 3	2 0
Number	1,549	517	1,032	527	826	196
Female						
Urban	17 4	8 1	9.4	8 3	7 2	2 0
Rural	8.4	4 4	4 1	4 1	3 2	1 2
Total	10 1	5.1	5 0	4.9	3.9	1 3
Number	1,156	579	577	557	448	151
Total						
Urban	23 2	8 4	14.8	8 8	11.4	2.9
Rural	10 3	4 4	5 9	4 2	4.7	1 3
Total	12 7	5.1	7 5	5.1	6.0	1.6
Number	2,705	1,096	1,609	1,084	1,274	347

Figure 1 Non-response rate for giving blood specimen by selected characteristics, Uganda HIV/AIDS Sero-Behavioural Survey 2004-05





W/D/S Widowed/Divorced/Separated
Higher-risk sex Sex with a nonmarital, noncohabiting partner in the past year

Figure 1 also shows patterns of non-response for blood draw by selected risk factors for respondents who were interviewed (mostly refusal cases). Non-response rates were somewhat lower for women in polygamous union and for men and women who had multiple sex partners in the last 12 months. Non-response rates were also somewhat lower for men who did not use a condom at last sex in last 12 months. There was no clear pattern by higher-risk sex in last 12 months.

Effects of non-response bias on observed estimates

Table 3 shows how the predicted prevalence of HIV, syphilis, and HSV-2 among non-tested respondents differs from the observed prevalence among the tested respondents, and what impact this non-response bias has on the adjusted prevalence estimates of these infections for all eligible respondents.

Observed prevalence of HIV among the tested adults aged 15–59 is 6.3%. The prevalence is higher in urban areas (10.1%) than in rural areas (5.7%), and higher among women (7.3%) than among men (5.2%). Predicted prevalence of HIV among the non-tested respondents is lower (5.5%) than the observed prevalence among those tested. This pattern holds irrespective of sex, urban/rural residence, interview status, and reason for not testing. Adjusting the observed HIV national estimate for tested adults, by accounting for the predicted rates among the non-tested, makes little difference to the observed estimates. Overall, adjusted prevalence among all eligible respondents is only slightly lower (6.2%) than the observed prevalence among the tested (6.3%).

Observed prevalence of syphilis among the tested adults aged 15–59 is 3.4%. It is higher in rural areas (3.5%) than in urban areas (2.6%), but about the same in men (3.5%) and women (3.3%). As for HIV, the non-tested respondents have lower predicted prevalence of syphilis (3.0%), and adjusting for lower predicted prevalence among the non-tested makes little difference to the observed national prevalence.

Table 3 Observed prevalence estimates of HIV, syphilis, and herpes simplex virus (HSV-2) among the tested, predicted estimates among the non-tested, and adjusted estimates for all eligible respondents, by sex and urban/rural residence, Uganda HIV/AIDS Sero-Behavioural Survey, 2004–2005

		Predicted prevalence among non-tested						
		Interview status		Reason not tested				
Sex/residence	Observed prevalence among tested	Interviewed	Not inter-viewed	Refused	Absent	Other/ missing	Total non-tested	Adjusted prevalence among all eligible
				HIV				
Male								
Urban	6.9	6 5	6.6	6 4	6.5	7 1	6 6	6 8
Rural	4 9	3 3	3.7	3 3	3.7	3 5	3.5	4.7
Total	5.2	4.1	4 5	4.1	4 5	4 5	4.4	5.0
Number	8,298	573	1,034	527	826	254	1,607	9,905
Female								
Urban	12 6	9 0	12 1	9 9	11.4	10 6	10.6	12.3
Rural	6 4	5 6	5.1	5 5	5.1	5 7	5.4	6.3
Total	7.3	6 3	7 0	6 5	6.8	6 5	6.6	7.2
Number	10,227	648	579	557	448	222	1,227	11,454
Total								
Urban	10.1	7.9	9.1	8 3	8.9	8 8	8.6	9.8
Rural	5.7	4.5	4.3	4 5	4.2	4 6	4 4	5.6
Total	6 3	5 4	5.7	5.5	5.5	5 6	5.5	6 2
Number	18,525	1,221	1,613	1,084	1,274	476	2,834	21,359
				SYPHILIS				
Male								
Urban	2.9	3 0	2 6	3.1	2 6	2 6	2 8	2 9
Rural	3.6	3 5	2 6	3 3	2 8	3 2	3 1	3 5
Total	3 5	3 4	2.6	3.3	2.7	3 1	3 0	3 4
Number	8,061	809	1,035	527	826	491	1,844	9,905
Female								
Urban	2 3	2 0	2 0	2.1	2 0	2.0	2 0	2 3
Rural	3 5	3 6	2 8	3.4	3 0	3.6	3 4	3 4
Total	3 3	3.2	2.6	3 1	2 7	3.2	3 0	3 3
Number	9,842	1,030	582	557	448	607	1,612	11,454
Total								
Urban	2 6	2 5	2.4	2.5	2 4	2 4	2 4	2 5
Rural	3 5	3 6	2.8	3.3	3 0	3 4	3 2	3 5
Total	3.4	3.3	2.7	3 1	2 8	3 1	3 0	3 3
Number	17,903	1,839	1,617	1,084	1,274	1,098	3,456	21,359
				HSV-2				
Male								
Urban	36.9	37.8	35.3	38 2	35.7	35 1	36.4	36 8
Rural	41 0	38 3	33.1	37 8	34.1	34 9	35.5	40 2
Total	40.4	38 2	33 8	37.9	34 5	35.0	35 7	39 7
Number	8,115	757	1,033	527	826	437	1,790	9,905
Female								
Urban	51.1	48.3	48 2	50.0	48.1	46 9	48.3	50 5
Rural	50 8	48.1	41 4	48 0	42 9	45 3	45.7	50.2
Total	50 8	48 1	43.2	48.4	44 3	45.8	46 4	50.3
Number	9,900	973	581	557	448	549	1,554	11,454
Total								
Urban	44 8	44 2	40.7	44.3	41.0	42.2	42 5	44 2
Rural	46 4	43 8	36 0	43.2	37 1	40.2	40 1	45 6
Total	46 1	43 9	37.3	43.5	38.2	40.8	40.8	45.4
Number	18,015	1,730	1,614	1,084	1,274	986	3,344	21,359

Forty-six percent of the tested adults aged 15–59 were infected with HSV-2, indicating widespread prevalence of HSV-2 among Ugandan adults. The prevalence is higher among women (51%) than among men (40%), but it is about the same in urban and rural areas. The non-tested respondents have lower predicted prevalence of HSV-2 (41%). Adjusting for lower predicted prevalence among the non-tested makes an insignificant difference to the observed national prevalence.

CONCLUSIONS

The UHSBS was a large population-based survey that collected nationally-representative data on the prevalence of HIV, syphilis, herpes, and hepatitis B among adult men and women aged 15–59 in Uganda. The survey also tested children <5 years for HIV. The survey protocol allowed for anonymously linking laboratory test results for individuals with their socio-demographic and behavioral information collected in the household and individual questionnaires, while protecting confidentiality of the respondents. Laboratory testing for each biomarker was conducted using standard testing and quality-control procedures.

The survey obtained high participation rates. Of the eligible 9,905 men and 11,454 women aged 15–59 years, individual questionnaires were completed for 89% of men and 95% of women. Blood specimens were collected for 84% of men and 90% of women. Although the overall non-response rate was low, it was higher among men and among urban, more educated, and richer respondents, which is typical of most household surveys in developing countries.[10]

Our analysis to evaluate survey estimates for potential bias due to non-response indicated that non-response in the UHSBS sample did not appear to bias prevalence estimates for HIV, syphilis, and HSV-2. For each of the three infections evaluated, contrary to expectations, non-tested respondents tended to have lower predicted prevalence than the observed prevalence among the tested. This bias had virtually no effect on the observed national prevalence estimates.

One limitation is that the estimates are only adjusted to the extent that the socio-demographic and behavioral characteristics included in the analysis are correlated with the risks of HIV, syphilis, and HSV-2 infection. Another limitation is that the adjustments for "not interviewed, not tested" respondents (mostly absentees) are based on limited information available from the household questionnaire. Moreover, our adjustments for non-response do not account for any bias due to exclusion of population members not living in households, such as those living on the street or in institutions (e.g., prisons, boarding schools, military barracks, refugee camps, and brothels).

In summary, the UHSBS provided high-quality, reliable, representative national prevalence estimates of HIV, syphilis, herpes, and hepatitis B, and associated characteristics and risk factors. These data are useful for: identifying geographic regions with elevated rates of HIV, other

infections and higher-risk and vulnerable populations; providing a better understanding of risky and protective sexual behaviors; assessing availability and access to health services; and planning for prevention, care, and treatment programs. Data from UHSBS are also useful for calibrating prevalence estimates from surveillance systems and improving accuracy of national estimates. However, to provide trend data on key biomarkers and associated risk factors, there is need to carry out such surveys at regular intervals.

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