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Correlates of Undiagnosed HIV Infection and Retesting Among Voluntary HIV Testing Clients at Mildmay Clinic, Uganda

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Abstract

Increasing HIV diagnosis is important for combatting HIV. We invited individuals aged ≥ 13 years seeking voluntary HIV testing at Mildmay Clinic in Uganda to undertake a computer or audio-computer-assisted self-interview to facilitate post-test counseling. We evaluated first-visit data from 12,233 consenting individuals between January 2011 and October 2013. HIV prevalence was 39.0%. Of those with HIV, 37.2% already knew they were infected. Undiagnosed infection was associated with not being single, screening positive for depression (aOR 1.16, 95% CI 1.04–1.28), and screening for harmful drinking behavior (aOR 1.23, 95% CI 1.10–1.39). The odds of retesting subsequent to HIV diagnosis were lower for males (aOR 0.80, 95% CI 0.70–0.92) and those screening positive for harmful drinking behavior (aOR 0.77, 95% CI 0.66–0.88). Retesting was also associated with higher education and perceived social status below ‘better off’. Our findings reiterate the value of population-based HIV surveys to provide estimates of testing coverage.

Keywords

Uganda; HIV testing; HIV retesting; Undiagnosed HIV; Self-interview

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Authors’ Contributions WH designed the research with ES, BM, MO (Mary Odiit), and SS. BM coordinated data collection supervised by MO (Mary Odiit) and YK. MO (Moses Ogwal), ES, and SS provided technical support. AH and LH analyzed and interpreted the data. AH, LH, and WH were major contributors in writing the manuscript. All authors read and approved the final manuscript.

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Availability of Data and Materials The dataset used and analyzed during the current study is available from the corresponding author on reasonable request.

Conflict of interest The authors have no conflicts of interest to disclose.

Ethical Approval This article does not contain any studies with animals performed by any of the authors. All procedures performed with human participants in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Background

HIV testing is the entry point into the HIV service cascade for the general population and is important for identifying infections and stopping the spread of the disease [1]. Data from Zimbabwe, Malawi, and Zambia reveal that the major barrier to reaching UNAIDS targets of 90% of people living with HIV diagnosed, 90% of them on treatment, and 90% of them having suppressed viral load is diagnosing HIV infections [2]. Globally, by the end of 2017, 75% of persons living with HIV were aware of their status [3].

Some countries have used extensive intake forms to collect data on HIV testing and counseling (HTC) clients from routine HIV testing facilities. However, given the volume of data, few have been able to analyze and use the data [4–6]. In the absence of national population-based data, which are usually only conducted every five years, few countries understand who is being tested for HIV beyond basic demographics such as sex and age [7]. In 2012, Uganda's National HIV Testing Services Policy recommended follow-up testing after 3 months for individuals thought to be in the window period. The 2016 update revised this to 14 days to 3 months later, depending on the population [8]. New guidelines are under development. The annual number of people tested for HIV in Uganda increased from 7.0 million in 2013 to 8.6 million in 2014 [9]. This translates to approximately half of adults being tested each year and on the surface bodes well for efforts to diagnose 90% of HIV infections. However, testing data must be carefully scrutinized because it most often represents the number of tests conducted rather than unique people tested. The proportion of testers who are retesters, that is, people who have been diagnosed with HIV but who test again, is often unknown and could artificially increase the yield of HIV positivity. In one study in Mozambique, for instance, 13.0% of HIV-positive voluntary counseling and testing clients and 29.4% of those testing through provider-initiated counseling and testing were retesters [10]. Efforts to diagnose 90% of HIV infections require that testing targets the right people, especially those most at risk. For example, data from surveys conducted in Kampala, the capital of Uganda, from 2012 to 2013 indicate that only 20.2% of men who have sex with men [11], and 46% of female sex workers living with HIV are aware of their status [12].

With a better understanding of the demographic characteristics of who is being tested and who needs to be tested, countries can better target outreach and testing interventions. Additional information about the risk behaviors of testers can further allow HIV testing counselors to tailor messages to encourage shorter repeat testing intervals for those at greatest risk [13].

Much of the literature on individuals testing for HIV multiple times focuses on those who previously tested negative for HIV [14–16]. Little is known about the sub-group of people living with HIV who return to testing facilities for retesting, ostensibly in hopes that they have been cured of the disease. Such individuals may inflate positivity rates and also put additional strain on resources, both human and otherwise. We implemented a computer-assisted self-interview system (CASI) at Mildmay Uganda's clinic in greater Kampala, a large HIV testing and treatment facility, to collect biobehavioral information about

individuals testing for HIV. Here we assess correlates of living with undiagnosed HIV and compare testers who are diagnosed for the first time to retesters.

Methods

Study Design and Setting

We analyzed cross-sectional first-visit data from Mildmay Clinic in Uganda, located just south of Kampala, collected between January 2011 and October 2013. All clients aged 13 or older attending Mildmay for the purpose of client-initiated HIV testing and counseling at a voluntary counseling and testing center during this period were consented to have their routinely collected data analyzed.

Data Collection

Clients attending Mildmay underwent routine registration, followed by Mildmay counseling staff providing group pre-test counseling. Mildmay laboratory staff then drew venous blood and tested specimens for HIV in real time using Uganda's national HIV serial rapid testing algorithm which includes Determine (screening, Alere, Waltham, MA, US), Stat Pak (confirmatory, Chembio, Medford, NY, US), and Unigold (tiebreaker, Trinity Biotech, Bray, Ireland). Interviews were conducted after blood draw.

Interview data were collected primarily through CASI (without audio) or audio CASI (ACASI, using Questionnaire Design System™, Nova Research, Silver Spring, MD), either in Luganda, the main language spoken in greater Kampala, or English on either palm-held devices or net-books. CASI was used by literate HTC clients who did not want to use the audio feature. Staff were present while participants underwent a tutorial explaining how to navigate the A/CASI environment and remained nearby during the subsequent self-administered interview in order to respond to questions or switch to a face-to-face interview setting if participants had trouble with the self-interview. Interview domains included demographics, HIV testing characteristics, mental health (Patient Health Questionnaire-2 (PHQ-2) screening tool, with a score of 3 + defined as screening positive for possible depression), drug and alcohol use (Alcohol Use Disorders Identification Test-10 (AUDIT-10) scale, cut-off of 8 for hazardous drinking), as well as HIV related risk behaviors, focusing mostly on sexual risk behavior [17, 18]. All interview data were self-reported. Depending on respondents' answers and ease of computer use, the interview lasted approximately 30–45 min. Test results were returned after the interview, and counseling and referrals provided for HIV treatment.

Data Management and Analysis

Following the interview, staff printed auto-generated summaries of key risk behaviors and made them available to Mildmay's counselors to inform the ensuing routine post testing counseling sessions taking place in separate, private rooms. Later, participants' interview data were merged with the corresponding Mildmay's HIV testing results for analysis. Data cleaning and analysis were conducted using SAS software, Version 9.3 (Cary, NC). We examined participants' sociodemographic and biobehavioral characteristics, and compared participants by HIV status and testing history using 2 tests.

We confined our analysis to the first test during the study period for each participant. Two separate bivariate logistic regression analyses were conducted to examine factors associated with our outcomes of interest: (1) HIV infection, and (2) retesting for HIV. Adjusted multivariable logistic regression models were then developed for each analysis that included variables found to be statistically significant in the unadjusted models ($p < 0.10$) and a P value < 0.05 was considered statistically significant. Unadjusted and adjusted odds ratios and corresponding 95% confidence intervals (95% CI) were reported. Missing values were excluded from the analysis.

Human Subjects Considerations

We obtained written informed consent to retain interview and biomarker data for data analysis. Children ages 13 and above are allowed to obtain HIV testing without parental permission in Uganda. As such, permission for analyzing the self-interview data was not obtained from guardians of children because doing so would require informing the guardian that a child sought testing and possibly discourage testing, something that national guidelines sought to prevent.

HTC clients who did not provide consent continued to receive Mildmay's usual HTC services but their data were not included in this analysis. Personal identifiers, including Mildmay ID numbers, were collected as per Mildmay's routine procedures. All personal identifiers were removed prior to data analysis. We collected alphanumeric finger-print codes without storing fingerprint images in order to distinguish new from returning HTC clients. No monetary or material incentives were given. The protocol was approved by the relevant institutional review boards.

Results

A total of 12,233 individuals participated in this study. All individuals aged ≥ 13 years seeking HTC services at Mild-may during the analysis period agreed to an interview to facilitate counseling, and 99.8% agreed to have their data analyzed. Our analysis of user experience of the ACASI interview format revealed that 41.5% of testers would give different answers to a person than to a computer and 62.8% appreciated the privacy aspect of ACASI even though they knew that their responses would be viewed by a counselor (Table 1).

Characteristics of People Accessing Voluntary Counseling and Testing

Females comprised 57.2% of the clients evaluated (Table 2). The majority of clients (65.9%) came from Wakiso District (where Mildmay Clinic is located) and 27.2% from Kampala. HIV-negative testers were young compared to people with HIV. Among those testing HIV-negative, 35.8% were less than 25 years old compared to 18.6% of those newly diagnosed with HIV and 18.9% among those aware of their HIV infection ($p < 0.0001$). HIV-negative testers were also better educated, with 23.6% having at least 14 years of education versus 9.3% of those unware of their infection and 16.0% of those who were aware ($p < 0.0001$). Whereas more than half of males with HIV (52.2% of unaware and 53.9% of aware) lived with a sex partner, only 36.6% of HIV-negative males did ($p < 0.0001$). Cohabitation was

less common among female testers (p = 0.0002), among whom 39.9% of HIV-negative females, 35.7% of unaware females, and 37.4% of aware females lived with a sex partner.

Both depression and harmful drinking were most common in testers with HIV. Prevalence of depression was similar among those unaware and aware of their infection (40.1% vs. 38.8%, p = 0.4008). Harmful drinking was more prevalent among those unaware of their infection compared to aware (29.2% vs. 22.6%, P < 0.0001). Over one-quarter of all females had ever been forced to have sex (Table 3). Among males, the estimate was similar among HIV-negative participants (8.0%) and those previously diagnosed with HIV (12.2%). More than one in 10 males (14.1%) bought sex in the last 6 months, and the proportion of people reportedly selling sex was approximately twice as high in males than females, with males also having a higher HIV prevalence among both the HIV-aware and unaware groups compared to females (p < 0.0001). Condom use at last sex was 28.6% among those without HIV, 22.4% among the unaware, and 28.3% among the aware (p < 0.0001).

Prior HIV testing was much more common among HIV-negative participants compared to those newly diagnosed with HIV (67.0% and 26.7%, respectively, p < 0.0001). While 38.1% of HIV-negative participants tested because they felt ill or feared they had AIDS, 66.5% of newly diagnosed participants tested for this reason (p < 0.0001). Similarly, 32.1% of HIV-negative participants believed they were likely to get HIV in the next year compared to 63.7% of unaware HIV-infected individuals (p < 0.0001). More than half of each group did not know the HIV status of their last sex partner, and among HIV-unaware individuals, 78.2% did not know (p < 0.0001). The CD4 count of males was lower than for females (p < 0.0001); 61.8% of males and 50.5% of females unaware of their status had a CD4 count less than 350, the treatment eligibility threshold in Uganda at the time of data collection.

HIV prevalence was 39.0%; however, 37.2% of people diagnosed with HIV already knew their sero-status. HIV prevalence among those who had not previously tested HIV positive was 23.4% among males and 32.8% among females, for a combined prevalence of 28.5%.

Factors Associated with Undiagnosed HIV

In multivariate analysis, the odds of having undiagnosed HIV infection were lower for males compared to females (adjusted Odds Ratio (aOR) 0.60, 95% CI 0.53–0.67) and for people living in Wakiso District compared to Kampala (aOR 0.65, 95% CI 0.58–0.73) (Table 4). While the adjusted odds of undiagnosed HIV were higher among those aged ≥ 19 years than for those aged 18 years or lower, the odds did not increase with age; and for those aged > 49 years, the odds of undiagnosed HIV were significantly lower than among the age groups 25–34 years and 35–49 years. All categories of people who have ever been married were more likely to have undiagnosed HIV than those who had never been married, with widowers having the highest odds (aOR 3.34, 95% CI 2.58–4.33).

The odds of having undiagnosed HIV were also higher among individuals screening positive for depression (aOR 1.16, 95% CI 1.04–1.28) and those screening for harmful drinking behavior (aOR 1.23, 95% CI 1.10–1.39) according to the PHQ-2 and AUDIT-10 scales, respectively. Those who had never tested for HIV were more likely to be undiagnosed (aOR 5.72, 95% CI 5.13–6.37) than those who had, as were those who perceived themselves as

being extremely likely to acquire HIV in the next year (aOR 3.53, 95% CI 3.03–4.12). Neither selling sex in the last 6 months nor the number of sexual partners in the last 6 months were significantly associated with undiagnosed HIV.

Factors Associated with Retesting for HIV

The odds of retesting among individuals testing positive for HIV were lower for males compared to females (aOR 0.80, 95% CI 0.70–0.92) and those screening positive for harmful drinking behavior compared to those who did not (aOR 0.77, 95% CI 0.66–0.88) (Table 5). Having been forced to have sex was associated with a greater odds of retesting (aOR 1.26, 95% CI 1.10–1.46). Retesting was also associated with higher education level and perceived social status below 'better off'. Retesting testing was not associated with age, district of residence, marital status, having sold or bought sex in the last 6 months, or the number of partners in the same period.

Discussion

Our examination of people testing for HIV in one of Uganda's largest HIV service facilities reveals important information about who is getting tested and the characteristics of those testing for HIV. Perhaps most importantly, it has revealed the large proportion of PLHIV who seek retesting after having already been diagnosed. In the Mildmay context, as the clinic is a well-known treatment provider, it is possible that some HIV-positive clients may have opted for testing at Mildmay with the intention of seeking care or treatment at this facility. In our sample, individuals already diagnosed with HIV accounted for an excess 1776 people tested for HIV. At a national level, with more than 8.6 million people testing, and assuming prevalence of 7.1%, this could result in an additional 227,753 people being tested unnecessarily [9]. It overestimates the "positive yield" among tested clients and could also inflate testing coverage.

It further contributes to an underestimation of linkage to care rates. Population-based surveys with viral load testing and testing for the presence of antiretroviral medications provide the best portrait of progress toward 90–90–90 goals and can help calibrate service data [19, 20].

Though adult HIV prevalence in Uganda is estimated at 7.1%, prevalence among testers at this facility who had not been previously diagnosed with HIV was four times higher (28.5%) [21]. Though unlikely, there may be a high concentration of people in Mildmay's catchment area who are unaware of their infection status. That a large proportion of people living with HIV (PLHIV) come from Kampala suggests the need to assess the reach and quality of testing services in the city. It may be that people feel more comfortable testing farther from home to maintain a sense of anonymity. Simultaneously, the greater odds of undiagnosed HIV among people from Kampala suggest a greater need for prevention, testing, and treatment services in the city.

The odds of undiagnosed HIV infection were also higher among females than males, and ever married females in particular, especially those who are no longer married, emphasizing the need for testing campaigns to focus on these populations. Consistent with findings from

other studies, those testing for HIV for the first time were more likely to be HIV-infected than people who had tested before [4, 5, 16]. This is to be expected as repeat testers had less exposure time since their last negative test than first-time testers. Repeat testing among the "worried well", that is, people who are not at high risk for HIV but who nonetheless test regularly, may also account for the lower prevalence among repeat testers. Regular testing can decrease time from infection to diagnosis and the start of treatment with the result of decreased morbidity, mortality and risk for onward transmission [1, 22, 23]. However, focusing on reducing the time between tests may come at the expense of testing others for the first time. Testing people more often with the result of identifying more new infections may result in fewer PLHIV being identified as such infections are relatively rare, but as they may be in the acute phase of infection their viral load might be higher and the transmission risk higher [24, 25]. Data on community viral load among testers at Mildmay could facilitate prior-itization of groups for testing. To decrease the use of health resources by the worried well, HIV counselors could advise people with no or little risk behavior of what constitutes risk behavior and when testing may be warranted.

The increased odds of undiagnosed HIV infection among those with depression and harmful alcohol behaviors highlights an opportunity for better linkages between mental health and substance abuse services with HIV services. Individuals with depression or who abuse alcohol could be tested for HIV and referred for services as needed [26]. HIV testing, self-tests, or referrals for testing could be co-located at or near liquor stores, bars, barbers, or other venues where men can be found [27].

In our study the odds of undiagnosed HIV infection increased significantly with each level of increased self-perceived risk of acquiring HIV. Outreach workers should be encouraged to screen for HIV risk behaviors and take extra efforts to connect individuals with higher self-perceived risk to HIV testing, including self-testing. Where HIV test kits are limited asking people their self-perceived risk of getting HIV may be a useful way to triage who to test and who to request to return for testing at a later time.

Over one-third (37.2%) of people diagnosed with HIV already knew they were infected. Such retesting of individuals puts a strain on supplies and human resources. Given the high positivity, it is possible that some of these people were silent transfers who had tested positive and possibly even started treatment elsewhere [28, 29]. Other possible explanations include being informed that they have been cured by a traditional or faith healer, believe that they may be cured because they are virally suppressed, or may have challenges accepting their HIV status. Populations with a higher odds of retesting may benefit from additional counseling after diagnosis and while on treatment to reinforce that HIV is a chronic and incurable disease. Qualitative research should be undertaken to determine why people with known infection are restesting and inform how to decrease retesting.

Our findings are limited by the cross-sectional nature of this survey, that we included only one testing facility, and that non-biological results rely on self-reported data. Nevertheless, our assessment of participant experience with ACASI suggests that the self-interview format promoted the provision of more accurate self-reported responses by participants, consequently increasing the validity of our findings. ACASI facilitates the collection of

sensitive data and should be exploited to its fullest [30–35]. Due to the small number of individuals who tested multiple times during the study period, we are unable to describe behavior changes over time, or before and after a diagnosis with HIV. The lack of viral load data also hinders our understanding of transmission risk of people testing for HIV at Mildmay Clinic. Funding constraints prevented the testing of HIV viral load and the presence of antiretroviral medications. Such testing would facilitate an understanding of why so many who had already been diagnosed with HIV visited Mildmay for HIV testing. Conducting qualitative interviews of a sample of people testing at Mildmay could provide further insight. In the meantime, testing programs may wish to consider having HIV counselors ask clients whether they have already been diagnosed with HIV.

Conclusion

Understanding who is and who is not testing for HIV and who is aware of their infection is key to identifying people with undiagnosed infection. To reach these people testing strategies should focus on those who have never tested before. To better understand the proportion of HIV testing clients who have already been diagnosed with HIV, testing providers should ask clients for their status rather than assuming that all clients are undiagnosed. Positivity data from HIV testing facilities should be used with caution and adjusted to account for repeat testers who have already been diagnosed with HIV. Including an assessment of prior HIV diagnosis during pre-test counseling may reduce the number of PLHIV retested.

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Table 1

Perspectives on using computer-assisted self-interview

	All participants (N = 12,233)	
	N	%
Preferred interview method	12,232	
Computer	7343	60.0
Person	3038	24.8
No preference	1851	15.1
What liked most about computer interview	12,233	
Privacy	7679	62.8
Entertaining	928	7.6
New experience/learned something	3192	26.1
Other	434	3.5
Main thing did not like about computer interview	12,233	
Nothing	8134	66.5
Prefer talking to real person	2330	19.0
Difficult to use	1301	10.6
Other	468	3.8
Would give different answers if interview with person	11,658	
Yes	4841	41.5
No	6817	58.5
Frequency of computer use	12,233	
Never used before	8240	67.4
Monthly or less	2169	17.7
Daily or weekly	1824	14.9

Table 2

Socio-demographic characteristics of individuals seeking testing at Mildmay Clinic, Uganda

Demographic variables	All participants (N = 12,232)		Male HIV- (N = 3601)		Female HIV- (N = 3870)		Male Aware HIV+ (N = 536)		Female Aware HIV + (N = 1235)		Male Unaware HIV + (N = 1097)		Female Unaware HIV+ (N = 1893)		X^2 p-value
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	
Sex	12,232														
Male	5234	42.8%													
Female	6998	57.2%													
Age	12,233		3601		3870		536		1235		1097		1893		<0.0001
13–19	955	7.8%	332	9.2%	448	11.6%	8	1.5%	58	4.7%	17	1.5%	92	4.8%	
20–24	2607	21.3%	865	24.0%	1026	26.5%	41	7.6%	228	18.5%	79	7.2%	368	19.4%	
25–34	5151	42.1%	1547	43.0%	1442	37.3%	215	40.1%	586	47.4%	470	42.8%	890	47.0%	
35–49	3010	24.6%	724	20.1%	770	19.9%	236	44.0%	326	26.4%	471	42.9%	483	25.5%	
50 +	510	4.2%	133	3.7%	184	4.8%	36	6.7%	37	3.0%	60	5.5%	60	3.2%	
Nationality	12,233		3601		3870		536		1235		1097		1893		<0.0001
Ugandan	11,864	97.0%	3525	97.9%	3739	96.6%	528	98.5%	1192	96.5%	1068	97.4%	1811	95.7%	
Years of school completed	12,231		3600		3869		536		1235		1097		1893		<0.0001
Never attended school	1405	11.5%	275	7.6%	389	10.1%	59	11.0%	159	12.9%	175	16.0%	348	18.4%	
1–7 years	3741	30.6%	833	23.1%	1111	28.7%	184	34.3%	436	35.3%	458	41.8%	719	38.0%	
8–13 years	4758	38.9%	1465	40.7%	1630	42.1%	176	32.8%	473	38.3%	355	32.4%	658	34.8%	
14 +years	2327	19.0%	1027	28.5%	739	19.1%	117	21.8%	167	13.5%	109	9.9%	168	8.9%	
District where live now	12,233		3601		3870		536		1235		1097		1893		<0.0001
Kampala	3327	27.2%	819	22.7%	971	25.1%	182	34.0%	429	34.7%	300	27.3%	626	33.1%	
Wakiso	8062	65.9%	2574	71.5%	2690	69.5%	297	55.4%	705	57.1%	672	61.3%	1123	59.3%	
Elsewhere	844	6.9%	208	5.8%	209	5.4%	57	10.6%	101	8.2%	125	11.4%	144	7.6%	
Live in urban or rural area (if not in Kampala)	8906		2782		2899		354		806		797		1267		<0.0001
Urban	4753	53.4%	1517	54.5%	1677	57.8%	168	47.5%	424	52.6%	329	41.3%	637	50.3%	
Self-perceived social status	12,233		3601		3870		536		1235		1097		1893		<0.0001
Very poor	1165	9.5%	242	6.7%	274	7.1%	63	11.8%	170	13.8%	122	11.1%	294	15.5%	
Poor	3413	27.9%	895	24.9%	874	22.6%	190	35.4%	467	37.8%	380	34.6%	607	32.1%	
Average	6095	49.8%	1991	55.3%	2097	54.2%	250	46.6%	489	39.6%	494	45.0%	773	40.8%	

Demographic variables	All participants (N = 12,232)		Male HIV- (N = 3601)		Female HIV- (N = 3870)		Male Aware HIV+ (N = 536)		Female Aware HIV + (N = 1235)		Male Unaware HIV + (N = 1097)		Female Unaware HIV+ (N = 1893)		X^2 p-value
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	
Better off	1560	12.8%	473	13.1%	625	16.1%	33	6.2%	109	8.8%	101	9.2%	219	11.6%	
Religion	12,233		3601		3870		536		1235		1097		1893		<0.0001
Protestant	3456	28.3%	1075	29.9%	994	25.7%	183	34.1%	356	28.8%	347	31.6%	500	26.4%	
Catholic	4260	34.8%	1.212	33.7%	1243	32.1%	211	39.4%	403	32.6%	491	44.8%	700	37.0%	
Muslim	2043	16.7%	565	15.7%	670	17.3%	67	12.5%	237	19.2%	139	12.7%	365	19.3%	
Born again	2209	18.1%	658	18.3%	873	22.6%	66	12.3%	219	17.7%	100	9.1%	293	15.5%	
Other	183	1.5%	60	1.7%	72	1.9%	7	1.3%	14	1.1%	3	0.3%	12	0.6%	
None	82	0.7%	31	0.9%	18	0.5%	2	0.4%	6	0.5%	7	0.6%	23	1.2%	
Marital status	12,233		3601		3870		536		1235		1087		1893		<0.0001
Never married	4281	35.0%	1858	51.6%	1432	37.0%	101	18.8%	261	21.1%	234	21.3%	395	20.9%	
Currently married	4417	36.1%	1223	34.0%	1397	36.1%	272	50.7%	416	33.7%	513	46.8%	595	31.4%	
Divorced	996	8.1%	102	2.8%	378	9.8%	16	3.0%	163	13.2%	56	5.1%	281	14.8%	
Separated	1933	15.8%	386	10.7%	521	13.5%	129	24.1%	248	20.1%	252	23.0%	397	21.0%	
Widowed	606	5.0%	32	0.9%	142	3.7%	18	3.4%	147	11.9%	42	3.8%	225	11.9%	
Live with a sex partner	12,233		3601		3870		536		1235		1097		1893		<0.0001
Yes	4861	39.7%	1318	36.6%	1544	39.9%	289	53.9%	462	37.4%	573	52.2%	675	35.7%	
Ever been pregnant	6998		-	-	3870		-	-	1235		-	-	1893		<0.0001
Yes	5415	77.4%	-	-	2768	71.5%	-	-	1070	86.6%	-	-	1577	83.3%	
Number of times pregnant, lifetime	5194				2625				1038				1531		<0.0001
1–2	1996	38.4%	-	-	1089	41.5%	-	-	349	33.6%	-	-	558	36.4%	
3–5	2319	44.6%	-	-	1094	41.7%	-	-	512	49.3%	-	-	713	46.6%	
>5	879	16.9%	-	-	442	16.8%	-	-	177	17.1%	-	-	260	17.0%	

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Table 3

Biobehavioral characteristics of HIV testing clients at Mildmay Clinic

	All participants (N = 12,233)		**Male HIV- (N = 3601)**		**Female HIV- (N = 3870)**		**Male Aware HIV + (N = 536)**		**Female Aware HIV + (N = 1235)**		**Male Unaware HIV+ (N = 1097)**		**Female Unaware HIV+ (N = 1893)**		**X^2 p-value**
	n	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Depressed	12,232		3601		3870		536		1235		1097		1892		<0.0001
Yes	4076	33.3%	1025	28.5%	1165	30.1%	211	39.4%	477	38.6%	438	39.9%	760	40.2%	
Harmful drinking behavior	12,231		3601		3870		536		1235		1097		1892		<0.0001
Yes	2687	22.0%	785	21.8%	628	16.2%	173	32.3%	228	18.5%	430	39.2%	443	23.4%	
Ever used a male condom	11,370		3221		3579		508		1210		1024		1827		<0.0001
Yes	9143	80.4%	2633	81.7%	2748	76.8%	452	89.0%	980	81.0%	866	84.6	1463	80.1%	
Ever paid someone for sex	11,164		3175		3521		503		1168		1003		1793		<0.0001
Yes	1374	12.3%	637	20.1%	176	5.0%	141	28.0%	85	7.3%	226	22.5%	109	6.1%	
Ever sold sex in exchange for something	11,165		3175		3522		503		1168		1003		1793		<0.0001
Yes	694	6.2%	251	7.9%	141	4.0%	46	9.1%	64	5.5%	102	10.2%	90	5.0%	
Ever forced to have sex	11,433		3221		3612		508		1217		1024		1850		<0.0001
Yes	2472	21.6%	257	8.0%	1042	28.8%	62	12.2%	435	35.7%	85	8.3%	591	31.9%	
Had sex past 6 months	11,441		3.222		3616		508		1217		1024		1853		<0.0001
Yes	8911	77.9%	2590	80.4%	2825	78.1%	415	81.7%	868	71.3%	837	81.7%	1376	74.3%	
Bought sex past 6 months	8911		2590		2825		415		868		837		1376		<0.0001
Yes	567	6.4%	367	14.2%	17	0.6%	66	15.9%	5	0.6%	110	13.1%	2	0.1%	
Sold sex past 6 months	8911		2590		2825		415		868		837		1376		<0.0001
Yes	274	3.1%	107	4.1%	57	2.0%	22	5.3%	26	3.0%	35	4.2%	27	2.0%	
Condom use at last sex	8872		2590		2804		415		864		837		1362		<0.0001
Yes	2397	27.0%	843	32.5%	699	24.9%	115	27.7%	247	28.6%	187	22.3%	306	22.5%	
Type of last sex partner	8909		2590		2825		415		868		837		1374		<0.0001
Steady	7163	80.4%	1874	72.4%	2474	87.6%	302	72.8%	738	85.0%	605	72.3%	1170	85.2%	
Casual	1410	15.8%	552	21.3%	301	10.7%	82	19.8%	115	13.2%	192	22.9%	168	12.2%	
Commercial	336	3.8%	164	6.3%	50	1.8%	31	7.5%	15	1.7%	40	4.8%	36	2.6%	
What think last partner’s HIV status	8909		2590		2825		415		868		837		1374		<0.0001
Negative	1425	16.0%	423	16.3%	599	21.2%	74	17.8%	133	15.3%	70	8.4%	126	9.2%	

	All participants (N = 12,233)		Male HIV- (N = 3601)		Female HIV- (N = 3870)		Male Aware HIV + (N = 536)		Female Aware HIV + (N = 1235)		Male Unaware HIV+ (N = 1097)		Female Unaware HIV+ (N = 1893)		X^2 p-value
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	
Positive	1901	21.3%	643	24.8%	659	23.3%	84	20.2%	229	26.4%	109	13.0%	177	‘12.9%	
Don’t know	5583	62.7%	1524	58.8%	1567	55.5%	257	61.9%	506	58.3%	658	78.6%	1071	77.9%	
HIV testing & treatment															
Reason for testing	12,229		3601		3866		536		1235		1097		1893		<0.0001
I feel ill	2947	24.1%	529	14.7%	587	15.2%	243	45.3%	419	33.9%	506	46.1%	663	35.0%	
I fear I have AIDS	2972	24.3%	812	22.5%	914	23.6%	117	21.8%	310	25.1%	299	27.3%	520	27.5%	
I feel I am at risk	1980	16.2%	587	16.3%	612	15.8%	87	16.2%	249	20.2%	119	10.9%	325	17.2%	
I have or want a new partner	1172	9.6%	456	12.7%	465	12.0%	26	4.9%	71	5.8%	58	5.3%	96	5.1%	
To get married	1202	9.8%	470	13.1%	537	13.9%	16	3.0%	51	4.1%	37	3.4%	91	4.8%	
Other	1956	16.0%	747	20.7%	751	19.4%	47	8.8%	135	10.9%	78	7.1%	198	10.5%	
Main reason for feeling at risk	1980		584		612		87		249		119		325		<0.0001
I fear I have an STI	316	16.0%	88	15.0%	98	16.0%	15	17.2%	39	15.7%	18	15.1%	58	17.9%	
I had unprotected sex	958	48.4%	352	60.0%	288	47.1%	35	40.2%	106	42.6%	59	49.6%	117	36.0%	
I have an ill partner or family member	351	17.7%	67	11.4%	131	21.4%	18	20.7%	47	18.9%	20	16.8%	68	20.9%	
I lost a partner or family member	197	10.1%	23	3.9%	39	6.4%	13	14.9%	42	16.9%	15	12.6%	65	20.0%	
Other	155	7.8%	54	9.2%	56	9.2%	6	6.9%	15	6.0%	7	5.9%	17	5.2%	
Ever tested for HIV	12,233		3601		3870		536		1235		1097		1893		<0.0001
Yes	7571	61.9%	2223	61.7%	2779	71.8%	536	100%	1235	100%	208	19.0%	589	31.1%	
Years since last HIV test	12,233		3601		3870		536		1235		1097		1893		<0.0001
Less than 1 year	2387	19.5%	709	19.7%	753	19.5%	267	49.8%	531	43.0%	38	3.5%	88	4.6%	
1–2 years	3430	28.0%	1074	29.8%	1391	35.9%	171	31.9%	450	36.4%	73	6.7%	271	14.3%	
3 + years	1754	14.3%	440	12.2%	635	16.4%	98	18.3%	254	20.6%	97	8.8%	230	12.2%	
Never tested	4662	38.1%	1378	38.3%	1091	28.2%	0	0.0%	0	0.0%	889	81.0%	1304	68.9%	
Self-perceived likelihood of infection in next year	9713		3386		3623						992		1712		<0.0001
Extremely unlikely	3786	39.0%	1662	49.1%	1572	43.4%	-	-	-	-	206	20.8%	346	20.2%	
Somewhat unlikely	1955	20.1%	736	21.7%	789	21.8%	-	-	-	-	165	16.6%	265	15.5%	
Somewhat likely	2372	24.4%	654	19.3%	816	22.5%	-	-	-	-	340	34.3%	562	32.8%	

	All participants (N = 12,233)		Male HIV- (N = 3601)		Female HIV- (N = 3870)		Male Aware HIV + (N = 536)		Female Aware HIV + (N = 1235)		Male Unaware HIV+ (N = 1097)		Female Unaware HIV+ (N = 1893)		X^2 p-value
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	
Extremely likely	1600	16.5%	334	9.9%	446	12.3%	-	-	-	-	281	28.3%	539	31.5%	
What you think is HIV status now	12,021		3594		3843		491		1105		1096		1891		<0.0001
Positive	2068	17.2%	151	4.2%	159	4.1%	393	80.0%	841	76.1%	217	19.8%	307	16.2%	
Negative	2634	21.9%	1241	34.5%	1159	30.2%	7	1.4%	26	2.4%	68	6.2%	132	7.0%	
Don’t know	7319	60.9%	2202	61.3%	2525	65.7%	91	18.5%	238	21.5%	811	74.0%	1452	76.8%	
Biomarkers															
HIV prevalence—all	12,233		-	-	-	-	-	-	-	-	-	-	-	-	
Positive	4766	39.0%	-	-	-	-	-	-	-	-	-	-	-	-	
HIV prevalence—previously unknown status	10,473														
Positive	2990	28.5%													
CD4 count	4346						469		1154		970		1753		<0.0001
<350	2379	54.8%	-	-	-	-	287	61.2%	608	52.7%	599	61.8%	885	50.5%	
350–199	822	18.9%	-	-	-	-	83	17.7%	217	18.8%	174	17.9%	347	19.8%	
500 +	1146	26.3%	-	-	-	-	99	21.1%	329	28.5%	197	20.3%	521	29.7%	

STI sexually transmitted infection, *CD4* cluster of differentiation 4

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Table 4

Factors associated with HIV positivity among HIV− and unaware HIV+ testers

	Bivariate models		Multivariate Model	
	OR (95% CI)	**p-value**	**aOR (95% CI)**	**p-value**
Sex				
Female	1.0	< 0.0001	1.0	< 0.0001
Male	0.62 (0.57–0.68)		0.60 (0.53–0.67)	
District where live				
Kampala	1.0	< 0.0001	1.0	< 0.0001
Wakiso	0.66 (0.60–0.73)		0.65 (0.58–0.73)	
Elsewhere	1.25 (1.05–1.48)		1.07 (0.87–1.31)	
Age				
13–19	1.0	< 0.0001	1.0	< 0.0001
20–24	1.69 (1.35–2.12)		2.03 (1.59–2.61)	
25–34	3.26 (2.64–4.02)		3.12 (2.45–3.97)	
35–49	4.57 (3.68–5.67)		3.12 (2.41–4.02)	
50 +	2.71 (2.03–3.62)		1.66 (1.18–2.32)	
Years of school completed				
14 + years	1.0	< 0.0001	1.0	< 0.0001
8–13 years	2.09 (1.81–2.41)		1.34 (1.14–1.58)	
1–7 years	3.86 (3.34–4.47)		1.53 (1.29–1.82)	
Never attended school	5.02 (4.23–5.96)		1.34 (1.22–1.84)	
Self-perceived social status				
Better off	1.0	< 0.0001	1.0	< 0.0001
Average	1.06 (0.93–1.22)		1.02 (0.86–1.20)	
Poor	1.91 (1.65–2.22)		1.38 (1.17–1.64)	
Very poor	2.77 (2.31–3.31)		1.48 (1.20–1.83)	
Marital status				
Never married	1.0	< 0.0001	1.0	< 0.0001
Currently married	2.21 (1.98–2.47)		1.44 (1.21–1.72)	
Divorced	3.67 (3.12–4.32)		1.52 (1.24–1.86)	

	Bivariate models		Multivariate Model	
	OR (95% CI)	**p-value**	**aOR (95% CI)**	**p-value**
Separated	3.74 (3.28–4.27)		2.06 (1.75–2.43)	
Widowed	8.03 (6.51–9.89)		3.34 (2.58–4.33)	
Live with a sex partner				
No	1.0		1.0	
Yes	1.15 (1.06–1.26)	0.0012	1.02 (0.88–1.19)	0.7966
Depressed				
No	1.0	< 0.0001	1.0	
Yes	1.61 (1.48–1.76)		1.16 (1.04–1.28)	0.0295
Harmful drinking behavior				
No	1.0	< 0.0001	1.0	
Yes	1.77 (1.60–1.95)		1.23 (1.10–1.39)	0.0006
Ever paid someone for sex				
No	1.0	0.8234		
Yes	0.99 (0.86–1.13)		-	-
Ever sold sex in exchange for something				
No	1.0	0.0598	**	
Yes	1.19 (0.99–1.42)			
Ever forced to have sex				
No	1.0	< 0.0001	1.0	0.1779
Yes	1.36 (1.22–1.50)		1.13 (0.99–1.28)	
Bought sex past 6 months				
No	1.0	0.0011	1.0	0.0022
Yes	0.70 (0.56–0.87)		0.69 (0.54–0.89)	
Sold sex past 6 months				
No	1.0	0.4942		
Yes	0.90 (0.67–1.21)		-	-
Condom use at last sex				
Yes	1.0	< 0.0001	**	
No	1.39 (1.23–1.56)			
Type of last sex partner				

	Bivariate models		Multivariate Model	
	OR (95% CI)	**p-value**	**aOR (95% CI)**	**p-value**
Steady	1.0	0.4933		
Casual	1.03 (0.90–1.18)		-	-
Commercial	0.87 (0.66–1.13)		-	-
What think last partner's HIV status				
Negative	1.0	< 0.0001	**	
Positive	1.14 (0.94–1.40)			
Don't know	2.91 (2.47–3.42)			
Ever tested for HIV				
Yes	1.0	< 0.0001	1.0	< 0.0001
No	5.57 (5.07–6.13)		5.72 (5.13–6.37)	
Self-perceived likelihood of infection in next year				
Extremely unlikely	1.0	< 0.0001	1.0	< 0.0001
Somewhat unlikely	1.65 (1.44–1.90)		1.37 (1.17–1.60)	
Somewhat likely	3.60 (3.18–4.06)		2.35 (2.04–2.70)	
Extremely unlikely	6.16 (5.39–7.04)		3.53 (3.03–4.12)	
Total steady partners past 6 months				
0	1.0	0.0013		
1	0.94 (0.86–1.03)		-	-
2	0.75 (0.65–0.87)		-	-
3 +	1.04 (0.84–1.30)		-	-
Total casual partners past 6 months				
0	1.0	0.0895		
1	1.15 (1.03–1.28)		-	-
2	1.05 (0.91–1.23)		-	-
3 +	1.03 (0.86–1.24)		-	-

OR odds ratio, *aOR* adjusted odds ratio

** Dropped due to large number of missing values

Table 5

Factors associated with retesting among PLHIV

Demographic Variables	Bivariate models		Multivariate Model	
	OR (95% CI)	p-value	aOR (95% CI)	p-value
Sex				
Female	1.0	< 0.0001	1.0	0.0018
Male	0.75 (0.66–0.85)		0.80 (0.70–0.92)	
District where live				
Kampala	1.0	0.0377	1.0	0.1156
Wakiso	0.85 (0.74–0.96)		0.87 (0.77–1.00)	
Elsewhere	0.89 (0.71–1.11)		0.97 (0.77–1.22)	
Age				
13–19	1.0	0.9982		
20–24	0.99 (0.71–1.40)		-	-
25–34	0.97 (0.71–1.34)		-	-
35–49	0.97 (0.70–1.34)		-	-
50 +	1.01 (0.66–1.53)		-	-
Years of school completed				
Never attended school	1.0	< 0.0001	1.0	< 0.0001
1–7 years	1.26 (1.05–1.52)		1.28 (1.06–1.54)	
8–13 years	1.54 (1.28–1.85)		1.56 (1.29–1.89)	
14 + years	2.46 (1.96–3.09)		2.59 (2.05–3.28)	
Self-perceived social status				
Better off	1.0	0.0027	1.0	0.0005
Average	1.31 (1.06–1.63)		1.25 (1.0–1.56)	
Poor	1.50 (1.20–1.87)		1.54 (1.23–1.93)	
Very poor	1.26 (0.98–1.63		1.34 (1.04–1.74)	
Marital status				
Never married	1.0	0.5922		
Currently married	0.93 (0.79–1.09)		-	-
Divorced	1.04 (0.87–1.35)		-	-

Demographic Variables	Bivariate models		Multivariate Model	
	OR (95% CI)	p-value	aOR (95% CI)	p-value
Separated	0.99 (0.83–1.19)		-	-
Widowed	0.93 (0.74–1.18)		-	-
Live with a sex partner				
No	1.0	0.6524		
Yes	1.03 (0.91–1.16)		-	-
Depressed				
No	1.0	0.4015	-	-
Yes	0.95 (0.84–1.07)			
Harmful drinking behavior				
No	1.0	< 0.0001	1.0	0.0003
Yes	0.71 (0.62–0.81)		0.77 (0.66–0.88)	
Ever used a male condom				
Yes	1.0	0.1501		
No	0.89 (0.76–1.04)		-	-
Ever paid someone for sex				
No	1.0	0.1341	-	-
Yes	1.15 (0.96–1.38)			
Ever sold sex in exchange for something				
No	1.0	0.7120	-	-
Yes	0.96 (0.75–1.2)			
Ever forced to have sex				
No	1.0	< 0.0001	1.0	0.0038
Yes	1.32 (1.15–1.50)		1.26 (1.10–1.46)	
Bought sex past 6 months				
No	1.0	0.6218	-	-
Yes	1.08 (0.80–1.46)			
Sold sex past 6 months				
No	1.0	0.1652	-	-
Yes	1.31 (0.89–1.93)			
Condom use at last sex				

Demographic Variables	Bivariate models		Multivariate Model	
	OR (95% CI)	p-value	aOR (95% CI)	p-value
No	1.0	0.0001		
Yes	1.37 (1.17–1.60)		**	
Type of last sex partner				
Steady	1.0	0.7269		
Casual	0.93 (0.77–1.13)		-	-
Commercial	1.06 (0.73–1.53)		-	-
What think last partner's HIV status				
Negative	1.0	< 0.0001		
Positive	1.04 (0.81–1.34)		**	
Don't know	0.42 (0.94–0.52)			
Total steady partners past 6 months				
0	1.0	0.4499		
1	1.06 (0.93–1.2)		-	-
2	1.08 (0.88–1.32)		-	-
3 +	0.85 (0.62–1.16)		-	-
Total casual partners past 6 months				
0	1.0	0.0554	1.0	0.2225
1	0.84 (0.75–1.02)		0.92 (0.79–1.07)	
2	0.76 (0.61–0.95)		0.84 (0.67–1.06)	
3 +	0.96 (0.75–1.24)		1.13 (0.87–1.48)	

OR odds ratio, *aOR* adjusted odds ratio

** Dropped due to large number of missing values