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Predictors of repeat HIV testing among voluntary counseling and testing center clients in Uganda

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Abstract

Predictors of repeat HIV testing among voluntary counseling and testing center clients in Uganda

By Lee Hundley

Background: Regular engagement in HIV testing and counseling (HCT) is known to lead to improved behavioral and physical health outcomes at the individual and population level. However, more research is needed to determine motivators of repeat testing for varied population subgroups in order to effectively target testing outreach efforts to link more people to testing and treatment.

Objective: The purpose of this analysis was to assess predictors of repeat HIV testing among clients of the Mildmay testing and counseling center in Kampala, Uganda.

Methods: Data was collected as part of routine procedures at the Mildmay HCT center between 2011 and 2013. Descriptive frequencies were assessed to compare demographic, behavioral, and other relevant factors among male and female repeat testers versus first-time testers. Bivariate and multivariate logistic regression analyses were conducted to examine the association between variables of interest and repeat HIV testing among males and females. Final multivariate models were selected using backwards elimination.

Results: Of the 12,233 participants, 7,571 (61.9%) had previously tested for HIV at the time of the survey. Among males, 39.2% of first-time were HIV-positive compared to 25.1% of repeat testers. Female first-time testers had an HIV prevalence of 54.5% compared to 39.6% of repeat testers. Bivariate analysis revealed that people reporting that they were “extremely likely” to become infected in the next year had the lowest likelihood of repeat testing (men: aPR 0.62, 95% CI 0.55-0.69; women: aPR 0.70, 95% CI 0.66-0.76). Among both men and women, predictors of repeat HIV testing included high education level, being married, and safe drinking behavior. Age was associated with HIV testing history among HIV-negative participants but not among HIV-positive among both men and women.

Conclusion: The analysis revealed that HIV testing behaviors may vary by several demographic and behavioral factors, as well as other individual characteristics and beliefs. This indicates the need for more individualized testing outreach efforts in order to reach groups least likely to test for HIV including at-risk young people, those who perceive themselves to be at high risk of infection, and individuals who do not know the HIV status of their last partner.

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Introduction

HIV testing and counseling (HCT) is a crucial early step in the process of reducing incident HIV infections and linking HIV-positive individuals to care and treatment. Increasing coverage of HCT is necessary for achieving the first of UNAIDS' 90-90-90 goals—that 90% of all individuals living with HIV are aware of their positive status as a result of testing and diagnosis (1). In addition to achieving population-level goals, routine HIV testing is known to lead to improved outcomes for individuals who may be at risk of HIV infection. Studies have shown that regular HCT is associated with: safer sexual practices, including having less risky sexual partnerships and fewer concurrent sexual partners (2); greater comprehensive knowledge of HIV (3); increased knowledge of partner's HIV serostatus (4); and increased condom use (5).

For individuals who are already HIV-positive but do not know their status, testing for HIV earlier can have substantial effects on their symptoms and long-term health outcomes. A study of HIV-related symptoms among HIV-infected adults in rural Uganda found that, on average individuals exhibited 14 different symptoms, at time of diagnosis. The most common symptoms included fatigue (61%), itching skin (61%), weight reduction (70%), pain (76%) and cough (53%), among others; all symptoms that can have a profound effect on an individual's quality of life (6). Early diagnosis allows an HIV-positive person to also begin treatment earlier. Consistent adherence to antiretroviral treatment (ART) is associated with decreased viral load, increased CD4 count, and lower mortality risk compared to individuals who are not adherent to treatment (7). It is clear that early testing and diagnosis, followed by linkage to care and treatment, is crucial for the short and long-term health of HIV-positive individuals.

Testing behaviors can vary widely by several demographic factors, yet HIV testing outreach efforts often do not take these differences into account. A previous study in Uganda found that higher socio-economic status is associated with a higher likelihood of testing for HIV at HCT clinics (8). This indicates the need for further outreach efforts aimed at increasing uptake of HCT among individuals of lower socioeconomic status. Higher prevalence of repeat testing has also been found to be associated with older age (9); being single rather than married (10); having higher numbers of sexual partners (11); and having a recent new or unfaithful partner (4).

There is also evidence to suggest that testing efforts targeted specifically at couples, rather than individuals, can lead to higher rates of testing among individuals involved in a steady relationship with a sexual partner. A recent study in Uganda found that individuals in an ongoing sexually active relationship were more likely to have ever tested for HIV if they had previously been exposed to a couples' HCT promotional campaign (12). Among married couples, longer marital duration and awareness of couples' HCT (CHCT) services in the community has also been found to be associated with repeat HIV testing (13). However, barriers to testing that are in some instances unique to couples still exist. Known barriers to testing among couples include fear of a positive HIV test, mistrust in marriage, and poor perceptions or lack of knowledge of

CHCT (14). More effective CHCT outreach campaigns are needed to address the unique needs and barriers to testing of couples.

There are notable differences in testing behaviors across population subgroups, which suggests the need for more targeted outreach efforts to reach groups that are less likely to have previously tested. The implementation of personalized and varied methods of testing and care has been perceived as more acceptable compared to more generalized approaches (15). Designing these types of specialized approaches effectively requires an in-depth knowledge of the demographic and behavioral differences that lead individuals to initiate testing or to test at varying frequencies. Though some of these differences are understood, there is still a lack of consistent data that explains the varied testing behaviors of different population subgroups. This analysis seeks to shed more light on those differences by examining predictors of repeat HIV testing among clients of a large testing and counseling center in Uganda. Results of this analysis may be used to inform future testing campaigns in settings where various population subgroups with unique demographic and behavioral differences are often missed by such outreach efforts.

Methods

Data collection setting and design

These data were collected at a large HIV counseling and testing (HCT) center near Kampala, Uganda. The clinic is one of several in the country run by Mildmay Uganda (MU), a national non-government organization that receives funding from the President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention (CDC). CDC Uganda supported design and implementation of the study in collaboration with MU staff. Data was collected as part of routine clinic procedures. Data are then flagged by a computer and the computer generates a report that indicates to Mildmay counselors what to discuss with participants during counseling. All individuals aged 13 years or older were offered entry into the study following collection of blood samples for HIV testing. Collection of data specific to this analysis began in January of 2011 and was completed in October of 2013, though data collection at Mildmay is still ongoing.

Data collection procedures

HIV testing

Venous blood samples were collected by Mildmay staff for all clients attending the clinic. Specimens were subsequently tested using the serial national HIV rapid test algorithm (16), which uses Determine, Stat-Pak, and Unigold rapid HIV tests. Blood samples were also used to measure CD4 count for samples that tested HIV-positive.

ACASI interviews

Following collection of blood samples, all individuals aged 13 years or older began the interview process. The interview data were collected using audio computer-assisted self-interviews (ACASI). Study staff began the interview by entering preliminary information including unique identifiers for the interviewer and participant, whether or not the participant came alone or with a partner, and interview language. The interview was available in both English and Luganda, a branch of the Bantu language that is the primary language spoken by individuals in Kampala and Southern Uganda. Participants then completed a tutorial that provided guidance on using the ACASI interface and led participants through examples of different types of questions that they would encounter in the survey (multiple choice, numeric, etc.). Following the tutorial, participants began the full interview which was designed to take approximately 25 – 50 minutes to complete. A Mildmay staff member remained with the participant through the duration of the interview to answer any questions that the participants had. Participants could also request to switch to a face-to-face interview conducted by a staff member if they found the self-interview to be difficult. Upon conclusion of the interview, individuals were asked to provide consent for the study team to analyze the data that they provided. Data for those who did not consent was not included in this analysis.

Variables and measures

Primary outcome

The primary outcome of this analysis was repeat HIV testing. Repeat testing was assessed during the interview using the question, “Have you ever tested for HIV?”

Individuals who answered “yes” were classified as repeat testers, while those who answered “no” were considered first-time testers. Participants who indicated that they had previously tested for HIV were asked to report the result of their most recent test. Any participants who refused to answer or who responded “I don’t know” to the question regarding ever testing for HIV were excluded from this analysis. Following exclusion of these observations, there were 12,233 observations remaining for data analysis.

Demographics

Demographic variables selected for inclusion in the analysis included sex, age, nationality, education level, district of residence, urban versus rural residence, self-perceived social status, religion, marital status, and living situation (with or without a sex partner). For female participants, variables assessing ever being pregnant and number of lifetime pregnancies were also included. Total number of lifetime pregnancies was categorized as: 1 – 2, 3 – 5, and >5.

Using categories agreed upon by the study team for a previous analysis of these data, the, continuous variable assessing age was categorized as follows: 13 – 19 years, 20 – 24 years, 25 – 34 years, 35 – 49 years, and 50+ years. Education level was assessed as a continuous variable using the question, “How many years have you attended school?” In an effort to approximate categories of primary school, secondary school, and university or higher, responses were categorized for this analysis as follows: never attended school, 1 – 7 years, 8 – 13 years, and 14+ years. Self-perceived social status was measured using the question, “Compared to most others, would you say you are: 1) very poor, 2) poor, 3) average, 4) better off?”.

Risk factors, behaviors and perceptions

The remaining variables of interest assessed relevant behaviors and risk factors, such as lifetime and recent sexual history, sexual violence, and condom use. The interview also included a module on perceptions and self-efficacy in regards to personal wellbeing, mental health and self-perceived HIV risk. These variables include perceived likelihood of infection in coming year, reason for current HIV test, and belief regarding current HIV status. A number of these variables were recoded to account for skip patterns that were built into the survey. For example, participants who answered “no” to the question, “Did you have sex in the past six months?” were excluded from all subsequent questions regarding sexual behaviors in the previous six months. One such question was the categorical variable indicating number of steady sexual partners in the previous six months. This variable was recoded so that participants who previously indicated that they had not had sex in the past six months would be included in the category of “0 partners”, where previously they had been excluded entirely.

Depression was assessed using questions from the Patient Health Questionnare-2 (PHQ-2) (17) and was categorized as “depressed” or “not depressed”. Harmful drinking behavior was assessed using the AUDIT-C scale (18), and was also dichotomized to indicate “harmful drinking behavior” versus “no harmful drinking behavior”.

Biomarkers

Results of HIV testing and CD4 counts were obtained as described above and included in descriptive analysis. Using the variable indicating result of last HIV-test among repeat testers, awareness of positive status among those who tested HIV-positive was also assessed.

Data analysis

Univariate descriptive analysis

All descriptive analysis was conducted using SAS software, Version 9.4 (SAS Institute, Cary, NC). Frequency distributions of all variables of interest were reported for the total study population, as well as the following four subgroups: male first-time testers, male repeat testers, female first-time testers, and female repeat testers.

Bivariate logistic regression

Due to the high prevalence of the outcome (repeat testing) in the study population it is possible that prevalence odds ratios (POR) may overestimate the true association between the independent variables of interest and the outcome of repeat HIV testing. A potentially more accurate measure of association is a prevalence ratio (PR). The magnitude of the difference between the two measures depends directly on the prevalence of the outcome, which in this case is quite substantial. As such, bivariate analyses were conducted to determine crude estimates of both prevalence odds ratios and prevalence ratios for comparison.

Based on an examination of existing literature, sixteen variables were selected for the logistic regression analysis. Six demographic variables were selected, with the remaining eight variables including behavioral factors and HIV status. Bivariate logistic regression models were created to assess the association of each variable of interest with the outcome of repeat HIV testing without controlling for the other factors. Due to known differences in testing patterns between males and females, which are partially influenced by females' exposure to testing during prenatal care (19), analyses were stratified by sex. Estimation of crude prevalence odds ratios was conducted using the *proc logistic* procedure in SAS 9.4, while prevalence ratios were estimated using the *proc rlogist* procedure in SAS-callable SUDAAN version 11 (RTI International, Research Triangle Park, N.C.) (20).

Multivariate logistic regression

All variables that were independently associated with the outcome (*p-value* < 0.05 based on the Wald chi-square value of the Type 3 Analysis of Effects) were included in the full multivariate models, with a few exceptions. Three variables were excluded from the multivariate analysis due to the number of missing values, which was the result of a built-in skip pattern in the survey that excluded individuals who had not had sex in the six months prior to the survey. These variables were: condom use at last sex, type of last sex partner, and HIV status of last sexual partner. Dropping these variables was deemed preferable to the alternative of excluding participants from the analysis who had not had sex in the past 6 months, as this would have excluded data for this group from all other variables of interest. So as not to lose data for another large subgroup, a fourth variable, self-perceived likelihood of HIV infection in the next year, was also excluded from multivariate analysis due to missing values resulting from a skip pattern that excluded all participants who were currently aware of their HIV-positive status.

Four separate multivariate logistic regression models were fit to determine prevalence ratios and prevalence odds ratios, stratified once again by sex, for the remaining significant variables. For each model, backwards elimination was conducted to yield final models which only included variables that were significantly associated (*p-value* < 0.05) with the outcome of repeat testing. No statistically insignificant variables were forced to remain in the models. Following backwards elimination, two-way interaction between the outcome and all remaining independent variables was assessed. Backwards elimination was also used to assess the presence of interaction, with p-values corrected using a Bonferroni adjustment to account for the number of terms being tested during each step. One interaction term was found to be significant in the model for males only (age by HIV status), while four were significant in the model for females (age by marital status, age by sex in previous 6 months, age by HIV status, and sex in past 6 months by HIV status). The interaction between age and marital status in the model for females was excluded due to sparse data in certain levels of the interaction term, which yielded prevalence ratios with very wide confidence intervals. The interaction between sex in the past six months and HIV status in the model for females was also excluded as a result of further analysis which showed that the stratified prevalence ratios did not differ meaningfully. All remaing meaningful, significant interaction terms were retained in the models and reported separately in Tables 3 – 4. Interaction terms were excluded from

Tables 5 and 6 (POR), as all results described in the text hereafter refer to the prevalence ratios reported in tables 3 and 4.

Collinearity was assessed for each model using a SAS macro (21). A critical value of >30 for the condition index (CDI) was used to indicate collinearity (22). No collinearity was observed in any of the multivariate models.

Results of the multivariate analyses are reported as adjusted prevalence ratios (aPR) (Tables 3 & 4) and adjusted prevalence odds ratios (aPOR) (Tables 5 & 6) with 95% confidence intervals. Adjusted measures of association were only included for variables that remained statistically significant in the final multivariate models. Levels of categorical variables that remained statistically significant at $\alpha = 0.05$ in the final multivariate models are presented in bold print to indicate significant associations with the outcome of repeat testing.

Results

Demographic characteristics

Demographic characteristics are presented in Table 1 for the total study population, as well as separately for male first-time testers, male repeat testers, female first-time testers, and female repeat testers. The majority of the 12,233 participants in the study were females (57%), and nearly all participants were of Ugandan nationality (97%). Female repeat testers were the largest subgroup (38%) of the overall population by sex and testing status. Two-thirds of the participants (66%) resided in the Wakiso district where the Mildmay clinic is located. The majority of participants (63%) were between the ages of 20 and 34. A slightly larger share of first time testers than repeat testers were aged 13-19 years (11% and 6%, respectively). A substantial portion of all participants had seven years of education or less (42%) and first-time testers had less education than repeat testers. Among males, 47% of first-time testers had 7 or fewer years of education, while the same was true for 31% of repeat testers. Similarly, among females, 54% of first-time testers had 7 or fewer years of education compared to 41% of repeat testers.

Approximately one-third of the population had never been married (35%), while a similar number were currently married (36%). First-time female testers were least likely to be married (28%), while male repeat testers were most likely (41%) to be married. Participants currently living with a sex partner comprised nearly 40% of the study population. Among all females, 77% had been pregnant at least once in their lifetime, though differences existed between first-time (71%) and repeat (81%) testers. A substantial majority of those who had ever been pregnant (62%) indicated that they had been pregnant 3 or more times, including nearly 17% who had been pregnant more than 5 times. These figures were similar among first-time and repeat testers.

Risk factors, behaviors and perceptions

One-third of the study participants exhibited signs of depression, (Table 2), while harmful drinking behavior was slightly less prevalent among participants (22%). though male first-time testers (30%). More than 80% of participants indicated that they or, if female, their male partner had ever used a male condom, which was consistent across subgroups by sex and testing history. Males reported ever paying for sex at substantially higher rates (19.5% for both first time and repeat testers) than female first-time (6%) and repeat testers (5%). More than one quarter of females (26% of first time-testers; 31% of repeat testers) had ever been forced to have sex with someone against their will.

Nearly three-quarters (73%) of participants had sex in the six months prior to the survey, which was consistent across subgroups. Frequency of buying (5%) and selling sex (2%) was low among all participants in the last six months. Condom use at last sexual encounter was also low (20%) among all participants, though slightly higher for male repeat testers (25%). Nearly 25% of participants were in a concurrent sexual relationship during the previous six months.

The majority of individuals who came to the clinic to be tested had previously tested for HIV (62%). Among all participants, one-quarter indicated that their reason for coming to Mildmay for an HIV test was that they felt ill, while another quarter feared that they had

AIDS. Another 16% felt at risk, of whom 48% had recently had unprotected sex. Nearly half (49%) of first-time testers said they thought it was either “somewhat likely” or “extremely likely” that they would become infected with HIV in the next year, while only 26% of repeat testers said the same. Among repeat testers, 20% of males and 29% of females reported that the result of their last HIV test was positive.

Biomarkers

HIV prevalence was 39% among the entire study population (Table 2). Prevalence was highest among female first-time testers (55%), which was more than double the prevalence of HIV among male repeat testers (25%). Newly diagnosed cases accounted for 63% of the prevalent cases, while the remaining 37% were previously aware of their HIV-positive status. When known positives were excluded, the difference in prevalence between first-time testers and repeat testers grew even larger. HIV-prevalence among male first-time testers (39%) was 30 percentage points higher than among repeat testers (9%), while the difference among female first-time and repeat testers was 37 percentage points (55% vs 18%). More than half of all HIV-positive participants (55%) had CD4 counts below 350 cells/mm^3, which was the threshold for treatment eligibility as determined by the Uganda Ministry of Health at the time of data collection. CD4 count below 350 cells/mm^3 was slightly more common among first-time testers (57%) than repeat testers (52%).

Bivariate Analysis

Results of the bivariate logistic regression analysis assessing the association of variables of interest with the outcome of repeat testing are displayed in Table 3 (PR) and Table 5 (POR) for male participants. Demographic factors that were independently associated with repeat HIV testing included age, years of school completed, and marital status. Several other factors were also associated with repeat HIV testing among males, including depression, alcohol abuse, having sex in the previous six months, number of steady sex partners in previous six months, self-perceived likelihood of infection in next year, condom use at last sex, and knowledge of last sexual partner's HIV status. Current HIV status was also independently associated with repeat HIV testing.

Table 4 (PR) and Table 6 (POR) include results of bivariate logistic regression analysis among female participants. Age, years of school completed, perceived social status, marital status, and living with a sex partner were all independently associated with repeat HIV testing among females (all *p-values* <0.0001). Other variables independently associated with repeat HIV testing among females included depression, alcohol abuse, ever paying for sex, ever being forced to have sex, having sex in the previous six months, number of steady sex partners in previous six months, self-perceived likelihood of infection in next year, type of last sex partner, and knowledge of last sexual partner's HIV status. As with male participants, current HIV status was independently associated with repeat HIV testing among females.

Though excluded from multivariate analyses due to excluded observations, bivariate analyses yielded significant results for the independent association between self-perceived likelihood of infection, as well as knowledge of last partner's HIV status, and repeat testing. Those who felt that they were "extremely likely" to be infected with HIV in the next year were significantly less likely to have previously tested for HIV, compared to those who said that they were "extremely unlikely" to be infected. This was true for both males (PR 0.62, 95% confidence interval [CI] 0.55 – 0.69) and females (PR 0.70, 95% CI 0.66 – 0.76). Among both groups, the prevalence ratio of repeat testing decreased as perceived likelihood of infection increased. Additionally, males who did not know the HIV status of their last sexual partner were less likely to be repeat testers (PR 0.66, 95% CI 0.62 – 0.70) than those who thought that their last partner was HIV-negative; similar results were found among females (PR 0.76, 95% CI: 0.73 – 0.79).

For both groups, statistical significance was determined using an alpha level of 0.05, though nearly all significant variables had p-values less than 0.0001. The same conclusions could be drawn by examining prevalence ratios and prevalence odds ratios, as the p-values were identical.

Multivariate Analysis

Due to the high prevalence of repeat HIV testing among both males (57%) and females (66%), only adjusted prevalence ratios (aPR) will be reported herein. Adjusted prevalence ratios are displayed in Table 3 (men) and Table 4 (females). Adjusted prevalence odds ratios are available for comparison in Tables 5 and 6. The final multivariate models used to determine adjusted prevalence odds ratios included the same variables as those used to determine adjusted prevalence ratios (with the exception of significant interaction terms, as noted previously). However, it is likely that the adjusted prevalence odds ratios exaggerated the relationship between the independent variables and the outcome of repeat testing for reasons stated previously, and should thus be considered with caution.

In the final multivariate model for males, six variables remained significantly associated with repeat HIV testing: age, years of school completed, marital status, alcohol abuse, number of steady sex partners in past six months, and current HIV status. There was also significant interaction between age and HIV status. Among males who tested positive for HIV at the time of the survey, there were no significant associations between age and repeat testing for any category of HIV. Among HIV-negative individuals, however, prevalence of repeat HIV testing was significantly higher for all age groups compared to those aged 13 – 19, ranging from 47% higher among those aged 20 – 24 (aPR 1.47, 95% [CI] 1.26 – 1.70) to 73% higher among those aged 50 and older (aPR 1.73, 95% CI 1.43 – 2.10). A similar trend was observed according to increasing years of education. Males with 14 or more years of education had the highest prevalence of repeat HIV testing compared to those with no education (aPR 1.79, 95% CI 1.59 – 2.01). Repeat testing was also 27% more prevalent among males with 1 – 7 years of education (aPR 1.27, 95% CI 1.12 – 1.43) and 49% more likely among those with 8 – 13 years of education (aPR 1.49, 95% CI 1.33 – 1.68). Compared to those who had never been married, prevalence of repeat testing was higher among males who were currently married (aPR 1.11, 95% CI 1.04 – 1.18) and males who were separated (aPR 1.12, 95% CI 1.04 – 1.21). No significant association was found for those who were divorced or widowed.

The probability of being a repeat HIV tester was 10% lower among males with harmful drinking behavior (aPR 0.90, 95% CI 0.85 – 0.96) compared to males with no harmful drinking behavior. Having two or more steady sex partners in the past six months, compared to having no steady sex partners, was associated with a higher probability of repeat testing (aPR 1.13, 95% CI 1.07 – 1.20). Perceived social status, depression, and having sex in the past six months were not associated with repeat HIV testing when adjusting for other significant covariates in the final model.

The final multivariate model for females (Table 4) included all variables that were also in the final model for males, with the exception of number of steady sex partners in the previous six months. Three additional variables were included in the model for females that were not in the final model for males: depression, having sex in the previous six months, and ever being forced to have sex. There was significant interaction between age and HIV status. As was the case among males, there was no significant association between age and repeat HIV testing among those who were HIV positive. There was, however, a significant association among HIV-negative females. In contrast to males, among whom probability of being a repeat tester increased with age, HIV-negative females aged 25 – 34 were most likely to be repeat HIV testers (aPR 1.44, 95% CI 1.32 – 1.58) compared to females aged 13 – 19. The oldest group of HIV-negative females (aged 50+) had the lowest probability of being a repeat tester (aPR 1.19, 95% CI 1.01 – 1.39) among the four age categories compared to the youngest age group. Prevalence of repeat HIV testing also increased as years of education increased, with those having 14 or more years of education being 50% more likely to be a repeat HIV tester (aPR 1.50, 95% CI 1.40 – 1.61).

Results also revealed significant interaction between age and having sex in the previous six months. Females who had not had sex in the previous six months were more likely to be repeat testers across all age categories than females who did have sex in the previous six months. There was no significant association between age and repeat testing among females aged 35 – 49 and 50+ who were recently sexually active. Among those who were not sexually active in the past six months, females aged 25-34 were once again most likely to be repeat HIV testers (aPR 1.44, 95% CI 1.32 – 1.58) compared to those aged 13 – 19.

Only one category of marital status, currently married, was significantly associated with being a repeat tester among females (aPR 1.14, 95% CI 1.09 – 1.20). Females with depressive symptoms (aPR 0.95, CI 0.93 – 0.99) and harmful drinking behavior (aPR 0.94, CI 0.90 – 0.99) were only slightly less likely to be repeat HIV testers than females who were not depressed or abusing alcohol. Ever being forced to have sex (aPR 1.08, 95% CI 1.05 – 1.12) was associated with a small increased probability of being a repeat HIV tester. Perceived social status, living with a sex partner, and number of steady partners in the previous six months were not associated with repeat HIV testing when adjusting for other significant covariates in the final model.

Discussion

Though recent efforts to increase uptake of HIV testing and counseling in Uganda have contributed to a steady increase in the number of individuals tested (5.5 million in 2011 to 9.5 million in 2014), proportions of males and females aged 15 – 49 who have tested in the past year and know their results remains relatively low, ranging from 42% in 2012 to 52% in 2014 (23). The results of this analysis indicate that a sizeable proportion of those seeking HIV testing had previously tested for HIV (62%). Additionally, a substantial proportion of participants who reported having previously tested for HIV (25%) also indicated that the result of their last HIV test was positive. This subgroup is not one that is targeted for uptake of repeat testing due to the minimal value of retesting other than to confirm a previous diagnosis, which was not recommended by the World Health Organization (WHO) at the time these data were collected. Repeat testing of those who are already known HIV-positives also contributes to wasteful use of resources in areas where testing kits and clinic staff may already be in short supply. It is important that future efforts in increasing uptake of HIV testing and counseling be targeted more precisely at individuals who are unaware of their HIV status or who have never tested for HIV, so as to maximize the use of testing resources in Uganda. Testing and counseling centers may consider asking individuals who come for testing whether or not they have tested previously and if they are aware of their status. Individuals who indicate that they are known positives could then be linked to care and treatment services and counseled as to why it is no longer necessary to be tested.

Perhaps the most striking result was the relationship between repeat testing and HIV status, especially when considering the interaction between HIV status and age. Univariate and bivariate results showed that people with HIV were more likely to be testing for the first time than were HIV-negative individuals. HIV prevalence was 15% higher for first-time testers compared to repeat testers; this was true among both males and females. This difference is even more stark when previously aware HIV-positive individuals were excluded. Bivariate analysis indicated that the prevalence of repeat testing was 26 percentage points lower among HIV-positive males compared to HIV-negative males; a difference of 19 percentage points was found when examining the same comparison among females. These findings are consistent with other studies which found that first-time testers were more likely to be infected with HIV at the time of their first test than those who had tested previously (24, 25).

Individuals who have never tested or received counseling may be less aware of potential risk factors for HIV infection, which could lead them to engage in risky behaviors that repeat testers would be more likely to avoid (3). These individuals have also had more time and opportunities to acquire HIV compared to previously-negative repeat testers, who could have become infected in the time between their last test and current test. These results provide further evidence of the importance of reaching individuals who have never tested for HIV in order to link HIV-positive individuals to care and treatment earlier.

The association between age and repeat testing was affected substantially by HIV status. For both males and females, prevalence of repeat testing was substantially higher for all age groups compared to the youngest group, those aged 13 – 19, but only among those who were HIV-negative. No significant association between age and repeat testing was found among HIV-positive participants. This result could be misleading, however, as HIV prevalence was understandably lower among those aged 13-19 relative to all other age groups. However, previous research has revealed that substantial numbers of adolescents in Sub-Saharan Africa begin having sex before the age of 15, many of whom are engaging in unprotected vaginal sex (26). Though sex may be infrequent among this age group, young girls (aged 10 – 14) in particular are at a higher risk of HIV infection per sexual act, due to older average age of male partners, low rates of condom use, frequent coercion by male partners, and immaturity of sexual organs (27-29). A study of testing behaviors of adolescents (aged 10-24) in Uganda and Kenya found that only 28% of those surveyed (overall N=86,421) had previously tested for HIV (30). Given the results of this analysis coupled with previous research, it is evident that adolescents in Uganda currently test at a rate much lower than other age groups, and that adolescents may be at a particularly high risk of HIV infection per sexual act. While it is not surprising that the youngest participants would be less likely to have previously tested for HIV, these results do indicate the need to target future testing campaigns and outreach efforts to the unique needs of high-risk adolescents.

Though not included in multivariate analysis, results of bivariate analyses of the association between self-perceived likelihood of infection and knowledge of last partner's

HIV with repeat HIV testing reveal a serious need that must addressed as part of future testing initiatives. First, among both males and females who were not known HIV-positives, there is a clear negative association between perceived likelihood of HIV infection and probability of repeat testing. Separate analyses of the same study population determined that the odds of HIV infection were significantly higher for individuals who said they were “extremely likely” to be infected, compared to those who said they were “extremely unlikely” (aOR 3.53, 95% CI 3.03 – 4.12) (31). Ideally, given these results, those who perceive themselves to be most at risk of infection would also be the most likely to be repeat HIV testers. However, the data in this study reveal that the opposite is true. These results are consistent with those from a similar study of females in Ethiopia that also showed a significantly lower odds of repeat testing among females who reported a high perceived risk of HIV infection (aOR 0.60 - 0.70) (24). Future efforts should prioritize reaching individuals that consider themselves at high risk of HIV infection, which could be effectively achieved through targeted community outreach efforts and peer education (32). It is likely that these individuals are engaged in behaviors that put them at particular risk of infection. Linking these individuals to testing and counseling earlier, and subsequently to care and treatment if they test positive, will lead to improved individual outcomes (33) as well as reduced incidence in the overall population (11).

Bivariate analysis of the association between knowledge of last partner’s HIV status and repeat testing revealed that those who did not know the status of their most recent partner (within the last 6 months) were significantly less likely to have previously tested for HIV compared to those who believed their last partner's status was negative or positive. Prevalence of repeat testing was 24 percentage points lower among females who did not know their last partner's status compared to those who believed their last partner was negative; the same comparison among males revealed a difference of 34 percentage points. Similar conclusions could be drawn from these results as those stated previously in regards to the relationship between HIV status and testing behavior. Individuals who have never been exposed to HCT likely possess lower awareness of the risks associated with being unaware of their partner's HIV status. It is also possible that individuals who did not ask their last partner about their HIV status did not do so for reasons similar to their reasons for never previously testing for HIV, such as fear of or ambivalence towards becoming positive. In the aforementioned separate analysis of the same population, individuals who did not know the status of their last partner had odds of HIV infection nearly three times higher than those who did know the status of their last partner (OR 2.91, 95% CI 2.47 – 3.42) (31). As was the case among those perceiving extreme likelihood of infection, these results reveal a subset of individuals with an elevated risk of infection who are also those least likely to be repeat HIV testers. Linking individuals with steady or casual sexual partners to couples' HIV counseling and testing (CHCT) should also be a priority of future outreach efforts aimed at increasing testing coverage. Another study in Uganda estimated that couples who had previously tested for HIV (either alone or as a couple) were twice as likely to have been exposed to a couples testing and counseling campaign than couples who had not (12). Motivators of couples testing and counseling include: perceived benefits of testing, male involvement in antenatal care (ANC) and encouragement from ANC physicians to engage in CHCT, preparation for marriage, and sickness of a partner or child (34). This knowledge can contribute to more effective interventions that would provide opportunities to link couples to testing and reduce the risk of HIV transmission among individuals with new sexual partners whose HIV status they may not know.

Limitations

The methods and results of this study are subject to several key limitations. As was stated previously, the high prevalence of the outcome among the study participants increased the likelihood that odds ratios would overstate the true association between repeat testing and the covariates of interest. Instead, prevalence ratios were calculated using marginal probabilities generated by the *proc rlogist* procedure in SUDAAN. Though there is evidence to support the use of logistic regression analyses for calculating prevalence ratios with cross-sectional data (35), other studies have concluded that alternative methods, such as proportional hazards regression or generalized linear models, may be superior to logistic regression methods in some instances (36).

Results may also be limited due to the inclusion of aware HIV-positive individuals in the analysis. These made up a substantial portion of the repeat testers that were HIV-positive at the time of the survey. It was determined that the data for these individuals were valuable in obtaining the most complete measures of association for the outcome of interest, but the presence of this group may have distorted the interpretation of the results when compared to individuals who were not known positives.

The cross-sectional nature of the data is a considerable limitation that may affect the reliability of any conclusions drawn from the results. Several items in the survey, including the outcome variable of repeat testing, may have been subject to limitations related to information biases that are inherent in self-report survey data. Specifically, social desirability bias may have led some participants to falsely indicate that they had previously tested for HIV, thus inflating the prevalence of the outcome in the study population. Similar biases may have affected responses to other sensitive questions, such as number of sexual partners, frequency of condom use, result of last HIV test, or questions about buying and selling sex. These biases may have been mitigated, however, due to the interviews being conducted in ACASI format rather than face-to-face. There is also no evidence to suggest that this bias is differential by the outcome.

Conclusions

Though the benefits of repeat HIV testing are well documented, efforts to increase the prevalence and frequency of regular testing often do not account for meaningful differences across subpopulations related to testing behavior. The results of this analysis provide insight into the demographic and behavioral differences between repeat and first-time HIV testers. The importance of linking individuals to testing earlier is clear, as HIV prevalence among first-time testers was substantially higher than among participants who had previously tested for HIV. These results also emphasize the need to target testing campaigns and outreach efforts to the needs of specific subgroups, including couples and sexually active adolescents, in addition to more generalized, large-scale efforts. More effective efforts should also be made to identify individuals who consider themselves to be most at risk, as this perception is strongly associated with a lower probability of repeat HIV testing and a higher risk of HIV infection. Tailoring testing interventions to the varying needs of a diverse population will lead to higher testing coverage overall, earlier detection and treatment of HIV-positive individuals, and a reduction in incidence rates in the general population.

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List of Tables

Table 1. Socio-demographic characteristics of HCT clients in Uganda by sex and HIV testing history, 2011 – 2013 (N = 12,233)

	All participants (N=12,233)		Male First Time Testers (N=2,267)		Female First Time Testers (N=2,395)		Male Repeat Testers (N=2,967)		Female Repeat Testers (N=4,603)	
Demographic Variables	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Sex	**12,232**									
Male	5,234	42.8%								
Female	6,998	57.2%								
Age	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
13 – 19	955	7.8%	222	9.8%	281	11.7%	135	4.6%	317	6.9%
20 - 24	2,607	21.3%	428	18.9%	496	20.7%	557	18.8%	1,126	24.5%
25 – 34	5,151	42.1%	878	38.7%	896	37.4%	1,354	45.6%	2,022	43.9%
35 – 49	3,010	24.6%	640	28.2%	606	25.3%	791	26.7%	973	21.1%
50 +	510	4.2%	99	4.4%	116	4.8%	130	4.4%	165	3.6%
Nationality	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Ugandan	11,864	97.0%	2,204	97.2%	2,299	96.0%	2,917	98.3%	4,443	96.5%
Years of school completed	**12,231**		**2,267**		**2,395**		**2,966**		**4,602**	
Never attended school	1,405	11.5%	316	13.9%	434	18.1%	193	6.5%	462	10.0%
1 – 7 years	3,741	30.6%	753	33.2%	862	36.0%	722	24.3%	1,404	30.5%
8 – 13 years	4,758	38.9%	832	36.7%	877	36.6%	1,164	39.2%	1,884	40.9%
14+ years	2,327	19.0%	366	16.1%	222	9.3%	887	29.9%	852	18.5%
District where live now	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Kampala	3,327	27.2%	543	24.0%	716	29.9%	758	25.6%	1,310	28.5%
Wakiso	8,062	65.9%	1,537	67.8%	1,521	63.5%	2,006	67.6%	2,997	65.1%
Elsewhere	844	6.9%	187	8.3%	158	6.6%	203	6.8%	296	6.4%
Live in urban or rural area (if not in Kampala)	**8,906**		**1,724**		**1,679**		**2,209**		**3,293**	
Urban	4,753	53.4%	821	47.6%	893	53.2%	1,193	54.0%	1,845	56.0%

Table 1 continued

Self-perceived social status	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Very poor	1,165	9.5%	223	9.8%	325	13.6%	204	6.9%	413	9.0%
Poor	3,413	27.9%	683	30.1%	698	29.1%	782	23.4%	1,250	27.2%
Average	6,095	49.8%	1,095	48.3%	1,049	43.8%	1,640	55.3%	2,310	50.2%
Better off	1,560	12.8%	266	11.7%	323	13.5%	341	11.5%	630	13.7%
Religion	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Protestant	3,456	28.3%	710	31.3%	622	26.0%	895	30.2%	1,228	26.7%
Catholic	4,260	34.8%	847	37.4%	846	35.3%	1,067	36.0%	1,500	32.6%
Muslim	2,043	16.7%	353	15.6%	450	18.8%	418	14.1%	822	17.9%
Born Again	2,209	18.1%	307	13.5%	425	17.8%	517	17.4%	960	20.9%
Other	183	1.5%	29	1.3%	39	1.6%	45	0.8%	70	0.5%
None	82	0.7%	21	0.9%	13	0.5%	25	1.5%	23	1.5%
Marital status	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Never married	4,281	35.0%	965	42.6%	739	30.9%	1,228	41.4%	1,349	29.3%
Currently married	4,417	36.1%	805	35.5%	659	27.5%	1,203	40.6%	1,749	38.0%
Divorced	996	8.1%	94	4.2%	332	13.9%	80	2.7%	490	10.7%
Separated	1,933	15.8%	349	15.4%	437	18.3%	418	14.1%	729	15.8%
Widowed	606	5.0%	54	2.4%	228	9.5%	38	1.3%	286	6.2%
Live with a sex partner	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Yes	4,861	39.7%	944	41.6%	777	32.4%	1,236	41.7%	1,904	29.3%
Ever been pregnant	**7,003**				**2,395**				**4,603**	
Yes	5,417	77.4%	-	-	1,694	70.7%	-	-	3,721	80.8%
Number of times pregnant, lifetime	**5,194**				**1,608**				**3,586**	
1 – 2	1,996	38.4%	-	-	566	35.2%	-	-	1,430	39.9%
3 – 5	2,319	44.7%	-	-	723	45.0%	-	-	1,596	44.5%
>5	879	16.9%	-	-	319	19.8%	-	-	560	15.6%

Table 2. Risk factors, behaviors and perceptions of HCT clients in Uganda by sex and HIV testing history, 2011 – 2013 (N=12,233)

	All participants (N=12,233)		Male First Time Testers (N=2,267)		Female First Time Testers (N=2,395)		Male Repeat Testers (N=2,967)		Female Repeat Testers (N=4,603)	
Variables	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Depressed	**12,232**		**2,267**		**2,395**		**2,967**		**4,602**	
Yes	4,076	33.3%	783	34.5%	890	37.2%	891	30.0%	1,512	32.9%
Harmful drinking behavior	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Yes	2,687	22.0%	683	30.1%	493	20.6%	705	23.8%	806	17.5%
Ever used a male condom	**11,370**		**2,009**		**2,183**		**2,744**		**4,433**	
Yes	9,143	80.4%	1,610	80.1%	1,654	75.8%	2,341	85.3%	3,537	79.8%
Ever paid someone for sex	**11,964**		**2,226**		**2,301**		**2,936**		**4,500**	
Yes	1,374	11.5%	432	19.4%	144	6.3%	572	19.5%	226	5.0%
Ever sold sex in exchange for something	**11,965**		**2,226**		**2,301**		**2,936**		**4,501**	
Yes	694	5.8%	188	8.5%	104	4.5%	211	7.2%	191	4.2%
Ever forced to have sex	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Yes	2,472	20.2%	174	7.7%	638	26.6%	230	7.8%	1,430	31.1%
Had sex past 6 months	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Yes	8,909	72.8%	1,594	70.3%	1,572	65.6%	2,248	75.8%	3,495	75.9%
Number of steady partners past 6 months	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
0	5,145	42.1%	1,084	47.8%	1,167	48.7%	1,178	39.7%	1,715	35.2%
1	5,213	42.6%	737	32.5%	1,003	41.9%	1,082	36.5%	2,391	53.6%
2+	1,875	15.3%	446	19.7%	225	9.4%	707	23.8%	497	11.2%

Table 2 continued

Number of casual partners past 6 months	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
0	8,144	66.6%	1,342	59.2%	1,735	72.4%	1,746	58.9%	3,320	72.1%
1	2,336	19.1%	475	21.0%	422	17.6%	578	19.5%	861	18.7%
2+	1,753	14.3%	450	19.9%	238	9.9%	643	21.7%	422	9.2%
Concurrent steady and casual partners past 6 mo.	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Yes	3,032	24.8%	663	29.3%	469	19.6%	929	31.3%	971	21.1%
Bought sex past 6 months	**11,964**		**2,226**		**2,301**		**2,936**		**4,500**	
Yes	567	4.7%	229	10.3%	9	0.4%	314	10.7%	15	0.3%
Sold sex past 6 months	**11,965**		**2,226**		**2,301**		**2,936**		**4,501**	
Yes	273	2.3%	73	3.3%	37	1.6%	90	3.1%	73	1.6%
Condom use at last sex (had sex past 6 months)	**12,195**		**2,267**		**2,395**		**2,967**		**4,582**	
Yes	2,397	19.7%	414	18.3%	360	15.1%	731	24.6%	892	19.5%
No	6,474	53.1%	1,180	52.1%	1,195	50.3%	1,517	51.1%	2,582	56.4%
No sex past 6 months	3,324	27.3%	673	29.7%	823	34.6%	719	24.2%	1,108	24.2%
Type of last sex partner (had sex last 6 months)	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Steady	7,163	58.6%	1,126	49.7%	1,324	53.3%	1,665	55.8%	3,058	66.4%
Casual	1,410	11.5%	364	16.1%	206	8.6%	462	15.6%	378	8.2%
Commercial	336	2.8%	104	4.6%	42	1.8%	131	4.4%	59	1.3%
No sex past 6 months	3,324	27.2%	673	29.7%	823	34.4%	719	24.2%	1,108	24.1%
What think last partner's HIV status	**8,918**		**1,594**		**1,572**		**2,248**		**3,495**	
Negative	1,425	16.0%	139	8.7%	160	10.2%	428	19.0%	698	20.0%
Positive	1,901	21.3%	232	14.6%	208	13.2%	604	26.9%	857	24.5%
Don't know	5,583	62.7%	1,223	76.7%	1,204	76.6%	1,216	54.1%	1,940	55.5%

Table 2 continued

HIV Testing & Treatment										
Ever tested for HIV	**12,233**									
Yes	7,571	61.9%								
No	4,662	38.1%								
Reason for testing	**12,229**		**2,267**		**2,395**		**2,967**		**4,599**	
I feel ill	2,947	24.1%	669	29.5%	693	28.9%	609	20.5%	976	21.2%
I fear I have AIDS	2,972	24.3%	602	26.6%	683	28.5%	626	21.1%	1,061	23.1%
I feel I am at risk	1,980	16.2%	291	12.8%	371	15.5%	502	16.9%	815	17.7%
I have or want a new partner	1,172	9.6%	179	7.9%	156	6.5%	361	12.2%	476	10.4%
To get married	1,202	9.8%	190	8.4%	189	7.9%	333	11.2%	490	10.7%
Other	1,956	16.0%	336	14.8%	303	12.7%	536	18.1%	781	17.0%
Main reason for feeling at risk	**1,980**		**291**		**371**		**502**		**815**	
I fear I have an STI	316	16.0%	49	16.8%	64	17.3%	72	14.3%	131	16.1%
I had unprotected sex	958	48.4%	162	55.7%	147	39.6%	284	56.6%	364	44.7%
I have an ill partner or family member	351	17.7%	32	11.0%	76	20.5%	73	14.5%	170	20.9%
I lost a partner or family member	200	10.1%	27	9.3%	62	16.7%	27	5.4%	84	10.3%
Other	155	7.8%	21	7.2%	22	5.9%	46	9.2%	66	8.1%
Self-perceived likelihood of infection in next year	**11,640**		**2,014**		**2,072**		**2,959**		**4,594**	
Extremely unlikely	3,786	32.5%	725	36.0%	595	28.7%	1,143	38.6%	1,323	28.8%
Somewhat unlikely	1,957	16.8%	375	18.6%	369	17.8%	526	17.8%	685	14.9%
Somewhat likely	2,372	20.4%	533	36.5%	601	29.0%	461	15.6%	777	16.9%
Extremely likely	1,600	13.8%	381	18.9%	507	24.5%	234	7.9%	478	10.4%
Known HIV+	1,926	16.6%	-	-	-	-	595	20.1%	1,331	29.0%

Table 2 continued

What you think HIV status is now	**12,021**		**2,267**		**2,395**		**2,914**		**4,444**	
Positive	2,068	17.2%	239	10.5%	265	11.1%	522	17.9%	1,042	23.5%
Negative	2,634	21.9%	341	15.0%	282	11.8%	975	33.5%	1,035	22.3%
Don't know	7,319	60.9%	1,687	74.4%	1,848	77.2%	1,417	48.6%	2,367	53.3%
Self-reported result of last HIV test							**2,967**		**4,603**	
Positive							595	20.1%	1,331	28.9%
Negative							2,262	76.2%	3,087	67.1%
Did not receive result							110	3.7%	185	4.0%
Biomarkers										
HIV Status (all)	**12,233**		**2,267**		**2,395**		**2,967**		**4,603**	
Positive	4,761	38.9%	889	39.2%	1,304	54.5%	744	25.1%	1,824	39.6%
HIV Status (exclude aware positives)	**10,462**		**2,267**		**2,395**		**2,431**		**3,368**	
Positive	2,990	28.6%	889	39.2%	1,304	54.5%	208	8.6%	589	17.5%
Awareness of positive status	**4,761**		**889**		**1,205**		**744**		**1,824**	
Newly diagnosed	2,990	62.8%	889	100%	1,205	100%	208	28.0%	589	32.3%
Previously aware	1,771	37.2%	-	-	-	-	536	72.0%	1,235	67.7%
CD4 Count	**4,346**		**791**		**1,205**		**648**		**1,702**	
< 350	2,379	54.7%	506	64.0%	644	53.4%	380	58.6%	849	49.9%
350 – 499	821	18.9%	140	17.7%	231	19.2%	117	18.1%	333	19.6%
500 +	1,146	26.4%	145	18.3%	330	27.4%	151	23.3%	520	30.6%

Table 3. Bivariate and multivariate prevalence ratios of predictors of repeat testing among male HCT clients in Uganda, 2011 – 2013 (N=5,234)

Demographic Variables	Bivariate models		Multivariate Model	
	PR (95% CI)[a]	p-value	aPR (95% CI)[a]	p-value
Years of school completed				
Never attended school	**1.00**	**<0.0001**	**1.00**	
1 – 7 years	**1.29 (1.14 – 1.46)**		**1.27 (1.12 – 1.43)**	**0.0001**
8 – 13 years	**1.54 (1.37 – 1.73)**		**1.49 (1.33 – 1.68)**	**<0.0001**
14+ years	**1.87 (1.66 – 2.10)**		**1.79 (1.59 – 2.01)**	**<0.0001**
District where live				
Kampala	1.00	0.0943		
Wakiso	0.97 (0.92 – 1.03)			
Elsewhere	0.89 (0.80 – 0.99)			
Self-perceived social status				
Better off	**1.00**	**<0.0001**	#	
Average	**0.85 (0.75 – 0.96)**			
Poor	**0.95 (0.87 – 1.03)**			
Very poor	**1.07 (0.99 – 1.15)**			
Marital status				
Never married	**1.00**	**<0.0001**	**1.00**	
Currently married	**1.07 (1.02 – 1.13)**		**1.11 (1.04 – 1.18)**	**0.0004**
Divorced	**0.82 (0.70 – 0.97)**		0.96 (0.83 – 1.11)	0.6771
Separated	**0.97 (0.90 – 1.05)**		**1.12 (1.04 – 1.21)**	**0.0030**
Widowed	**0.74 (0.58 – 0.94)**		0.95 (0.78 – 1.16)	0.5883
Live with a sex partner				
Yes	1.00			
No	1.00 (0.95 – 1.05)	0.9900		

Table 3 continued

Other factors				
Depressed				
No	**1.00**		#	
Yes	**0.91 (0.87 – 0.96)**	**0.0005**		
Harmful drinking behavior				
No	**1.00**		**1.00**	
Yes	**0.86 (0.81 – 0.92)**	**<0.0001**	**0.90 (0.85 – 0.96)**	**0.0003**
Ever paid someone for sex				
No	1.00			
Yes	1.00 (0.94 – 1.06)	0.9461		
Ever sold sex in exchange for something				
No	1.00			
Yes	0.92 (0.84 – 1.02)	0.0939		
Ever forced to have sex				
No	1.00			
Yes	1.00 (0.92 – 1.10)	0.9181		
Total steady partners past 6 mo.				
0	**1.00**	**<0.0001**	**1.00**	
1	**1.14 (1.08 – 1.21)**		1.05 (0.99 – 1.11)	0.0793
2+	**1.18 (1.11 – 1.25)**		**1.13 (1.07 – 1.20)**	**0.0001**
Total casual partners past 6 mo.				
0	1.00	0.1783		
1	0.97 (0.91 – 1.03)			
2+	1.04 (0.98 – 1.10)			

Table 3 continued

Concurrent steady-casual partners past 6 months			
No	1.00		
Yes	1.04 (0.99 – 1.10)	0.1077	
Had sex past 6 months			
No	**1.00**		#
Yes	**1.13 (1.07 – 1.20)**	**<0.0001**	
Bought sex past 6 months			
No	1.00		
Yes	1.02 (0.94 – 1.10)	0.6367	
Sold sex past 6 months			
No	1.00		
Yes	0.97 (0.84 – 1.12)	0.6633	
Self-perceived likelihood of infection in next year			
Extremely unlikely	**1.00**	**<0.0001**	*
Somewhat unlikely	**0.95 (0.89 – 1.02)**		
Somewhat likely	**0.74 (0.68 – 0.80)**		
Extremely likely	**0.62 (0.55 – 0.69)**		
Condom use at last sex			
Yes	**1.00**		
No	**0.88 (0.83 – 0.93)**	**<0.0001**	*
Type of last sex partner			
Steady	1.00	0.1248	*
Casual	0.94 (0.88 – 1.01)		
Commercial	0.94 (0.83 – 1.05)		

Table 3 continued

What think last partner's HIV status			
Negative	**1.00**	**<0.0001**	*
Positive	**0.96 (0.90 – 1.02)**		
Don't know	**0.66 (0.62 – 0.70)**		
2-way interactions			
Age			
13 – 19	**1.00**	**<0.0001**	See interaction
20 - 24	**1.50 (1.29 – 1.73)**		See interaction
25 – 34	**1.60 (1.40 – 1.84)**		See interaction
35 – 49	**1.46 (1.27 – 1.68)**		See interaction
50 +	**1.50 (1.26 – 1.79)**		See interaction
HIV status			
Negative	**1.0**		See interaction
Positive	**0.74 (0.70 – 0.78)**	**<0.0001**	See interaction

Interaction terms	**Bivariate models**	**Multivariate models**
	PR (95% CI)	**PR (95% CI)**
Interaction: age by HIV status		
HIV-positive		
13 – 19	1.00	1.00
20 - 24	1.09 (0.70 – 1.70)	1.05 (0.72 – 1.54)
25 – 34	0.95 (0.63 – 1.44)	0.90 (0.63 – 1.29)
35 – 49	0.92 (0.61 – 1.40)	0.86 (0.60 – 1.23)
50 +	0.95 (0.60 – 1.52)	0.91 (0.61 – 1.35)
HIV-negative		
13 – 19	**1.00**	**1.00**
20 - 24	**1.54 (1.32 – 1.79)**	**1.47 (1.26 – 1.70)**
25 – 34	**1.82 (1.57 – 2.10)**	**1.72 (1.48 – 1.99)**
35 – 49	**1.78 (1.53 – 2.07)**	**1.71 (1.46 – 2.00)**
50 +	**1.75 (1.45 – 2.11)**	**1.73 (1.43 – 2.10)**

[a] Measures of association in bold statistically significant at $\alpha = 0.05$

[#] Variable dropped from multivariate model during backwards elimination (*p –value >0.05)*

[*] Variable excluded from multivariate analysis due to missing values as result of skip patterns in survey

Table 4. Bivariate and multivariate prevalence ratios of predictors of repeat testing among female HCT clients in Uganda, 2011 – 2013 (N=6,998)

Demographic Variables	Bivariate models		Multivariate Model	
	PR (95% CI)[a]	p-value	OR (95% CI)[a]	p-value
Years of school completed				
Never attended school	**1.00**	**<0.0001**	**1.00**	
1 – 7 years	**1.20 (1.12 – 1.29)**		**1.19 (1.11 – 1.28)**	**<0.0001**
8 – 13 years	**1.32 (1.24 – 1.42)**		**1.31 (1.23 – 1.40)**	**<0.0001**
14+ years	**1.54 (1.43 – 1.65)**		**1.49 (1.39 – 1.60)**	**<0.0001**
District where live				
Kampala	1.00	0.4035		
Wakiso	1.03 (0.99 – 1.07)			
Elsewhere	1.01 (0.94 – 1.09)			
Self-perceived social status				
Better off	**1.00**	**<0.0001**	#	
Average	**0.85 (0.78 – 0.92)**			
Poor	**0.97 (0.92 – 1.03)**			
Very poor	**1.04 (0.99 – 1.09)**			
Marital status				
Never married	**1.00**	**<0.0001**	**1.00**	
Currently married	**1.12 (1.08 – 1.17)**		**1.14 (1.09 – 1.20)**	**<0.0001**
Divorced	**0.92 (0.86 – 0.98)**		1.03 (0.97 – 1.10)	0.3731
Separated	**0.97 (0.92 – 1.02)**		1.04 (0.98 – 1.10)	0.2246
Widowed	**0.86 (0.79 – 0.94)**		1.02 (0.94 – 1.11)	0.5908
Live with a sex partner				
Yes	**1.00**	**<0.0001**	#	
No	**0.88 (0.85 – 0.92)**			

Table 4 continued

Other factors				
Depressed				
No	**1.00**	**0.0003**	**1.00**	
Yes	**0.94 (0.90 – 0.97)**		**0.96 (0.93 – 0.99)**	**0.0091**
Harmful drinking behavior				
No	**1.00**	**0.0017**	**1.00**	
Yes	**0.93 (0.89 – 0.98)**		**0.94 (0.90 – 0.99)**	**0.0052**
Ever paid someone for sex				
No	**1.00**	**0.0339**	**#**	
Yes	**0.92 (0.85 – 1.00)**			
Ever sold sex in exchange for something				
No	1.00	0.5967		
Yes	0.98 (0.90 – 1.07)			
Ever forced to have sex				
No	**1.00**	**0.0001**	**1.00**	
Yes	**1.07 (1.04 – 1.11)**		**1.08 (1.05 – 1.12)**	**<0.0001**
Total steady partners past 6 mo.				
0	**1.00**	**<0.0001**	#	
1	**1.18 (1.14 – 1.23)**			
2+	**1.16 (1.09 – 1.23)**			
Total casual partners past 6 mo.				
0	1.00	0.3640		
1	1.02 (0.98 – 1.07)			
2+	0.97 (0.92 – 1.03)			

Table 4 continued

Concurrent steady-casual partners past 6 months			
No	1.00	0.1377	
Yes	1.03 (0.99 – 1.07)		
Bought sex past 6 months			
No	1.00	0.7040	
Yes	0.94 (0.69 – 1.29)		
Sold sex past 6 months			
No	1.00	0.9658	
Yes	1.00 (0.88 – 1.15)		
Self-perceived likelihood of infection in next year			
Extremely unlikely	**1.00**	**<0.0001**	*
Somewhat unlikely	**0.94 (0.89 – 0.99)**		
Somewhat likely	**0.82 (0.77 – 0.86)**		
Extremely likely	**0.70 (0.66 – 0.76)**		
Condom use at last sex			
Yes	1.00		
No	0.96 (0.92 – 1.00)	0.0543	*
Type of last sex partner			
Steady	**1.00**	**0.0039**	*
Casual	**0.93 (0.87 – 0.99)**		
Commercial	**0.84 (0.72 – 0.99)**		
What think last partner's HIV status			
Negative	**1.00**	**<0.0001**	*
Positive	**0.99 (0.95 – 1.03)**		
Don't know	**0.76 (0.73 – 0.79)**		

Table 4 continued

2-way interaction			
Age			
13 – 19	**1.00**	**<0.0001**	See interaction
20 - 24	**1.31 (1.21 – 1.42)**		See interaction
25 – 34	**1.31 (1.21 – 1.41)**		See interaction
35 – 49	**1.16 (1.07 – 1.27)**		See interaction
50 +	**1.11 (0.98 – 1.25)**		See interaction
Had sex past 6 months			
No	**1.00**	**<0.0001**	See interaction
Yes	**1.20 (1.15 – 1.25)**		See interaction
HIV status			
Negative	**1.0**	**<0.0001**	See interaction
Positive	**0.81 (0.78 – 0.84)**		See interaction

Interaction terms	**Bivariate models**	**Multivariate models**
	PR (95% CI)	**PR (95% CI)**
Interaction: age by sex past 6 months		
Yes		
13 – 19	**1.00**	**1.00**
20 - 24	**1.20 (1.10 – 1.31)**	**1.13 (1.04 – 1.24)**
25 – 34	**1.17 (1.07 – 1.27)**	**1.16 (1.06 – 1.26)**
35 – 49	1.05 (0.95 – 1.15)	1.04 (0.94 – 1.14)
50 +	1.01 (0.84 – 1.22)	0.96 (0.78 – 1.17)
No		
13 – 19	**1.00**	**1.00**
20 - 24	**1.43 (1.19 – 1.72)**	**1.25 (1.04 – 1.49)**
25 – 34	**1.60 (1.34 – 1.90)**	**1.44 (1.22 – 1.70)**
35 – 49	**1.46 (1.22 – 1.74)**	**1.38 (1.16 – 1.64)**
50 +	**1.44 (1.18 – 1.77)**	**1.34 (1.11 – 1.63)**

Table 4 continued

Interaction: age by HIV status		
HIV-positive		
13 – 19	1.00	1.00
20 - 24	1.09 (0.94 – 1.27)	1.05 (0.89 – 1.17)
25 – 34	1.01 (0.87 – 1.16)	0.98 (0.86 – 1.12)
35 – 49	0.91 (0.78 – 1.05)	0.90 (0.78 – 1.04)
50 +	0.91 (0.73 – 1.15)	0.89 (0.69 – 1.14)
HIV-negative		
13 – 19	**1.00**	**1.00**
20 - 24	**1.42 (1.29 – 1.56)**	**1.29 (1.17 – 1.42)**
25 – 34	**1.56 (1.42 – 1.71)**	**1.44 (1.32 – 1.58)**
35 – 49	**1.38 (1.25 – 1.53)**	**1.31 (1.19 – 1.45)**
50 +	**1.20 (1.04 – 1.39)**	**1.19 (1.01 – 1.39)**

[a] Measures of association in bold statistically significant at $\alpha = 0.05$

[#] Variable dropped from multivariate model during backwards elimination (*p –value >0.05)*

[*] Variable excluded from multivariate analysis due to missing values as result of skip patterns in survey

Table 5. Bivariate and multivariate odds ratios of predictors of repeat testing among male HCT clients in Uganda, 2011 – 2013 (N=5,234)

	Bivariate models		**Multivariate Model**	
Demographic Variables	**POR (95% CI)**	**p-value**	**aPOR (95% CI)**	**p-value**
Age				
13 – 19	**1.0**	**<0.0001**	**1.0**	
20 - 24	**2.14 (1.67 – 2.74)**		**2.12 (1.64 – 2.74)**	**<0.0001**
25 – 34	**2.54 (2.02 – 3.19)**		**2.88 (2.24 – 3.69)**	**<0.0001**
35 – 49	**2.03 (1.60 – 2.58)**		**2.65 (2.02 – 3.48)**	**<0.0001**
50 +	**2.16 (1.54 – 3.03)**		**2.89 (1.99 – 4.19)**	**<0.0001**
Years of school completed				
Never attended school	**1.0**	**<0.0001**	**1.0**	
1 – 7 years	**1.57 (1.28 – 1.93)**		**1.55 (1.25 – 1.91)**	**<0.0001**
8 – 13 years	**2.29 (1.88 – 2.80)**		**2.24 (1.82 – 2.76)**	**<0.0001**
14+ years	**3.97 (3.19 – 4.93)**		**3.77 (3.00 – 4.74)**	**<0.0001**
District where live				
Kampala	1.0	0.0942		
Wakiso	0.94 (0.82 – 1.06)			
Elsewhere	0.78 (0.62 – 0.98)			
Self-perceived social status				
Better off	**1.0**	**<0.0001**	#	
Average	**1.17 (0.98 – 1.40)**			
Poor	**0.89 (0.74 – 1.08)**			
Very poor	**0.71 (0.56 – 0.92)**			
Marital status				
Never married	**1.0**	**<0.0001**	**1.0**	
Currently married	**1.74 (1.04 – 1.33)**		**1.33 (1.14 – 1.55)**	**0.0004**
Divorced	**0.67 (0.49 – 0.91)**		0.93 (0.67 – 1.30)	0.6782
Separated	**0.94 (0.80 – 1.11)**		**1.34 (1.11 – 1.63)**	**0.0030**
Widowed	**0.55 (0.36 – 0.85)**		0.89 (0.56 – 1.40)	0.1755

Table 5 continued

Live with a sex partner				
Yes	1.0			
No	1.00 (0.89 – 1.12)	0.9900		
Behavioral Factors				
Depressed				
No	**1.0**		#	
Yes	**0.81 (0.72 – 0.91)**	**0.0005**		
Harmful drinking behavior				
No	**1.0**		**1.0**	
Yes	**0.72 (0.64 – 0.82)**	**<0.0001**	**0.78 (0.69 – 0.90)**	**0.0003**
Ever paid someone for sex				
No	1.0			
Yes	1.01 (0.87 – 1.16)	0.9461		
Ever sold sex in exchange for something				
No	1.0			
Yes	0.84 (0.68 – 1.03)	0.0938		
Ever forced to have sex				
No	1.0			
Yes	1.01 (0.82 – 1.24)	0.9181		
Total steady partners past 6 mo.				
0	**1.0**	**<0.0001**	**1.0**	
1	**1.35 (1.19 – 1.53)**		1.13 (0.99 – 1.29)	0.0800
2+	**1.46 (1.26 – 1.69)**		**1.36 (1.17 – 1.60)**	**<0.0001**
Total casual partners past 6 mo.				
0	1.0	0.1781		
1	0.94 (0.81 – 1.08)			
2+	1.10 (0.96 – 1.26)			

Table 5 continued

Concurrent steady-casual partners past 6 months			
No	1.0		
Yes	1.10 (0.98 – 1.24)	0.1076	
Had sex past 6 months			
No	**1.0**	**<0.0001**	#
Yes	**1.32 (1.17 – 1.49)**		
Bought sex past 6 months			
No	1.0		
Yes	1.04 (0.87 – 1.25)	0.6375	
Sold sex past 6 months			
No	1.0		
Yes	0.93 (0.68 – 1.28)	0.6619	
Self-perceived likelihood of infection in next year			
Extremely unlikely	**1.0**	**<0.0001**	*
Somewhat unlikely	**0.89 (0.76 – 1.05)**		
Somewhat likely	**0.55 (0.47 – 0.64)**		
Extremely likely	**0.39 (0.32 – 0.47)**		
Condom use at last sex			
Yes	**1.0**		
No	**0.73 (0.63 – 0.84)**	**<0.0001**	*
Type of last sex partner			
Steady	1.0	0.1246	
Casual	0.86 (0.74 – 1.01)		
Commercial	0.86 (0.66 – 1.12)		

Table 5 continued

What think last partner's HIV status				
Negative	**1.0**	**<0.0001**	*	
Positive	**0.85 (0.66 – 1.08)**			
Don't know	**0.32 (0.26 – 0.40)**			
HIV status				
Negative	**1.0**	**<0.0001**	**1.0**	
Positive	**0.52 (0.46 – 0.58)**		**0.52 (0.45 – 0.59)**	**<0.0001**

[a] Measures of association in bold statistically significant at $\alpha = 0.05$

[#] Variable dropped from multivariate model during backwards elimination (*p –value >0.05)*

[*] Variable excluded from multivariate analysis due to missing values as result of skip patterns in survey

Table 6. Bivariate and multivariate odds ratios of predictors of repeat testing among female HCT clients in Uganda, 2011 – 2013 (N=6,998)

	Bivariate models		**Multivariate Model**	
Demographic Variables	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Age				
13 – 19	**1.0**	**<0.0001**	**1.0**	
20 - 24	**2.01 (1.66 – 2.44)**		**1.86 (1.52 – 2.28)**	**<0.0001**
25 – 34	**2.00 (1.67 – 2.39)**		**2.14 (1.75 – 2.61)**	**<0.0001**
35 – 49	**1.42 (1.18 – 1.72)**		**1.67 (1.34 – 2.07)**	**<0.0001**
50 +	**1.26 (0.95 – 1.68)**		**1.56 (1.33 – 2.13)**	**0.0066**
Years of school completed				
Never attended school	**1.0**	**<0.0001**	**1.0**	
1 – 7 years	**1.53 (1.31 – 1.79)**		**1.56 (1.33 – 1.83)**	**<0.0001**
8 – 13 years	**2.02 (1.73 – 2.35)**		**2.05 (1.74 – 2.41)**	**<0.0001**
14+ years	**3.61 (2.96 – 4.39)**		**3.51 (2.84 – 4.33)**	**<0.0001**
District where live				
Kampala	1.0	0.4034		
Wakiso	1.08 (0.97 – 1.20)			
Elsewhere	1.02 (0.83 – 1.27)			
Self-perceived social status				
Better off	**1.0**	**<0.0001**	#	
Average	**1.13 (0.97 – 1.32)**			
Poor	**0.92 (0.78 – 1.08)**			
Very poor	**0.65 (0.54 – 0.79)**			
Marital status				
Never married	**1.0**	**<0.0001**	**1.0**	
Currently married	**1.45 (1.28 – 1.65)**		**1.60 (1.37 – 1.85)**	**<0.0001**
Divorced	**0.81 (0.69 – 0.95)**		1.13 (0.94 – 1.37)	0.1990
Separated	**0.91 (0.79 – 1.06)**		1.17 (0.99 – 1.39)	0.0706
Widowed	**0.69 (0.57 – 0.84)**		1.14 (0.91 – 1.43)	0.2590

Table 6 continued

Live with a sex partner				
Yes	**1.0**		#	
No	**0.68 (0.61 – 0.76)**	**<0.0001**		
Behavioral Factors				
Depressed				
No	**1.0**		**1.0**	
Yes	**0.83 (0.75 – 0.92)**	**0.0003**	**0.87 (0.78 – 0.97)**	**0.0091**
Harmful drinking behavior				
No	**0.1**		**1.0**	
Yes	**0.82 (0.72 – 0.93)**	**0.0017**	**0.83 (0.73 – 0.95)**	**0.0053**
Ever paid someone for sex				
No	**1.0**		#	
Yes	**0.79 (0.64 – 0.98)**	**0.0338**		
Ever sold sex in exchange for something				
No	1.0			
Yes	0.94 (0.73 – 1.19)	0.5932		
Ever forced to have sex				
No	**1.0**		**1.0**	
Yes	**1.24 (1.11 – 1.39)**	**0.0001**	**1.33 (1.18 – 1.49)**	**<0.0001**
Total steady partners past 6 mo.				
0	**1.0**	**<0.0001**	#	
1	**1.62 (1.46 – 1.80)**			
2+	**1.50 (1.26 – 1.79)**			
Total casual partners past 6 mo.				
0	1.0	0.3639		
1	1.07 (0.94 – 1.21)			
2+	0.93 (0.78 – 1.10)			

Table 6 continued

Concurrent steady-casual partners past 6 months				
No	1.0			
Yes	1.10 (0.97 – 1.24)	0.1376		
Had sex past 6 months				
No	**1.0**		**1.0**	
Yes	**1.65 (1.48 – 1.84)**	**<0.0001**	**1.41 (1.25 – 1.60)**	**<0.0001**
Bought sex past 6 months				
No	1.0	0.7040		
Yes	0.85 (0.37 – 1.95)			
Sold sex past 6 months				
No	1.0	0.9658		
Yes	1.01 (0.68 – 1.50)			
Self-perceived likelihood of infection in next year				
Extremely unlikely	**1.0**	**<0.0001**	*	
Somewhat unlikely	**0.84 (0.71 – 0.98)**			
Somewhat likely	**0.58 (0.50 – 0.67)**			
Extremely likely	**0.42 (0.36 – 0.50)**			
Condom use at last sex				
Yes	1.0			
No	0.87 (0.76 – 1.00)	0.0557	*	
Type of last sex partner				
Steady	**1.0**	**0.0033**	*	
Casual	**0.79 (0.66 – 0.95)**			
Commercial	**0.61 (0.41 – 0.91)**			

Table 6 continued

What think last partner's HIV status				
Negative	**1.0**	**<0.0001**	*	
Positive	**0.94 (0.75 – 1.19)**			
Don't know	**0.37 (0.31 – 0.45)**			
HIV status				
Negative	**1.0**		**1.0**	
Positive	**0.55 (0.50 – 0.61)**	**<0.0001**	**0.56 (0.50 – 0.62)**	**<0.001**

[a] Measures of association in bold statistically significant at $\alpha = 0.05$

[#] Variable dropped from multivariate model during backwards elimination (*p –value >0.05)*

[*] Variable excluded from multivariate analysis due to missing values as result of skip patterns in survey

Appendix I. SAS code – data cleaning

```
********************************
THESIS Data cleaning and recode

Lee Hundley
********************************;

libname H 'H:\_THESIS\SAS';
options nofmterr;

/*
proc contents data=h.biomarkers;
run;

proc contents data=h.visit1;
run;*/


********************************
VISIT 1
********************************;
proc sort data=h.biomarkers;
      by cid;
run;

proc sort data=h.visit1;
      by cid;
run;

*********************
FORMATS
*********************;

proc format;
value yrlast
                  1 = 'Less than 1 year'
                  2 = '1-2 years'
                  3 = '3+ years'
                  4 = 'Never tested';

value _yrlast
                  1 = 'Less than 1 year'
                  2 = '1-2 years'
                  3 = '3+ years';

value aware 1 = 'Unaware'
                  2 = 'Aware';

value hiv   1 = 'HIV-Positive'
                  2 = 'HIV-Negative';

value yesno 1 = 'Yes'
                  2 = 'No';

value age   1 = '13 - 19'
```

```
                2 = '20 - 24'
                3 = '25 - 34'
                4 = '35 - 49'
                5 = '50+';

value educ  1 = 'Never attended school'
                2 = '1 - 7 years'
                3 = '8 - 13 years'
                4 = '14+ years';

value cdfour 1 = '< 350'
                 2 = '350 - 499'
                 3 = '500+';

value phq    1 = 'Depressed'
                 2 = 'Not depressed';

value partner 1 = 'No partners'
                  2 = '1 partner'
                  3 = '2+ partners';

run;


data combine;
      merge h.biomarkers h.visit1;
      by cid;
      where visitno='V1'; ***Include data from visit 1 only ***;


      array change _numeric_;
        do over change;
            if change=995 then change=.;
        end;

      *Current year;
      year = year(date);

      if hvmu = "1- HIV-POSITIVEE" then hvmu = "1- HIV-POSITIVE";

      *HVMU2 - HIV status numerical;
      if hvmu = "1- HIV-POSITIVE" then hvmu2 = 1;
      else hvmu2 = 2;
      Label HVMU2 = 'HIV Status';
      format hvmu2 hiv.;

      *AGE_CAT - Categorical age;
      if age = . then age_cat = .;
      else if 13 le age le 19 then age_cat = 1;
      else if 20 le age le 24 then age_cat = 2;
      else if 25 le age le 34 then age_cat = 3;
      else if 35 le age le 49 then age_cat = 4;
      else if 50 le age le 80 then age_cat = 5;
      Label age_cat = 'Categorical age';
      format age_cat age.;

      *SCH_CAT - Categorical school years completed;
```

```
if t_sc_lev gt 25 or t_sch = . then sch_cat = .;
else if t_sch = 2 then sch_cat = 1;
else if 1 le t_sc_lev le 7 then sch_cat = 2;
else if 8 le t_sc_lev le 13 then sch_cat = 3;
else sch_cat = 4;
Label sch_cat = 'School years completed';
format sch_cat educ.;

*CD4_CAT - Categorical CD4;
if hvcd4 = . then cd4_cat = .;
else if hvcd4 lt 350.0 then cd4_cat = 1;
else if 350.0 le hvcd4 lt 500.0 then cd4_cat = 2;
else if hvcd4 ge 500.0 then cd4_cat=3;
else cd4_cat=.;
Label cd4_cat = 'Categorical CD4 count';
format cd4_cat cdfour.;

*YRLAST2 - Years since last HIV test;
yrlast2 = year - yrlast;
if yrlast = . then yrlast2 = .;
Label yrlast2 = 'Years since last HIV test';

*YRLAST3 - Categorical years since HIV test;
if etest = 2 then yrlast3 = 4;
else if yrlast = . then yrlast3 = .;
else if yrlast2 = 0 then yrlast3 = 1;
else if 1 le yrlast2 le 2 then yrlast3 = 2;
else if yrlast2 ge 3 then yrlast3 = 3;
else yrlast3 = .;
Label yrlast3 = 'Years since last HIV test-categorical';
format yrlast3 yrlast.;

*YRLAST4 - Categorical years since HIV test (without never test);
if yrlast = . then yrlast4 = .;
else if yrlast2 = 0 then yrlast4 = 1;
else if 1 le yrlast2 le 2 then yrlast4 = 2;
else if yrlast2 ge 3 then yrlast4 = 3;
else yrlast4 = .;
Label yrlast4 = 'Years since last HIV test-categorical';
format yrlast4 _yrlast.;

*AUDIT - AUDIT total score (alcohol use);
if alcever=2 then audit = 0;
else if alcfreq=0 then audit=0;
else if alcday=0 and alcbinge=0 then audit=0;
else audit = alcfreq + alcday + alcbinge + alcctrl + alcfail +
alcmorn + alcguilt
                  + alcmem + alcinj + alccon;

*ALC - Harmful drinking behavior - Audit score >= 8;
if audit = . then alc = .;
else if audit ge 8 then alc = 1;
else alc = 2;
Label alc = 'Harmful drinking behavior';
format alc yesno.;

*SHARE2 - Shared needles last 30 days;
```

```
	if share gt 0 then share2 = 1;
	if share = 0 then share2 = 0;
	label share2 = 'Shared needles last 30 days';

	*SWITH2 - Sexual identity;
	If SEX=1 and SWITH=2 then SWITH2=1;
	If SEX=2 and SWITH=1 then SWITH2=1;
	If SEX=1 and SWITH=1 then SWITH2=2;
	If SEX=2 and SWITH=2 then SWITH2=2;
	If SWITH=3 then SWITH2=3;
	Label swith2 = 'Sexual Identity';

	*RECCOPR - Proportion of vaginal sex acts protected by condom
P6M;
	recoppr = tcond / recvsex;
	if tcond = . or recvsex = . then recoppr = .;

	*ANALSX- sum of receptive and insertive anal sex acts P6M;
	analsx = recpsx + insx;

	*ANALCO - sum of times condom used during anal sex P6M;
	analco = ranalco + ianalco;

	*ANCOPR - Proportion of anal sex acts protected by condom P6M;
	ancopr = analco / analsx;

	*LIFPREG2 Times pregnant lifetime -categorical;
	if 1 le lifpreg le 2 then lifpreg2 = 1;
	else if 3 le lifpreg le 5 then lifpreg2 = 2;
	else if 6 le lifpreg le 30 then lifpreg2 = 3;
	else lifpreg2 = .;
	label lifpreg2 = 'Number of lifetime pregnancies-categorical';

	*LIFPREG3 Times pregnant lifetime -categorical;
	if 1 le lifpreg le 2 then lifpreg3 = 1;
	else if 3 le lifpreg le 5 then lifpreg3 = 2;
	else if 6 le lifpreg le 30 then lifpreg3 = 3;
	else if everpreg = 2 then lifpreg3 = 4;
	else lifpreg3 = .;
	label lifpreg3 = 'Number of lifetime pregnancies-categorical with
0';

	*UNAWARE - Unaware of HIV+ status;
	if hvmu2 = 2 then unaware = .;
	else if lres = 1 and hvmu2 = 1 then unaware = 2;
	else if lres ne 1 and hvmu2 = 1 then unaware = 1;
	else unaware = .;
	label unaware = 'Unaware of HIV+ status';
	format unaware aware.;

	*EVERSEX - Ever had sex: combined SEXINT & NSEX; *Survey skip
patterns dictated by nsex results;
	if nsex=2 or nsex=. then eversex = 1;
	else eversex = 2;
	Label eversex = 'Ever had sexual intercourse';
```

```
	*SEXP6M - Sex past 6 months - combined RECSEX & RECSEX2;  *Survey 
skip patterns dictated by recsex2 results;
	if eversex = 2 then sexp6m = 2;
	else if recsex2=2 then sexp6m=2;
	else sexp6m = 1;
	Label sexp6m = 'Had sex past 6 months';

	*EVERCOND - Ever used male condom - combined CONDOM & NCOND;
	if eversex=2 then evercond=2;
	else if condom = . and ncond = . then evercond = .;
	else if condom = 1 and (ncond = 2 or ncond = .) then evercond = 
1;
	else if ncond = 2 then evercond = 1;
	else evercond = 2;
	Label evercond = 'Ever used male condom during sex';

	*LSCOND2 - Recode LSCOND to include those who never used condom 
in denom.;
	if lscond = . and evercond = 2 and sexp6m = 1 then lscond2 = 2;
	*else if sexp6m = 2 then lscond2 = 0;  *No sex in past 6 months;
	else lscond2 = lscond;
	label lscond2 = 'Condom use at last sex';

	*_BUY6 - bought sex past 6 months;
	if eversex=2 then _buy6=2;
	else if lifbuy = . then _buy6 = .;
	else if lifbuy = 2 then _buy6 = 2;
	else if fbuypa ge 1 or mbuypa ge 1 then _buy6=1;
	else _buy6 = 2;
	label _buy6 = 'Paid for sex past 6 months';

	*_SELL6 - sold sex past 6 months;
	if eversex=2 then _sel6=2;
	else if lifsel = . then _sel6 = .;
	else if lifsel = 2 then _sel6 = 2;
	else if fselpa ge 1 or mselpa ge 1 then _sel6=1;
	else _sel6 = 2;
	label _sel6 = 'Sold sex past 6 months';

	*DEPRESS - continuous PHQ-2 score for depression;
	depress = intrest + fdown;
	Label depress = 'PHQ-2 Score for depression';

	*DEPRESS2 - dichotomous PHQ-2 score for depression;
	if depress = . then depress2 = .;
	else if depress ge 3 then depress2 = 1;
	else depress2 = 2;
	Label depress2 = 'Depression Y/N';
	format depress2 phq.;

	*TSTEPA - total number steady partners;
	if mstepa = . then mstepa2 = 0;
	else mstepa2 = mstepa;

	if fstepa = . then fstepa2 = 0;
	else fstepa2 = fstepa;
```

```
	tstepa = mstepa2 + fstepa2;
	label tstepa = 'Total steady partners, male & female';

	*STPACAT - categorical total steady partners;
	if sexp6m=2 or tstepa=0 then stpacat=1;
	else if tstepa = 1 then stpacat = 2;
	else if tstepa ge 2 then stpacat = 3;
	else stpacat = .;
	format stpacat partner.;

	*TCASPA - total number casual partners;
	if mcaspa = . then mcaspa2 = 0;
	else mcaspa2 = mcaspa;

	if fcaspa = . then fcaspa2 = 0;
	else fcaspa2 = fcaspa;

	tcaspa = mcaspa2 + fcaspa2;
	label tcaspa = 'Total casual partners, male & female';

	*CAPACAT - categorical total casual partners;
	if sexp6m=2 or tcaspa=0 then capacat=1;
	else if tcaspa = 1 then capacat = 2;
	else if tcaspa ge 2 then capacat = 3;
	else capacat = .;
	format capacat partner.;

	*CNCRNT - conncurent steady/casual partners;
	if (stpacat=2 or stpacat=3) and (capacat=2 or capacat=3) then
cncrnt = 1;
	else cncrnt=2;
	format cncrnt yesno.;

	*Add eversex=2 (never had sex) to lifetime sexual history
variables;
	if eversex=2 then forsex=2;
	if eversex=2 then lifbuy=2;
	if eversex=2 then lifsel=2;

	*Add level for 'no sex in past 6 months' to LSPRSTAT and LSXPART;
	*if sexp6m=2 then lsxpart = 0;
	*if sexp6m=2 then lsprstat= 0;

run;


/*proc contents data=merged;
run; */


*Drop 11 observations that have biomarker data but no survey data. Use
variable T_NAT to exclude missings. All obs from survey have valid
response for T_NAT;
data merged;
	set combine;
	where t_nat ne .;
run;
```

```
/*proc contents data=merged;
run;*/

***************************************************
New dataset with men only - bivariate/multivariate;
***************************************************;
data test1;
      set merged;
      where sex = 1;

      if etest=2 then etest=0;

      if stpacat = . then stpacat = 99;*/


run;

/*proc contents data=test1;
run;*/

***************************************************
New dataset with women only - bivariate/multivariate;
***************************************************;
data test2;
      set merged;
      where sex = 2;

      if etest=2 then etest=0;

run;

/*proc contents data=test2;
run;*/
```

Appendix . SAS Code – Prevalence Ratios

```
*****************************************
THESIS - PREVALENCE RATIOS
LEE HUNDLEY
*****************************************;

%include 'H:\_THESIS\SAS\data_clean.sas';


***********************************************************
Crude prevalence ratios for Repeat Testing (men only);
***********************************************************;

*Age (ref = age 13 - 19);
proc rlogist data=test1 design=srs;
      class age_cat;
      reflevel age_cat=1;
      model etest = age_cat;
      predmarg age_cat(1) / adjrr;
run;

*Education (ref = 14+ years);
proc rlogist data=test1 design=srs;
      class sch_cat;
      reflevel sch_cat=1;
      model etest =  sch_cat;
      predmarg sch_cat(1) / adjrr;
run;

*District where live (ref = Kampala);
proc rlogist data=test1 design=srs;
      class dis_live ;
      reflevel dis_live=1;
      model etest = dis_live;
      predmarg dis_live(1) / adjrr;
run;

*Social status (ref = better off);
proc rlogist data=test1 design=srs;
      class stdliv;
      reflevel stdliv=4;
      model etest =  stdliv;
      predmarg stdliv(4) / adjrr;
run;

*Marital status (ref = never married);
proc rlogist data=test1 design=srs;
      class mar_st;
      reflevel mar_st=1;
      model etest =  mar_st;
      predmarg mar_st(1) / adjrr;
run;

*Live with sex partner (ref = yes);
proc rlogist data=test1 design=srs;
```

```
      class liv_st;
      reflevel liv_st=1;
      model etest =  liv_st;
      predmarg liv_st(1) / adjrr;
run;

************************
Behavioral factors
************************;

*Depressed (ref = no);
proc rlogist data=test1 design=srs;
      class depress2;
      reflevel depress2=2;
      model etest =  depress2;
      predmarg depress2(2) / adjrr;
run;

*Harmful drinking (ref = no);
proc rlogist data=test1 design=srs;
      class alc;
      reflevel alc=2;
      model etest = alc;
      predmarg alc(2) / adjrr;
run;

*Ever paid for sex (ref = no);
proc rlogist data=test1 design=srs;
      class lifbuy;
      reflevel lifbuy=2;
      model etest =  lifbuy;
      predmarg lifbuy(2) / adjrr;
run;

*Ever sold sex (ref = no);
proc rlogist data=test1 design=srs;
      class lifsel;
      reflevel lifsel=2;
      model etest =  lifsel;
      predmarg lifsel(2) / adjrr;
run;

*Ever forced sex (ref = no);
proc rlogist data=test1 design=srs;
      class forsex;
      reflevel forsex=2;
      model etest =  forsex;
      predmarg forsex(2) / adjrr;
run;

*Total steady partners P6M categorical (ref = 0);
proc rlogist data=test1 design=srs;
      class stpacat;
      reflevel stpacat=1;
      model etest =  stpacat;
      predmarg stpacat(1) / adjrr;
run;
```

```
*Total casual partners P6M categorical (ref = 0);
proc rlogist data=test1 design=srs;
      class capacat;
      reflevel capacat=1;
      model etest =  capacat;
      predmarg capacat(1) / adjrr;
run;

*Concurrent steady-casual partners P6M (ref = no);
proc rlogist data=test1 design=srs;
      class cncrnt;
      reflevel cncrnt=2;
      model etest = cncrnt;
      predmarg cncrnt(2) / adjrr;
run;

*Sex P6M (ref = no);
proc rlogist data=test1 design=srs;
      class sexp6m;
      reflevel sexp6m=2;
      model etest =  sexp6m;
      predmarg sexp6m(2) / adjrr;
run;

*Buy Sex P6M (ref = no);
proc rlogist data=test1 design=srs;
      class _buy6;
      reflevel _buy6=2;
      model etest =  _buy6;
      predmarg _buy6(2) / adjrr;
run;

*Sell Sex P6M (ref = no);
proc rlogist data=test1 design=srs;
      class _sel6 ;
      reflevel _sel6=2;
      model etest =  _sel6;
      predmarg _sel6(2) / adjrr;
run;

*Likelihood of infection (ref = extremely unlikely);
proc rlogist data=test1 design=srs;
      class likeinf;
      reflevel likeinf=1;
      model etest =  likeinf;
      predmarg likeinf(1) / adjrr;
      subpopn sexp6m=1;
run;

*HIV status (ref = HIV-negative);
proc rlogist data=test1 design=srs;
      class hvmu2 ;
      reflevel hvmu2=2;
      model etest =  hvmu2;
      predmarg hvmu2(2) / adjrr;
run;
```

```
***********************************************************************
*
Subgroup analysis - only those who had sex past 6 months, n=3,824
(73%);
***********************************************************************
*

*Condom use last sex (ref = yes);
proc rlogist data=test1 design=srs;
      class lscond2;
      reflevel lscond2=1;
      model etest =  lscond2;
      predmarg lscond2(1) / adjrr;
      subpopn sexp6m=1;
run;

*Last partner type (ref = steady);
proc rlogist data=test1 design=srs;
      class lsxpart;
      reflevel lsxpart=1;
      model etest =  lsxpart;
      predmarg lsxpart(1) / adjrr;
      subpopn sexp6m=1;
run;

*Think Last partner status (ref = negative)  ***Excludes known HIV+
(LRES=1);
proc rlogist data=test1 design=srs;
      class lsprstat;
      reflevel lsprstat=1;
      model etest =  lsprstat;
      predmarg lsprstat(1) / adjrr;
      subpopn sexp6m=1;
run;


**********************************************************
Crude prevalence ratios for Repeat Testing (women only);
**********************************************************;

*Age (ref = age 13 - 19);
proc rlogist data=test2 design=srs;
      class age_cat;
      reflevel age_cat=1;
      model etest = age_cat;
      predmarg age_cat(1) / adjrr;
run;

*Education (ref = 14+ years);
proc rlogist data=test2 design=srs;
      class sch_cat;
      reflevel sch_cat=1;
      model etest =  sch_cat;
      predmarg sch_cat(1) / adjrr;
run;
```

```
*District where live (ref = Kampala);
proc rlogist data=test2 design=srs;
      class dis_live ;
      reflevel dis_live=1;
      model etest = dis_live;
      predmarg dis_live(1) / adjrr;
run;

*Social status (ref = better off);
proc rlogist data=test2 design=srs;
      class stdliv;
      reflevel stdliv=4;
      model etest =  stdliv;
      predmarg stdliv(4) / adjrr;
run;

*Marital status (ref = never married);
proc rlogist data=test2 design=srs;
      class mar_st;
      reflevel mar_st=1;
      model etest =  mar_st;
      predmarg mar_st(1) / adjrr;
run;

*Live with sex partner (ref = yes);
proc rlogist data=test2 design=srs;
      class liv_st;
      reflevel liv_st=1;
      model etest =  liv_st;
      predmarg liv_st(1) / adjrr;
run;

************************
Behavioral factors
************************;
*Depressed (ref = no);
proc rlogist data=test2 design=srs;
      class depress2;
      reflevel depress2=2;
      model etest =  depress2;
      predmarg depress2(2) / adjrr;
run;

*Harmful drinking (ref = no);
proc rlogist data=test2 design=srs;
      class alc;
      reflevel alc=2;
      model etest = alc;
      predmarg alc(2) / adjrr;
run;

*Ever paid for sex (ref = no);
proc rlogist data=test2 design=srs;
      class lifbuy;
      reflevel lifbuy=2;
      model etest =  lifbuy;
      predmarg lifbuy(2) / adjrr;
```

```
run;

*Ever sold sex (ref = no);
proc rlogist data=test2 design=srs;
      class lifsel;
      reflevel lifsel=2;
      model etest =  lifsel;
      predmarg lifsel(2) / adjrr;
run;

*Ever forced sex (ref = no);
proc rlogist data=test2 design=srs;
      class forsex;
      reflevel forsex=2;
      model etest =  forsex;
      predmarg forsex(2) / adjrr;
run;

*Total steady partners P6M categorical (ref = 0);
proc rlogist data=test2 design=srs;
      class stpacat;
      reflevel stpacat=1;
      model etest =  stpacat;
      predmarg stpacat(1) / adjrr;
run;

*Total casual partners P6M categorical (ref = 0);
proc rlogist data=test2 design=srs;
      class capacat;
      reflevel capacat=1;
      model etest =  capacat;
      predmarg capacat(1) / adjrr;
run;

*Concurrent steady-casual partners P6M (ref = no);
proc rlogist data=test2 design=srs;
      class cncrnt;
      reflevel cncrnt=2;
      model etest = cncrnt;
      predmarg cncrnt(2) / adjrr;
run;

*Sex P6M (ref = no);
proc rlogist data=test2 design=srs;
      class sexp6m;
      reflevel sexp6m=2;
      model etest =  sexp6m;
      predmarg sexp6m(2) / adjrr;
run;

*Buy Sex P6M (ref = no);
proc rlogist data=test2 design=srs;
      class _buy6;
      reflevel _buy6=2;
      model etest =  _buy6;
      predmarg _buy6(2) / adjrr;
run;
```

```
*Sell Sex P6M (ref = no);
proc rlogist data=test2 design=srs;
      class _sel6 ;
      reflevel _sel6=2;
      model etest =  _sel6;
      predmarg _sel6(2) / adjrr;
run;

*Likelihood of infection (ref = extremely unlikely);  ***Excludes known
HIV+ (LRES=1);
proc rlogist data=test2 design=srs;
      class likeinf;
      reflevel likeinf=1;
      model etest =  likeinf;
      predmarg likeinf(1) / adjrr;
run;

*HIV status (ref = HIV-negative);
proc rlogist data=test2 design=srs;
      class hvmu2 ;
      reflevel hvmu2=2;
      model etest =  hvmu2;
      predmarg hvmu2(2) / adjrr;
run;

***********************************************************************
*
Subgroup analysis - only those who had sex past 6 months, n=5,067
(72%);
***********************************************************************
*

*Condom use last sex (ref = yes);
proc rlogist data=test2 design=srs;
      class lscond2;
      reflevel lscond2=1;
      model etest =  lscond2;
      predmarg lscond2(1) / adjrr;
      subpopn sexp6m=1;
run;

*Last partner type (ref = steady);
proc rlogist data=test2 design=srs;
      class lsxpart;
      reflevel lsxpart=1;
      model etest =  lsxpart;
      predmarg lsxpart(1) / adjrr;
      subpopn sexp6m=1;
run;

*Think Last partner status (ref = negative);
proc rlogist data=test2 design=srs;
      class lsprstat;
      reflevel lsprstat=1;
      model etest =  lsprstat;
      predmarg lsprstat(1) / adjrr;
```

```
      subpopn sexp6m=1;
run;

*************************************************************
Multivariate prevalence ratios for Repeat Testing (MEN);
*************************************************************;

*Determine final multivariate model using backwards elimination;
proc rlogist data=test1 design=srs;
      class age_cat sch_cat stdliv mar_st depress2 alc stpacat sexp6m
hvmu2;

      reflevel age_cat=1 sch_cat=1 stdliv=4 mar_st=1 depress2=2 alc=2
                    stpacat=1 sexp6m=2 hvmu2=2;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc
                  stpacat sexp6m hvmu2;

      predmarg  age_cat(1) sch_cat(1) stdliv(4) mar_st(1) depress2(2)
alc(2)
                   stpacat(1) sexp6m(2) hvmu2(2)/ adjrr;

      PRINT ; ****NEED FOR PREV RATIOS***;
      PRINT / HLTEST=all;
run;


*Drop sexp6m (p-value= 0.4076);
proc rlogist data=test1 design=srs;
      class age_cat sch_cat stdliv mar_st depress2 alc stpacat hvmu2;

      reflevel age_cat=1 sch_cat=1 stdliv=4 mar_st=1 depress2=2 alc=2
                    stpacat=1 hvmu2=2;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc
                  stpacat hvmu2;

      predmarg  age_cat(1) sch_cat(1) stdliv(4) mar_st(1) depress2(2)
alc(2)
                   stpacat(1) hvmu2(2)/ adjrr;

      PRINT ; ****NEED FOR PREV RATIOS***;
      PRINT / HLTEST=all;
run;

*Drop stdliv (p-value= 0.3485);
proc rlogist data=test1 design=srs;
      class age_cat sch_cat mar_st depress2 alc stpacat hvmu2;

      reflevel age_cat=1 sch_cat=1 mar_st=1 depress2=2 alc=2 stpacat=1
hvmu2=2;

      model etest = age_cat sch_cat mar_st depress2 alc stpacat hvmu2;

      predmarg  age_cat(1) sch_cat(1) mar_st(1) depress2(2) alc(2)
stpacat(1) hvmu2(2)/ adjrr;
```

```
      PRINT ; ****NEED FOR PREV RATIOS***;
      PRINT / HLTEST=all;
run;

*Drop depress2 (p-value= 0.1661);
proc rlogist data=test1 design=srs;
      class age_cat sch_cat mar_st alc stpacat hvmu2;

      reflevel age_cat=1 sch_cat=1 mar_st=1 alc=2 stpacat=1 hvmu2=2;

      model etest = age_cat sch_cat mar_st alc stpacat hvmu2;

      predmarg  age_cat(1) sch_cat(1) mar_st(1) alc(2) stpacat(1)
hvmu2(2)/ adjrr;

      PRINT ; ****NEED FOR PREV RATIOS***;
      PRINT / HLTEST=all;
run;

***All remaining variables significant at p-value <0.05;

*Include interaction term age*HIV status (significant in POR
assessment);
proc rlogist data=test1 design=srs;
      class age_cat sch_cat mar_st alc stpacat hvmu2 ;

      reflevel age_cat=1 sch_cat=1 mar_st=1 alc=2 stpacat=1 hvmu2=2;

      model etest = age_cat sch_cat mar_st alc stpacat hvmu2
age_cat*hvmu2;

      predmarg  age_cat(1) sch_cat(1) mar_st(1) alc(2) stpacat(1)
hvmu2(2) / adjrr;

      *Interaction terms;
      predmarg age_cat(1)*hvmu2(1) / adjrr;
      predmarg age_cat(1)*hvmu2(2) / adjrr;


      PRINT ; ****NEED FOR PREV RATIOS***;
      *PRINT / HLTEST=all;
run;

*************************************************************
Recalute crude PR for variables included in interaction terms
*************************************************************;
*Age*HIV status;
proc rlogist data=test1 design=srs;
      class age_cat hvmu2 ;
      reflevel age_cat=1 hvmu2=2;
      model etest =  age_cat*hvmu2;
      predmarg age_cat(1)*hvmu2(1) / adjrr;
      predmarg age_cat(1)*hvmu2(2) / adjrr;
run;

*************************************************************
Multivariate prevalence ratios for Repeat Testing (WOMEN);
```

```
*************************************************************;

*Determine final multivariate model using backwards elimination;
proc rlogist data=test2 design=srs;
      class age_cat sch_cat stdliv mar_st liv_st depress2 alc
                  lifbuy forsex stpacat sexp6m hvmu2;

      reflevel age_cat=1 sch_cat=1 stdliv=4 mar_st=1 liv_st=1
depress2=2 alc=2
                   lifbuy=2 forsex=2 stpacat=1 sexp6m=2 hvmu2=2;

      model etest = age_cat sch_cat stdliv mar_st liv_st depress2 alc
                  lifbuy forsex stpacat sexp6m hvmu2;

      predmarg  age_cat(1) sch_cat(1) stdliv(4) mar_st(1) liv_st(1)
depress2(2) alc(2)
                   lifbuy(2) forsex(2) stpacat(1) sexp6m(2) hvmu2(2) /
adjrr;

      PRINT;
      PRINT / HLTEST=all;
run;

*Drop liv_st (p-value=0.5080);
proc rlogist data=test2 design=srs;
      class age_cat sch_cat stdliv mar_st depress2 alc
                  lifbuy forsex stpacat sexp6m hvmu2;

      reflevel age_cat=1 sch_cat=1 stdliv=4 mar_st=1 depress2=2 alc=2
                   lifbuy=2 forsex=2 stpacat=1 sexp6m=2 hvmu2=2;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc
                  lifbuy forsex stpacat sexp6m hvmu2;

      predmarg  age_cat(1) sch_cat(1) stdliv(4) mar_st(1) depress2(2)
alc(2)
                   lifbuy(2) forsex(2) stpacat(1) sexp6m(2) hvmu2(2) /
adjrr;


      PRINT;
      PRINT / HLTEST=all;
run;

*Drop stpacat (p-value=0.3642);
proc rlogist data=test2 design=srs;
      class age_cat sch_cat stdliv mar_st depress2 alc
                  lifbuy forsex sexp6m hvmu2;

      reflevel age_cat=1 sch_cat=1 stdliv=4 mar_st=1 depress2=2 alc=2
                   lifbuy=2 forsex=2 sexp6m=2 hvmu2=2;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc
                  lifbuy forsex sexp6m hvmu2;

      predmarg  age_cat(1) sch_cat(1) stdliv(4) mar_st(1) depress2(2)
alc(2)
```

```
                    lifbuy(2) forsex(2) sexp6m(2) hvmu2(2) / adjrr;

      PRINT;
      PRINT / HLTEST=all;
run;

*Drop lifbuy (p-value=0.2822);
proc rlogist data=test2 design=srs;
      class age_cat sch_cat stdliv mar_st depress2 alc
                   forsex sexp6m hvmu2;

      reflevel age_cat=1 sch_cat=1 stdliv=4 mar_st=1 depress2=2 alc=2
                    forsex=2 sexp6m=2 hvmu2=2;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc
                   forsex sexp6m hvmu2;

      predmarg age_cat(1) sch_cat(1) stdliv(4) mar_st(1) depress2(2)
alc(2)
                    forsex(2) sexp6m(2) hvmu2(2) / adjrr;

      PRINT;
      PRINT / HLTEST=all;
run;

*Drop stdliv (p-value=0.0709);
proc rlogist data=test2 design=srs;
      class age_cat sch_cat mar_st depress2 alc forsex sexp6m hvmu2;

      reflevel age_cat=1 sch_cat=1 mar_st=1 depress2=2 alc=2 forsex=2
sexp6m=2 hvmu2=2;

      model etest = age_cat sch_cat mar_st depress2 alc forsex sexp6m
hvmu2;

      predmarg age_cat(1) sch_cat(1) mar_st(1) depress2(2) alc(2)
forsex(2) sexp6m(2) hvmu2(2) / adjrr;

      PRINT;
      PRINT / HLTEST=all;
run;


***All remaining variables significant at p-value <0.05;

*Include interaction term age*HIV status (significant in POR
assessment);


proc rlogist data=test2 design=srs;
      class age_cat sch_cat mar_st depress2 alc forsex sexp6m hvmu2;

      reflevel age_cat=1 sch_cat=1 mar_st=1 depress2=2 alc=2 forsex=2
sexp6m=2 hvmu2=2;

      model etest = age_cat sch_cat mar_st depress2 alc forsex sexp6m
hvmu2
```

```
                              age_cat*sexp6m age_cat*hvmu2
sexp6m*hvmu2;

      predmarg age_cat(1) sch_cat(1) mar_st(1) depress2(2) alc(2)
forsex(2) sexp6m(2) hvmu2(2) / adjrr;

      *Interaction terms;
      predmarg age_cat(1)*sexp6m(1) / adjrr;
      predmarg age_cat(1)*sexp6m(2) / adjrr;

      predmarg age_cat(1)*hvmu2(1) / adjrr;
      predmarg age_cat(1)*hvmu2(2) / adjrr;

      predmarg sexp6m(1)*hvmu2(2) / adjrr;
      predmarg sexp6m(2)*hvmu2(2) / adjrr;

      PRINT;
      PRINT / HLTEST=all;
run;

**************************************************************
Recalute crude PR for variables included in interaction terms
**************************************************************;
*Age*sexp6m;
proc rlogist data=test2 design=srs;
      class age_cat sexp6m;
      reflevel age_cat=1 sexp6m=2;
      model etest = age_cat*sexp6m;
      predmarg age_cat(1)*sexp6m(1) / adjrr;
      predmarg age_cat(1)*sexp6m(2) / adjrr;
run;

*Age*HIV status;
proc rlogist data=test2 design=srs;
      class age_cat hvmu2 ;
      reflevel age_cat=1 hvmu2=2;
      model etest =  age_cat*hvmu2;
      predmarg age_cat(1)*hvmu2(1) / adjrr;
      predmarg age_cat(1)*hvmu2(2) / adjrr;
run;

*Sex P6M*HIV status (ref = no);
proc rlogist data=test2 design=srs;
      class sexp6m hvmu2;
      reflevel sexp6m=2 hvmu2=2;
      model etest =  sexp6m*hvmu2;
      predmarg sexp6m(1)*hvmu2(2) / adjrr;
      predmarg sexp6m(2)*hvmu2(2) / adjrr;
run;
```

Appendix II. SAS Code – Descriptives and Prevalence Odds Ratios

```
**********************************************
THESIS - DESCRIPTIVES & PREVALENCE ODDS RATIOS
LEE HUNDLEY
**********************************************;

%include 'H:\_THESIS\SAS\data_clean.sas';

***********************************
Demographics - All
***********************************;

*Categorical;

proc freq data=merged;
      tables sex age_cat sch_cat t_nat t_sch dis_live area stdliv relig
liv_st mar_st;
run;

proc freq data=merged;
      tables sxkindf sxkindm;
run;

proc freq data=merged;
      tables swith;
      where sex=1;
run;

proc freq data=merged;
      tables swith;
      where sex=2;
run;

*Pregnancy;

proc freq data=merged;
      tables everpreg*lifpreg / list missing;
run;

proc freq data=merged;
      tables everpreg;
run;

proc freq data=merged;
      tables lifpreg2;
      where everpreg=1;
run;

*Continuous;

proc univariate data=merged;
      var t_sc_lev age;
run;

proc means data=merged n mean std median qrange;
```

```
      var t_sc_lev age;
run;


*************************
Risk behaviors
*************************;

*Check accuracy of new variables;

proc freq data=merged;
      tables eversex sexp6m;
run;

proc freq data=merged;
      tables evercond*condom*ncond / list missing;
run;

proc freq data=merged;
      tables sexp6m*lscond*lscond2 / list missing;
run;

******All participants*****;

proc freq data=merged;
      tables depress2 alc;
run;

proc freq data=merged;
      tables forsex evercond lifbuy lifsel mlifsel flifsel;
run;

*Sex last 6 months;
proc freq data=merged;
      tables sexp6m;
run;

proc freq data=merged;
      tables _buy6 _sel6 lscond2 lsxpart lsprstat;
run;

*Kind of sex;
proc freq data=merged;
      tables sxkindf sxkindm;
run;

*Continuous;
proc means data=merged n mean std median qrange;
      var agesex;
      where eversex=1;
run;

proc means data=merged n mean std median qrange;
      var recvsex;
      where sexp6m = 1;
run;
```

```
proc means data=merged n mean std median qrange;
      var reccopr;
      where reccopr le 1 and sexp6m=1;
run;

***********************
HIV Testing
***********************;

*Check accuracy of new variables;
proc freq data=merged;
      tables unaware;
run;

proc freq data=merged;
      tables whytest whyrisk etest yrlast3 curst likeinf;
run;

*Last HIV test result among those who have tested;
proc freq data=merged;
      tables lres;
      where etest = 1;
run;

proc freq data=merged;
tables stdliv decide likeinf passon infect pavoid agree;
run;

*Septrin & ARVs among those who think they are HIV+;
proc freq data=merged;
      tables septrin arvs;
      where curst=1;
run;

************************
Sexual partners
************************;
proc freq data=merged;
      tables mstepa fstepa mcaspa fcaspa;
run;

proc freq data=merged;
      tables stpacat capacat;
run;

*Concurrent steady and casual partners P6M;
proc freq data=merged;
      tables cncrnt;
run;

**********************
Biomarkers
**********************;

proc sort data=merged;
      by hvmu2;
run;
```

```
proc freq data=merged;
      tables cd4_cat*hvcd4;
run;

proc freq data=merged;
      tables hvmu2;
run;

proc freq data=merged;
      tables hvmu2*cd4_cat / list missing;
      where hvmu2 = 1;
run;

proc freq data=merged;
      tables cd4_cat;
run;

*Compile ID's and dates for 415 HIV+ who are missing CD4 counts;
proc freq data=merged;
      tables cid*today / list missing;
      where hvmu2 = 1 and cd4_cat=.;
run;

*Awareness of positive status;
proc freq data=merged;
      tables unaware;
run;

*****************************************
Demographics - First time testers M vs F
*****************************************;

proc sort data=merged;
      by sex;
run;

*Categorical;

proc freq data=merged;
      tables sex;
      where etest=2;
run;

proc freq data=merged;
      tables age_cat t_nat sch_cat dis_live area stdliv relig mar_st
liv_st;
      by sex;
      where etest = 2;
run;

proc freq data=merged;
      tables sxkindf sxkindm;
      by sex;
      where etest = 2;
run;
```

```
*Pregnancy;
proc freq data=merged;
	tables everpreg;
	where etest=2 and sex=2;
run;

proc freq data=merged;
	tables lifpreg2;
	where everpreg=1 and etest = 2 and sex=2;
run;

*Continuous;

proc means data=merged n mean std median qrange;
	var t_sc_lev age;
run;


*****************************************
*Risk behaviors First time testers M vs F
*****************************************;

proc sort data=merged;
by sex;
run;

proc freq data=merged;
	tables depress2 alc;
	by sex;
	where etest = 2;
run;

proc freq data=merged;
	tables evercond;
	by sex;
	where eversex = 1 and etest = 2;  ***Exclude those who report
never having sex;
run;

proc freq data=merged;
	tables lifbuy lifsel forsex;
	by sex;
	where etest = 2;
run;

*Sex last 6 months;
proc freq data=merged;
	tables sexp6m;
	by sex;
	where etest = 2;
run;

proc freq data=merged;
	tables lscond2 lsxpart lsprstat;
	by sex;
	where etest = 2;
run;
```

```
proc freq data=merged;
tables lscond2 lsxpart lsprstat likeinf;
run;

proc freq data=merged;
      tables _buy6 _sel6 ;
      by sex;
      where etest = 2;
run;

*Continuous;
proc means data=merged n mean std median qrange;
      var agesex;
      by hvmu2;
      where eversex=1;
run;

proc means data=merged n mean std median qrange;
      var recvsex;
      by hvmu2;
      where sexp6m = 1;
run;

proc means data=merged n mean std median qrange;
      var reccopr;
      by hvmu2;
      where reccopr le 1 and sexp6m=1;
run;

***************************************
HIV Testing - First time testers M vs F
***************************************;

proc freq data=merged;
      tables etest;
run;

proc freq data=merged;
      tables whytest whyrisk curst likeinf;
      by sex;
      where etest = 2;
run;


**********************************************
Sexual partners - First time testers M vs F
**********************************************;
proc sort data=merged;
      by sex;
run;

proc freq data=merged;
      tables mstepa fstepa mcaspa fcaspa;
      by sex;
      where etest=2;
run;
```

```
proc freq data=merged;
      tables stpacat capacat;
      by sex;
      where etest=2;
run;

*Concurrent steady and casual partners P6M;
proc freq data=merged;
      tables cncrnt;
      by sex;
      where etest=2;
run;


*************************************
Biomarkers - First time testers M vs F
*************************************;

proc freq data=merged;
      tables hvmu2 cd4_cat unaware;
      by sex;
      where etest=2;
run;


************************************
Demographics - Repeat testers M vs F
************************************;

*Categorical;

proc freq data=merged;
      tables sex;
      where etest=1;
run;

proc freq data=merged;
      tables age_cat t_nat sch_cat dis_live area stdliv relig mar_st
liv_st;
      by sex;
      where etest = 1;
run;

*Pregnancy;
proc freq data=merged;
      tables everpreg;
      where etest=1 and sex=2;
run;

proc freq data=merged;
      tables lifpreg2;
      where everpreg=1 and etest = 1 and sex=2;
run;

*Continuous;
```

```
proc means data=merged n mean std median qrange;
      var t_sc_lev age;
run;


************************************
*Risk Behaviors Repeat testers M vs F
************************************;

proc sort data=merged;
      by sex;
run;

proc freq data=merged;
      tables depress2 alc;
      by sex;
      where etest = 1;
run;

proc freq data=merged;
      tables evercond;
      by sex;
      where eversex = 1 and etest = 1;  ***Exclude those who report
never having sex;
run;

proc freq data=merged;
      tables lifbuy lifsel forsex;
      by sex;
      where etest = 1;
run;

*Sex last 6 months;
proc freq data=merged;
      tables sexp6m;
      by sex;
      where etest = 1;
run;

proc freq data=merged;
      tables _buy6 _sel6;
      by sex;
      where etest = 1;
run;

proc freq data=merged;
      tables lscond2 lsxpart lsprstat;
      by sex;
      where etest = 1;
run;

*Continuous;
proc means data=merged n mean std median qrange;
      var agesex;
      by hvmu2;
      where eversex=1;
run;
```

```
proc means data=merged n mean std median qrange;
      var recvsex;
      by hvmu2;
      where sexp6m = 1;
run;

proc means data=merged n mean std median qrange;
      var reccopr;
      by hvmu2;
      where reccopr le 1 and sexp6m=1;
run;


***********************************
HIV Testing - Repeat testers M vs F
***********************************;

proc freq data=merged;
      tables whytest whyrisk yrlast3 likeinf curst;
      by sex;
      where etest = 1;
run;

*Last HIV test result amoong those who have tested;
proc freq data=merged;
      tables lres;
      by sex;
      where etest = 1;
run;

*Septrin & ARVs among those who think they are HIV+;
proc freq data=merged;
      tables septrin arvs;
      by sex;
      where curst=1 and hvmu2 = 1 and unaware = 2;
run;


********************************************
Sexual partners - Repeat testers M vs F
********************************************;
proc sort data=merged;
      by sex;
run;

proc freq data=merged;
      tables mstepa fstepa mcaspa fcaspa;
      by sex;
      where etest=1;
run;

proc freq data=merged;
      tables stpacat capacat;
      by sex;
      where etest=1;
run;
```

```
*Concurrent steady and casual partners P6M;
proc freq data=merged;
      tables cncrnt;
      by sex;
      where etest=1;
run;


**********************************
Biomarkers - Repeat testers M vs F
**********************************;

proc freq data=merged;
      tables hvmu2 cd4_cat unaware;
      by sex;
      where etest=1;
run;


***********************************************************************
*                  BIVARIATE ANALYSIS      - MEN ONLY                 *
***********************************************************************;

**********************
Demographics
**********************;

*Age (ref = age 13 - 19);
proc logistic data=test1 descending;
      class age_cat (ref='13 - 19') / param=ref;
      model etest = age_cat;
run;

*Education (ref = 14+ years);
proc logistic data=test1 descending;
      class sch_cat (ref='Never attended school') / param=ref;
      model etest (ref='2') =  sch_cat;
run;

*District where live (ref = Kampala);
proc logistic data=test1 descending;
      class dis_live (ref = first) / param=ref;
      model etest = dis_live;
run;

*Social status (ref = better off);
proc logistic data=test1 descending;
      class stdliv (ref='4') / param=ref;
      model etest =  stdliv;
run;

*Marital status (ref = never married);
proc logistic data=test1 descending;
      class mar_st (ref ='1') / param = ref;
      model etest =  mar_st;
run;
```

```
*Live with sex partner (ref = yes);
proc logistic data=test1 descending;
      class liv_st (ref='1') / param=ref;
      model etest =  liv_st;
run;

************************
Behavioral factors
************************;

*Depressed (ref = no);
proc logistic data=test1 descending;
      class depress2 (ref='Not depressed') / param=ref;
      model etest =  depress2;
run;

*Harmful drinking (ref = no);
proc logistic data=test1 descending;
      class alc (ref='No') / param=ref;
      model etest =  alc;
run;

*Ever paid for sex (ref = no);
proc logistic data=test1 descending;
      class lifbuy (ref='2') / param=ref;
      model etest =  lifbuy;
run;

*Ever sold sex (ref = no);
proc logistic data=test1 descending;
      class lifsel (ref='2') / param=ref;
      model etest =  lifsel;
run;

*Ever forced sex (ref = no);
proc logistic data=test1 descending;
      class forsex (ref='2') / param=ref;
      model etest =  forsex;
run;

*Total steady partners P6M categorical (ref = 0);
proc logistic data=test1 descending;
      class stpacat (ref='No partners') / param = ref;
      model etest =  stpacat;
run;

*Total casual partners P6M categorical (ref = 0);
proc logistic data=test1 descending;
      class capacat (ref='No partners') / param = ref;
      model etest =  capacat;
run;

*Concurrent steady-casual partners P6M (ref = no);
proc logistic data=test1 descending;
      class cncrnt (ref='No') / param = ref;
      model etest = cncrnt;
```

```
run;

*Sex P6M (ref = no);
proc logistic data=test1 descending;
      class sexp6m (ref='2') / param=ref;
      model etest =  sexp6m;
run;

*Buy Sex P6M (ref = no);
proc logistic data=test1 descending;
      class _buy6 (ref='2');
      model etest =  _buy6;
run;

*Sell Sex P6M (ref = no);
proc logistic data=test1 descending;
      class _sel6 (ref='2') / param=ref;
      model etest =  _sel6;
run;


*HIV status (ref=HIV-Negative);
proc logistic data=test1 descending;
      class hvmu2 (ref='HIV-Negative') / param=ref;
      model etest =  hvmu2;
run;

**********************************************************************
*
Subgroup analysis - excludes aware positives and missings n=5,336 (76%)
**********************************************************************
*
*Likelihood of infection (ref = extremely unlikely);
proc logistic data=test1 descending;
      class likeinf (ref='1') / param = ref;
      model etest =  likeinf;
run;

**********************************************************************
*
Subgroup analysis - only those who had sex past 6 months, n=3,824
(73%);
**********************************************************************
*

*Condom use last sex (ref = yes);
proc logistic data=test1 descending;
      class lscond2 (ref='1') / param=ref;
      model etest =  lscond2;
      where sexp6m=1;
run;

*Last partner type (ref = steady);
proc logistic data=test1 descending;
      class lsxpart (ref='1') / param = ref;
      model etest =  lsxpart;
      where sexp6m=1;
```

```
run;

*Think Last partner status (ref = negative);
proc logistic data=test1 descending;
      class lsprstat (ref='1') / param = ref;
      model etest =  lsprstat;
      where sexp6m=1;
run;


***********************************************************************
**
*                                    BIVARIATE ANALYSIS      - WOMEN
ONLY                        *
***********************************************************************
**;

*********************
Demographics
*********************;

*Age (ref = age 13 - 19);
proc logistic data=test2 descending;
      class age_cat (ref='13 - 19') / param=ref;
      model etest = age_cat;
run;

*Education (ref = 14+ years);
proc logistic data=test2 descending;
      class sch_cat (ref='Never attended school') / param=ref;
      model etest (ref='2') =  sch_cat;
run;

*District where live (ref = Kampala);
proc logistic data=test2 descending;
      class dis_live (ref = first) / param=ref;
      model etest = dis_live;
run;

*Social status (ref = better off);
proc logistic data=test2 descending;
      class stdliv (ref='4') / param=ref;
      model etest =  stdliv;
run;

*Marital status (ref = never married);
proc logistic data=test2 descending;
      class mar_st (ref ='1') / param = ref;
      model etest =  mar_st;
run;

*Live with sex partner (ref = yes);
proc logistic data=test2 descending;
      class liv_st (ref='1') / param=ref;
      model etest =  liv_st;
run;
```

```
************************
Behavioral factors
************************;

*Depressed (ref = no);
proc logistic data=test2 descending;
      class depress2 (ref='Not depressed') / param=ref;
      model etest =  depress2;
run;

*Harmful drinking (ref = no);
proc logistic data=test2 descending;
      class alc (ref='No') / param=ref;
      model etest =  alc;
run;

*Ever paid for sex (ref = no);
proc logistic data=test2 descending;
      class lifbuy (ref='2') / param=ref;
      model etest =  lifbuy;
run;

*Ever sold sex (ref = no);
proc logistic data=test2 descending;
      class lifsel (ref='2') / param=ref;
      model etest =  lifsel;
run;

*Ever forced sex (ref = no);
proc logistic data=test2 descending;
      class forsex (ref='2') / param=ref;
      model etest =  forsex;
run;

*Total steady partners P6M categorical (ref = 0);
proc logistic data=test2 descending;
      class stpacat (ref='No partners') / param = ref;
      model etest =  stpacat;
run;

*Total casual partners P6M categorical (ref = 0);
proc logistic data=test2 descending;
      class capacat (ref='No partners') / param = ref;
      model etest =  capacat;
run;

*Concurrent steady-casual partners P6M (ref = no);
proc logistic data=test2 descending;
      class cncrnt (ref='No') / param = ref;
      model etest = cncrnt;
run;

*Sex P6M (ref = no);
proc logistic data=test2 descending;
      class sexp6m (ref='2') / param=ref;
      model etest =  sexp6m;
run;
```

```
*Buy Sex P6M (ref = no);
proc logistic data=test2 descending;
      class _buy6 (ref='2');
      model etest =  _buy6;
run;

*Sell Sex P6M (ref = no);
proc logistic data=test2 descending;
      class _sel6 (ref='2') / param=ref;
      model etest =  _sel6;
run;

*HIV status (ref=HIV-Negative);
proc logistic data=test2 descending;
      class hvmu2 (ref='HIV-Negative') / param=ref;
      model etest =  hvmu2;
run;

**********************************************************************
*
Subgroup analysis - excludes aware positives and missings n=5,336 (76%)
**********************************************************************
*

*Likelihood of infection (ref = extremely unlikely);
proc logistic data=test2 descending;
      class likeinf (ref='1') / param = ref;
      model etest =  likeinf;
run;
**********************************************************************
*
Subgroup analysis - only those who had sex past 6 months, n=5,067
(72%);
**********************************************************************
*

*Condom use last sex (ref = yes);
proc logistic data=test2 descending;
      class lscond2 (ref='1') / param=ref;
      model etest =  lscond2;
      where sexp6m=1;
run;

*Last partner type (ref = steady);
proc logistic data=test2 descending;
      class lsxpart (ref='1') / param = ref;
      model etest =  lsxpart;
      where sexp6m=1;
run;

*Think Last partner status (ref = negative);
proc logistic data=test2 descending;
      class lsprstat (ref='1') / param = ref;
      model etest =  lsprstat;
      where sexp6m=1;
run;
```

```
******************************************************************
*                        MULTIVARIATE MODEL - MEN                 *
******************************************************************;

*Determine final multivariate model using backwards elimination;
proc logistic data=test1 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school') stdliv (ref='4')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No') sexp6m (ref='2')
            stpacat (ref='No partners') hvmu2 (ref='HIV-Negative') /
param = ref;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc stpacat
sexp6m hvmu2 / rsquare;

run;

*Drop sexp6m (p-value=0.4070);
proc logistic data=test1 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school') stdliv (ref='4')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No') stpacat (ref='No partners')
            hvmu2 (ref='HIV-Negative') / param = ref;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc stpacat
hvmu2 / rsquare;

run;

*Drop stdliv (p-value=0.3438);
proc logistic data=test1 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No') stpacat (ref='No partners')
            hvmu2 (ref='HIV-Negative') / param = ref;

      model etest = age_cat sch_cat mar_st depress2 alc stpacat hvmu2 /
rsquare;

run;

*Drop depress2 (p-value=0.1672);
proc logistic data=test1 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
      mar_st (ref='1') alc (ref='No') stpacat (ref='No partners')
      hvmu2 (ref='HIV-Negative')/ param = ref;
```

```
      model etest = age_cat sch_cat mar_st alc stpacat hvmu2 / rsquare;

run;

***All remaining variables significant at p-value <0.05;

***Assess all 2-way interaction among remaining covariates;
proc logistic data=test1;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
            mar_st (ref='1') alc (ref='No')     stpacat (ref='No
partners')
            hvmu2 (ref='HIV-Negative')/ param = ref;

      model etest = age_cat|sch_cat|mar_st|alc|stpacat|hvmu2 @2
/selection=backward;

run;

*Significant interaction between HIV status and age
*Determine if interaction term is meaningful-test by strata;

proc logistic data=test1 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
      mar_st (ref='1') alc (ref='No') stpacat (ref='No partners')
      hvmu2 (ref='HIV-Negative')/ param = glm;

      model etest = age_cat sch_cat mar_st alc stpacat hvmu2
age_cat*hvmu2/ rsquare;

      slice age_cat*hvmu2 / sliceby=hvmu2 diff oddsratio cl adjust=bon;

run;


***Assess collinearity using collin_2011 macro;
filename collin "S:\course\epi750\SAS macros\collin_2011.sas";
%include collin;

proc logistic data=test1 covout outest=logistic;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
            mar_st (ref='1') alc (ref='No')     stpacat (ref='No
partners')
            hvmu2 (ref='HIV-Negative')/ param = ref;

      model etest = age_cat sch_cat mar_st alc stpacat hvmu2/ covb;

run;

%collin(covdsn=logistic, output=LOG_COLIN)

*** No collinearity observed.  All CNI < 14 ;
```

```
***Final model includes age, education, marital status, alcohol use,
number of steady
partners, and HIV status.;

proc logistic data=test1 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
      mar_st (ref='1') alc (ref='No') stpacat (ref='No partners')
      hvmu2 (ref='HIV-Negative')/ param = ref;

      model etest = age_cat sch_cat mar_st alc stpacat hvmu2 / rsquare;

run;


*****************************************************************
*                  MULTIVARIATE MODEL - WOMEN ONLY                *
*****************************************************************;

*Determine final multivariate model using backwards elimination;
proc logistic data=test2 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school') stdliv (ref='4')
            mar_st (ref='1') liv_st (ref='1') depress2 (ref='Not
depressed') alc (ref='No')
            lifbuy (ref='2') forsex (ref='2') stpacat (ref='No
partners') sexp6m (ref='2')
            hvmu2 (ref='HIV-Negative') / param = ref;

      model etest = age_cat sch_cat stdliv mar_st liv_st depress2 alc
lifbuy
              forsex stpacat sexp6m hvmu2/ rsquare;
run;

*Drop liv_st (p-value=0.5075);
proc logistic data=test2 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school') stdliv (ref='4')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No')
            lifbuy (ref='2') forsex (ref='2') stpacat (ref='No
partners') sexp6m (ref='2')
            hvmu2 (ref='HIV-Negative') / param = ref;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc lifbuy
              forsex stpacat sexp6m hvmu2/ rsquare;
run;

*Drop stpacat (p-value=0.3641);
proc logistic data=test2 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school') stdliv (ref='4')
```

```
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No')
            lifbuy (ref='2') forsex (ref='2')sexp6m (ref='2') hvmu2
(ref='HIV-Negative') / param = ref;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc lifbuy
              forsex sexp6m hvmu2/ rsquare;
run;

*Drop lifbuy (p-value=0.2664);
proc logistic data=test2 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school') stdliv (ref='4')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No')
            forsex (ref='2')sexp6m (ref='2') hvmu2 (ref='HIV-Negative')
/ param = ref;

      model etest = age_cat sch_cat stdliv mar_st depress2 alc
              forsex sexp6m hvmu2/ rsquare;
run;

*Drop stdliv (p-value=0.0656);
proc logistic data=test2 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No')
            forsex (ref='2')sexp6m (ref='2') hvmu2 (ref='HIV-Negative')
/ param = ref;

      model etest = age_cat sch_cat mar_st depress2 alc forsex sexp6m
hvmu2/ rsquare;
run;

***All remaining variables significant at p-value <0.05;


***Assess all 2-way interaction;
proc logistic data=test2 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No')
            forsex (ref='2')sexp6m (ref='2') hvmu2 (ref='HIV-Negative')
/ param = ref;

      model etest = age_cat|sch_cat|mar_st|depress2|alc|
              forsex|sexp6m|hvmu2 @2 / selection=backward;
run;

*Four interaction terms significant--age_cat*mar_st, age_cat*sexp6m,
age_cat*hvmu2, sexp6m*hvmu2;
*Assess if terms are meaningful;
```

```
proc logistic data=test2 descending;

      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No')
            forsex (ref='2') sexp6m (ref='2') hvmu2 (ref='HIV-
Negative') / param = glm;

      model etest = age_cat sch_cat mar_st depress2 alc forsex sexp6m
hvmu2
      age_cat*mar_st age_cat*sexp6m age_cat*hvmu2 sexp6m*hvmu2/
rsquare;

      slice age_cat*mar_st / sliceby=mar_st diff oddsratio cl
adjust=bon;
      slice age_cat*sexp6m / sliceby=sexp6m diff oddsratio cl
adjust=bon;
      slice age_cat*hvmu2 / sliceby=hvmu2 diff oddsratio cl adjust=bon;
      slice sexp6m*hvmu2 / sliceby=hvmu2 diff oddsratio cl adjust=bon;

run;


***Assess collinearity using collin_2011 macro;
filename collin "S:\course\epi750\SAS macros\collin_2011.sas";
%include collin;

proc logistic data=test2 covout outest=logistic2 descending;

class age_cat (ref='13 - 19') sch_cat (ref='Never attended school')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No')
            forsex (ref='2')sexp6m (ref='2') hvmu2 (ref='HIV-Negative')
/ param = ref;

      model etest = age_cat sch_cat mar_st depress2 alc forsex sexp6m
hvmu2 / covb;
run;

%collin(covdsn=logistic2, output=LOG_COLIN2)

*** No collinearity observed. All CDI <14;

*Final model includes age, education, marital status, depression,
alcohol use, forced sex,
sex in past 6 months, and HIV status;
*Assess goodness of fit;

proc logistic data=test2 descending;
      class age_cat (ref='13 - 19') sch_cat (ref='Never attended
school')
            mar_st (ref='1') depress2 (ref='Not depressed') alc
(ref='No')
            forsex (ref='2')sexp6m (ref='2') hvmu2 (ref='HIV-Negative')
/ param = ref;
```

```
      model etest = age_cat sch_cat mar_st depress2 alc forsex sexp6m
hvmu2 / rsquare;
run;
```