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# Prevalence of Active Syphilis and HIV Status and Awareness Among Adults 15 – 59 years old in Tanzania (2016 – 2017): Results from Population-based Nationally Representative Survey

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**Abstract**

Prevalence of Active Syphilis and HIV Status and Awareness Among Adults 15 – 59 years old in Tanzania (2016 – 2017): Results from Population-based Nationally Representative Survey

By Omoremi Hamblin

**Introduction:** HIV and syphilis co-infection is common in communities with high STI prevalence. We examined the association between active syphilis, HIV new diagnosis, and other determinants among adults aged 15-59 years old in Tanzania.
**Methods:** We analyzed data from the Tanzania HIV Impact Survey (THIS) from 2016 to 2017 to describe the prevalence of active syphilis and associated factors. THIS was a nationally representative cross-sectional population-based survey of households. Eligible household members between the ages of 15 and 59 were interviewed and tested for syphilis and HIV. Stratum-specific prevalence was calculated for active syphilis for strata of sociodemographic factors, HIV infection status, self-reported high-risk sexual behavior variables (e.g., sold sex in the last 12 months), age, gender, education, marital status, wealth, and neighborhood of residence. New HIV diagnosis was defined by a positive HIV test result in a person who reported being HIV-negative. We performed bivariate and multivariable logistic regression analysis to study the association between active syphilis status and participant characteristics and behaviors. All reported results are weighted and account for the complex survey design.
**Results:** The overall syphilis prevalence was 0.8%. Among participants who were HIV positive and aware of their status, the odds of being syphilis positive were almost four times higher compared to participants who were HIV-negative; among those who were HIV positive but unaware of their status, the odds of being syphilis positive were almost six times higher compared to participants who were HIV negative. After adjusting for sociodemographic factors and sexual behaviors, HIV positivity awareness and unawareness remained significantly associated with active syphilis. Selling sex in the last 12 months and being divorced were both associated with a higher syphilis prevalence among those who responded affirmatively compared to those who responded negatively before and after controlling for other covariates.
**Conclusion:** To reduce the burden of curable active syphilis among adults in Tanzania, routine HIV and syphilis testing should continue to be encouraged whenever possible. Furthermore, targeted interventions that focus on testing and treating sex workers and those who are divorced should be developed.
**Keywords:** HIV; Syphilis; Sub-Saharan Africa; co-infection**.**

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**Introduction**

Sub-Saharan Africa has the highest annual incidence of sexually transmitted diseases (STDs), with an estimated 3.5 million syphilis cases annually (Gerbase & Mertens, 1998). Although HIV and syphilis can independently exist, coinfection is common. Among a cohort of people living with HIV (PLWH) in twelve AFRICOS health facilities in Kenya, Tanzania, Uganda, and Nigeria, 3.1% were also positive for syphilis (Gilbert et al, 2021). HIV and syphilis co-infection often occur because of their biologic connections. Syphilis is an ulcerative STD that breaks down the epithelial and mucosal barriers, facilitating the transmission and acquisition of HIV (Salado-Rasmussen, 2015, Lynn et al, 2004, & Kofoed et al, 2006). The distribution of STDs in sub-Saharan Africa is different from the rest of the world in that women and children have the highest incidence and prevalence rates of HIV and other STDs (UNAIDS, 2019 & UN, 2004). This observed high incidence and prevalence rates among women and children are most likely due to the required antenatal testing for HIV and syphilis to eliminate mother-to-child transmission in Africa and globally. Although men who have sex with men (MSM), transgender women, and sex worker populations remain at high risk for syphilis in low and middle-income countries (LMIC), data on the overall epidemiology of syphilis are sparse due to under-reporting and may be influenced by stigma and marginalization leading to limited access to health care (Kojima & Klausner, 2018).

An increased risk of HIV/syphilis coinfection has been reported among men, including MSM (Adolf et al, 2012 & Parmley et al, 2022). Among the AFRICOS cohort, lower educational levels and alcohol consumption were associated with HIV/syphilis coinfection (Gilbert et al, 2021). The risk factors for syphilis and HIV, considered independently, include having more than one sexual partner in the past year, low educational level, self-perceived high risk of STD,

early sexual debut, a lack of circumcision in males, other STDs, being male, being MSM, and being a migrant (Todd et al, 2001, Jary et al, 2019, & Zuma et al, 2003).

Although there is a robust program of testing for and treating HIV, syphilis programs are generally less well funded resulting in challenges with diagnosis. Syphilis is easily curable when detected and treated early. However, syphilis can progress to more advanced stages resulting in severe health outcomes if left untreated (CDC, 2022). The two infections may also interact: people coinfected with HIV and syphilis in the AFRICOS cohort had significantly lower CD4 cells count and fewer number of participants who were virally suppressed compared to those without syphilis (Gilbert et al, 2021). Untreated syphilis also poses a significant health risk for pregnant women and their unborn babies. Given that these infections commonly co-occur and the potential for worse HIV and pregnancy outcomes, it is important to provide syphilis tests to patients who request an HIV test. Training nurses to encourage and provide syphilis testing with HIV testing has been associated with an increase in STI testing among patients (Snow et al, 2013).

We analyzed nationally representative data from the population-based HIV impact assessment (PHIA) survey in Tanzania to examine factors associated with active syphilis infection. Specifically, we examined whether awareness of HIV status was associated with active syphilis infection. The large sample size and the population-based sampling of the PHIA surveys make it possible for us to describe population-based syphilis incidence.

## Methods

### *Description of PHIA Survey*

THIS was a nationally representative cross-sectional population-based survey of households conducted as part of the PEPFAR-supported PHIA project from October 2016 to

August 2017. The methods for the PHIA surveys have been previously described (Sachathep et al, 2021 & Patel et al, 2021). The THIS survey used a 2-stage cluster sampling to obtain a nationally representative sample of individuals living in households in Tanzania. The first stage of the survey used probability that was proportional to the size method to specify areas from the census of population and housing. The second stage randomly selected a sample of households in each of the identified areas. The eligible survey population included adults between the ages of 15 and 59 years who lived in residential households and slept in the eligible household the night before the survey and were willing and able to provide consent. Parental or guardian consent was not required for persons aged ≥15 years in Tanzania. All completed household questionnaires, individual questionnaires, and field laboratory data were collected and submitted electronically to a secure cloud server. Laboratory data were cleaned and merged with the final questionnaire database using specimen barcodes unique to each participant and study identification numbers. Data used for public use datasets and statistical analyses were stripped of any identifiers. Sampling weights were computed to adjust for the probability of household selection, nonresponse, and non-coverage. THIS survey consisted of approximately 34,000 participants (including children and adults). Through individual interviews, the survey assessed HIV indicators that were related to care and treatment, behavioral risk factors, knowledge, and stigma.

*HIV and Syphilis Testing*

HIV Home-Based Testing and Counseling was conducted in each household per the national guidelines. Participants who had a non-reactive result on SD Bioline and Uni-Gold screening tests were reported as HIV-negative and those who had reactive test results were reported as HIV positive. Those who received two discordant HIV test results were retested by Geenius HIV 1/2 Supplemental Assay to resolve discrepancies.

Testing for syphilis infection was conducted in each household among participants ages 15–59 years. The Chembio DPP® Syphilis Screen and Confirm Assay were used. This was done to detect antibodies against non-Treponemal (N-Trep) and Treponema pallidum (Trep) antigens by using whole blood samples. If the N-Trep line was reactive, active syphilis infection was positive, and if the N-Trep line was not reactive, active syphilis was negative. If the N-Trep line was not reactive and the Trep line was present, this signified past syphilis infection and participants were included in the negative active syphilis category. All rapid tests where *both* Trep and N-Trep lines were present or where only the Trep or N-Trep line was reactive were followed up with a confirmatory test. All tests where the control line did not appear on the Chembio DPP® tests or where the tests were considered invalid were repeated. The result was considered to be indeterminate if the result was still invalid after retesting and the participant was referred for further testing according to the PHIA protocol.

*Variables*

Active syphilis status, as defined above, was the outcome variable. We assessed the associations of syphilis status and residence, gender, age, wealth quintile, education, marital status, HIV diagnosis, anal sex, and bought/sold sex in the last twelve months. We chose these variables based on previous publications that had assessed HIV and syphilis risk factors in sub-Saharan Africa. Stratified prevalence of active syphilis was calculated for sociodemographic and high-risk sexual behavior variables. Participants with a positive HIV test at the time of the interview were considered to be aware of their HIV infection if they reported that they were HIV-positive, or if they had antiretrovirals (ARVs) detected in their blood (regardless of their self-reported HIV status). Those who reported being HIV negative and for whom ARV test results were missing or showed no ARVs detected were classified as unaware of their HIV status. The HIV diagnosis variable was created by combining both HIV awareness and HIV

status into three levels of HIV negative, HIV positive and aware, and HIV positive and unaware.

Having high-risk sexual behavior was defined as reporting one or more of the following: paid money for sex in the last 12 months, sold sex in the last 12 months, and/or engaged in anal sex. Participants who answered yes or no to the high-risk questions remained in the study and responses that were don't know, refused, or missing were coded as missing. Socio-demographic factors and high-risk sexual behaviors were included as covariates. The socio-demographic characteristics included gender, marital status, age, wealth quintile, urban/rural residence, and education.

*Statistical Analyses*

To study the associations between active syphilis status and its determinants, we described bivariate and multivariable associations with odds ratios. Bivariate analyses disaggregated the overall prevalence for each socio-demographic factor and sexual behavior variable, and multivariable analyses utilized logistic regression modeling and controlled for both high-risk sexual behaviors, sociodemographic factors (e.g, residence, gender, marital status, age, education, wealth quintile) and HIV diagnosis, and having sold sex in the last twelve months. We didn't include anal sex and bought sex in the last twelve months in the covariates controlled for because by themselves, they were not significant as predictors for active syphilis in our bivariate analyses. Active syphilis infection was modeled on HIV diagnosis and other variables as described above; all covariates were retained in the model, regardless of significance of association, and the adjusted odds ratios and corresponding 95% confidence intervals (CI) are presented. All reported results were weighted to account for the complex survey design. The data were analyzed using SAS Version 9.4.

**Results**

In total, 28,531 participants were included in the analysis for this study (Figure 1). About half were women and most of the participants were between ages 25 and 44. Most lived in rural areas and most had a primary school level of education. Overall, 5% of our participants were HIV positive of which 3.1% were aware of their HIV positive status and 1.9% were unaware that they were HIV positive status (Table 1). The overall prevalence of active syphilis was 0.8% (Table 2).

HIV positivity was significantly associated with active syphilis. In participants who were HIV positive and aware of their status, about 3% had active syphilis and among those who were HIV positive but unaware of their status, about 5% had active syphilis. Among participants who were HIV positive and aware of their HIV status, the odds of syphilis were almost four times more than among those who were HIV negative. The odds were even higher among those who were HIV positive and unaware of their status. They were almost six times more likely to have active syphilis when compared to those who were HIV positive. Transactional sex in the last twelve months was also associated with having active syphilis. The odds of active syphilis among participants who had sold sex were almost twice that of those who did not sell sex. However, those who bought sex were no more or less likely to have active syphilis.

Marital status was also associated with active syphilis: those who were divorced had the highest odds of having active syphilis. Their odds were more than five times more than those who had never been married, whereas the odds of active syphilis were over twice as high for people who were married/cohabiting/living together compared to never married. The wealth

quintile was significantly associated with active syphilis status, with the odds of having active syphilis being more than three times higher among those at the lowest level of wealth, compared to those who were at the highest level of wealth. Although education was also significantly associated with active syphilis, only having no education, or having attained education at the pre-primary level was significantly associated. Among this lower education group, the odds of active syphilis were more than four times higher than among those who got more than a secondary school education (Table 3).

After adjusting for sociodemographic factors and sexual behaviors, HIV positivity continued to be significantly associated with active syphilis. However, adjustment attenuated the odds of syphilis associated with being HIV positive, both for those who were aware and who were unaware (Table 3). Transactional sex in the last twelve months remained significantly associated with active syphilis; those who reported selling sex had double the odds of having active syphilis compared to those not reporting selling sex. Participants who bought sex were no more or less likely to have active syphilis. The odds of having active syphilis were nearly twice as high for participants who were divorced compared to those who were never married. Wealth quintile and education were not associated with active syphilis in the fully adjusted model.

**Discussion**

The analysis of this cross-sectional study explored factors associated with of active syphilis among Tanzanians aged 15 – 59 years. Although the overall prevalence of syphilis was 0.8%, among all participants, the HIV/syphilis co-infection rate was 3.9%. Of participants who were HIV positive and aware of their status, about 3% had active syphilis; among those who were

HIV positive but unaware of their status, about 5% had active syphilis. Although selling sex was associated with active syphilis, buying sex was not associated with active syphilis among our study participants. We also observed higher odds of syphilis among those who were divorced, although those who were separated did not have significantly higher odds after adjusting for sociodemographic factors and sexual behaviors. Anal sex was not significantly associated with active syphilis. This further highlights the uniqueness of the HIV epidemic in Africa compared to the rest of the world, where gay men and other men who have sex with other men, transgender people, and injection drug users are some of the key populations (UNAIDS, 2019, UNAIDS, 2021 & UN, 2004).

The population prevalence of syphilis was comparable to the prevalence among females (0.9%.) This was lower than the reported prevalence in antenatal care settings (2.4%) and among pregnant women in rural communities (1.6%); (Manyahi et al, 2015 & Yahya-Malima et al, 2008. Additionally, we observed a syphilis prevalence that ranged from 0.4% to 0.9% among youth which was lower than the range of 3.3% among males to 5.2% reported by Doyle et al in 2010 among females (Doyle et al, 2010). There are many reasons why we could have observed a lower syphilis prevalence. However, the decline is not surprising as other countries in Africa reported similar trends through 2008 (Korenromp et al, 2018). Our relatively low estimates might suggest that these trends continued through the past decade. The current efforts of the World Health Organization to increase syphilis testing and treatment for all pregnant women in antenatal care have resulted in early syphilis diagnosis and care among this group (Stewart et al, 2017). Also influencing the high prevalence of STDs including syphilis among women in rural settings are the synergistic effects of intimate partner violence, alcohol use, and depression where women exposed to these vulnerabilities were at an increased risk for risky sex and testing positive for HIV and other STI (Kiene et al, 2017). The prevalence reported by Doyle et

al. was the gender-specific prevalence, while our analysis considered syphilis prevalence by age but not by sex, among youths. Therefore, this could also explain the difference in syphilis prevalence between the studies.

The prevalence of HIV syphilis coinfection differs by HIV awareness among adults aged 15-59 years old in Tanzania. In a recent evaluation of the UNAIDS 90-90-90 cascade targets in Tanzania, only 78% of those who were HIV positive were aware of their status (UNAIDS, 2019). This is well below the target of achieving 90% awareness among those who are HIV positive by 2020. The joint prevalence of HIV/syphilis coinfection was 3.9% compared to 1.5% observed in Zambia using the same household population-based surveillance approach (Solomon et al, 2020). The prevalence of active syphilis was also higher among those unaware of their HIV status (4.7%) than among those who were aware (3%). An Ethiopian cross-sectional study reported that syphilis seroprevalence was higher among ART naïve participants (Shimelis et al, 2015). However, contemporary studies from Brazil and China reported the opposite, such that patients on ART had a higher risk for active syphilis and syphilis seroprevalence (Callegari et al, 2014 & Chen et al, 2019). The relationship between higher ART coverage and higher risk for syphilis is likely related to confounding with socioeconomic status and/or country support for ARV programs. Lack of access to testing is also an influential factor for HIV awareness. Some reported that among female and heterosexual male sex workers, low testing behavior was associated with fear, stigma, judgmental provider attitudes, paucity of testing sites, and high cost (Muhindo et al, 2020 & Muhindo et al, 2021).

Among the sexual behaviors considered, we found that buying sex in the last twelve months was associated with active syphilis. We documented that those who sold sex in the last twelve months had about twice the odds of having syphilis compared to those who did not sell sex. A cross-sectional study among a Tanzanian fishing community also found that transactional sex in

the last year, especially receiving gifts for sex was associated with about twice the burden of HIV (Kapiga et al, 2021). Among MSM, the odds of HIV and other bacteria STI were higher among those who frequently sold sex compared to those who did not (Berg et al, 2019). The difference in syphilis risks between those who buy sex and sell sex could be attributed to condom use and power dynamics between these two groups. Those who buy sex have a very high condom usage rate with 71% reporting consistent condom use (CCU) in the past and 80% reporting that they will consistently use condoms in the future when buying sex, thereby reducing their risk for HIV and other STIs (Manieri et al, 2013). The difference between condom uses among those who sell and buy sex in Laos is not large, with 42% of those who sell sex reporting CCU vs 47% among those who buy sex (Bowring et al, 2015). Those who pay for sex can require condom use, STI screening, and choose their partners, whereas those who sell sex have less negotiating power. Buying sex could be a protective factor because of these intentional protective actions, compared to people who do not buy sex and therefore have less power to require condoms or STI screening (van Empelen & Kok, 2006). Our study also found that being divorced was significantly associated with active syphilis. This was not surprising because women who are divorced are more likely to initiate a new sexual relationship, therefore, elevating their risk of STIs (Sherman et al, 2005).

Our study must also be considered in view of some limitations. Firstly, given that our study used a cross-sectional design, we are unable to infer a temporal or causal relationship between HIV positivity and active syphilis infection. Secondly, selection bias could exist because of the 7% of adults aged 15 – 59 years who refused HIV testing and therefore were excluded from the analysis. This could have biased our results away from the null because participants who self-reported being positive for HIV were more likely to agree to a blood draw because of the benefit of receiving their CD4 cells count. Finally, household surveys are poor at collecting information

on MSM and commercial sex workers. Notwithstanding the outlined limitations, this study has several strengths. Firstly, this randomized population-based survey allows us to capture a nationally representative sample and account for refusals among those sampled. Therefore, the findings can be generalizable to the adult population aged 15 – 59 years in Tanzania. Secondly, laboratory testing for HIV status ensured that we did not rely on self-report only thereby eliminating some important opportunities for misclassification, social desirability bias (Sackett, 1979). Thirdly, we collected and adjusted important covariates, including socio-demographic factors and sexual behaviors reducing the effects of potential confounding variables. Finally, our study had a large enough sample size that allowed us to detect a true effect between active syphilis and HIV positivity and to examine stratum-specific estimates with reasonable power.

In conclusion, we have identified a burden of curable active syphilis among adult Tanzanians aged 15 – 59 years old. Diagnosing and treating those living with syphilis infections has the potential to improve the health of those carrying the disease and prevent further spread to other populations. Our analysis suggests the need for continued combined HIV and syphilis screenings and an urgent need for clinical interventions that focus on increasing syphilis testing and treatment among sex workers and people who are divorced should be developed.

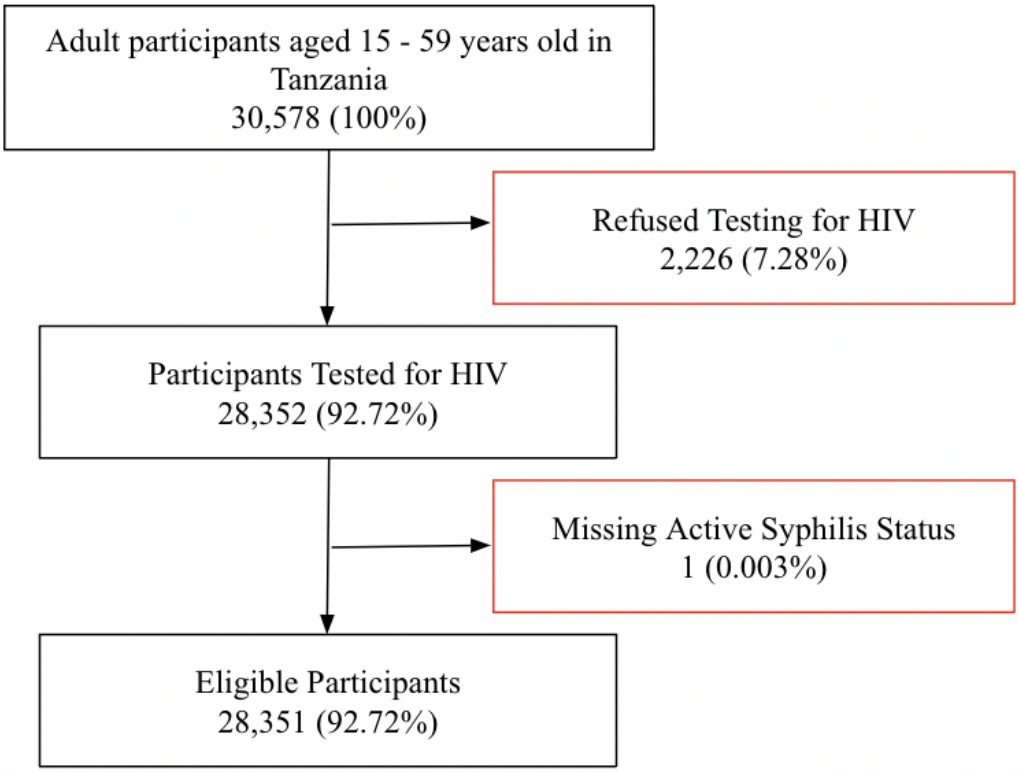


**Figure 1: Flow diagram of the inclusion of adults aged 15 - 59 years who participated in the Population-based HIV Impact Assessment (PHIA) in Tanzania (2016 to 2017).** Data are unweighted numbers of participants. Participants in red boxes were excluded because they refused to test for HIV, missing data on HIV awareness, status, and syphilis status. Denominators for percentages are adults aged 15 to 59 years in Tanzania.

**Table 1. Characteristics of adult participants aged 15 - 59 in the Population-based HIV Assessment Survey in Tanzania (2016 to 2017)**

| Characteristics | (N = 28,351) | Weighted Percent |
|---|---|---|
| Residence | | |
| Urban | 9,353 | 37.5% |
| Rural | 18,998 | 62.5% |
| Gender | | |
| Male | 12,271 | 49.1% |
| Female | 16,080 | 50.9% |
| Age in years | | |
| 15 to 19 | 5,532 | 21.0% |
| 20 to 24 | 4,832 | 17.5% |
| 25 to 44 | 13,310 | 46.1% |
| 45 to 59 | 4,677 | 15.4% |
| Wealth quintile | | |
| Lowest | 6,001 | 18.6% |
| Second | 6,004 | 20.3% |
| Middle | 6,342 | 20.8% |
| Fourth | 5,184 | 19.6% |
| Highest | 4,812 | 20.7% |
| Education | | |
| None/Pre-Primary | 4,275 | 12.9% |
| Primary | 17,217 | 60.1% |
| Post Primary/Secondary | 5,829 | 22.5% |
| More than secondary | 1,018 | 4.5% |
| Marital Status | | |
| Married/Co-habiting/Living together | 17,093 | 57.0% |
| Divorced | 1,182 | 3.7% |
| Separated | 1,271 | 4.5% |
| Widowed | 834 | 2.6% |
| Never Married | 7,916 | 32.1% |
| HIV Diagnosis | | |
| HIV Negative | 26,642 | 95.0% |
| HIV Positive and Aware | 1,076 | 3.1% |

| | | |
|---|---|---|
| HIV Positive and Unaware | 633 | 1.9% |
| Active Syphilis | | |
| Yes | 254 | 0.8% |
| Anal Sex | | |
| Yes | 340 | 1.2% |
| Bought Sex in the last 12 months | | |
| Yes | 1,176 | 5.3% |
| Sold Sex in the last 12 months | | |
| Yes | 917 | 3.6% |
| **Total** | **28,351** | **100.0%** |

N, Number of eligible participants; Percentages include sampling weights and may not sum to 100% because of rounding.

**Table 2. Prevalence of active syphilis status among participants in the Population-based HIV Assessment Survey by demographic characteristics and risk behaviors, Tanzania, 2016 – 2017**

| | Active Syphilis (N = 254) | Syphilis Negative (N = 28,097) | Weighted Prevalence |
|---|---|---|---|
| Residence | | | |
| Urban | 60 | 9,293 | 0.5% |
| Rural | 194 | 18,804 | 1.0% |
| Gender | | | |
| Male | 104 | 12,167 | 0.8% |
| Female | 150 | 15,930 | 0.9% |
| Age in years | | | |
| 15 to 19 | 21 | 5,511 | 0.4% |
| 20 to 24 | 36 | 4,796 | 0.6% |
| 25 to 44 | 131 | 13,179 | 0.9% |
| 45 to 59 | 66 | 4,611 | 1.5% |
| Wealth quintile | | | |
| Lowest | 65 | 5,936 | 1.1% |
| Second | 75 | 5,929 | 1.2% |
| Middle | 68 | 6,274 | 1.1% |
| Fourth | 31 | 5,153 | 0.7% |
| Highest | 15 | 4,797 | 0.3% |
| Education | | | |
| None/Pre-Primary | 64 | 4,211 | 1.6% |
| Primary | 166 | 17,051 | 0.9% |
| Post Primary/Secondary | 21 | 5,808 | 0.3% |
| More than secondary | 3 | 1,015 | 0.3% |
| Marital Status | | | |
| Married/Co-habiting/Living together | 161 | 16,932 | 0.9% |
| Divorced | 31 | 1,151 | 2.5% |
| Separated | 14 | 1,257 | 0.9% |
| Widowed | 16 | 818 | 2.0% |
| Never Married | 32 | 7,884 | 0.4% |

| | | | |
|---|---|---|---|
| HIV Diagnosis | | | |
| HIV Negative | 187 | 26,455 | 0.7% |
| HIV Positive and Aware | 39 | 1,037 | 3.4% |
| HIV Positive and Unaware | 28 | 605 | 4.7% |
| Anal Sex | | | |
| Yes | 9 | 331 | 1.3% |
| No | 243 | 27,524 | 0.8% |
| Bought Sex in the last 12 months | | | |
| Yes | 11 | 1,165 | 0.6% |
| No | 233 | 23,187 | 1.0% |
| Sold Sex in the last 12 months | | | |
| Yes | 21 | 896 | 2.1% |
| No | 223 | 23,455 | 0.9% |
| **Total** | **254** | **28,097** | **0.8%** |

N, the total number of eligible respondents.

**Table 3. Factors associated with active syphilis among participants in the Population-based HIV Assessment Survey, Tanzania, 2016 - 2017**

| | Bivariate analysis OR (95% CI) | Multivariate analysis aOR (95% CI) |
|---|---|---|
| Residence | | |
| Urban | 1.0 | 1.0 |
| Rural | 2.03 (1.36 - 3.04) | 1.38 (0.84 - 2.27) |
| Gender | | |
| Male | 1.0 | 1.0 |
| Female | 1.10 (0.83 - 1.45) | 0.85 (0.62 - 1.15) |
| Age in years | | |
| 15 to 19 | 1.0 | 1.0 |
| 20 to 24 | 1.52 (0.80 - 2.91) | 1.25 (0.62 - 2.52) |
| 25 to 44 | 2.15 (1.34 - 3.45) | 1.15 (0.59 - 2.22) |
| 45 to 59 | 3.70 (2.08 - 6.56) | 1.65 (0.78 - 3.50) |
| Wealth quintile | | |
| Lowest | 4.15 (1.91 - 9.00) | 1.90 (0.75 - 4.82) |
| Second | 4.44 (2.24 - 8.81) | 2.14 (0.95 - 4.82) |
| Middle | 4.04 (1.98 - 8.25) | 2.13 (0.90 - 5.01) |
| Fourth | 2.60 (1.37 - 4.94) | 1.62 (0.78 - 3.35) |
| Highest | 1.0 | 1.0 |
| Education | | |
| None/Pre-Primary | 5.46 (1.21 - 24.64) | 2.25 (0.52 - 9.82) |
| Primary | 3.09 (0.77 - 12.33) | 1.49 (0.38 - 5.88) |
| Post Primary/Secondary | 1.04 (0.22 - 4.92) | 0.67 (0.14 - 3.34) |
| More than secondary | 1.0 | 1.0 |
| Marital Status | | |
| Married/Co-habiting/Living together | 2.27 (1.50 - 3.42) | 1.26 (0.73 - 2.20) |
| Divorced | 6.03 (3.40 - 10.69) | 2.68 (1.18 - 6.11) |
| Separated | 2.13 (1.004 - 4.50) | 0.93 (0.37 -2.36) |
| Widowed | 4.79 (2.27 - 10.11) | 1.54 (0.59 - 4.00) |
| Never Married | 1.0 | 1.0 |
| HIV Diagnosis | | |
| HIV Negative | 1.0 | 1.0 |

| | | |
|---|---|---|
| HIV Positive and Aware | 4.94 (3.17 - 7.72) | 4.01 (2.42 - 6.64) |
| HIV Positive and Unaware | 6.91 (4.00 - 11.95) | 5.00 (2.86 - 8.75) |
| Anal Sex | | |
| Yes | 1.56 (0.68 - 3.61) | 1.06 (0.44 - 2.54) |
| No | 1.0 | 1.0 |
| Bought Sex in the last 12 months | | |
| Yes | 0.65 (0.30 - 1.39) | 0.50 (0.22 - 1.15) |
| No | 1.0 | 1.0 |
| Sold Sex in the last 12 months | | |
| Yes | 2.37 (1.36 - 4.16) | 2.22 (1.25 - 3.95) |
| No | 1.0 | 1.0 |

OR, odds ratio, ORs are bivariate and weighted; CI, confidence intervals, CI not including 1 is statistically significant. aOR, adjusted odds ratio. Multivariable analysis adjusted for residence, gender, age, wealth, education, marital status, HIV diagnosis, and sold sex in the last 12 months. P-values of categorical variables are for the joint test for significance.

**References**


Adawiyah, R. A., Saweri, O., Boettiger, D. C., Applegate, T. L., Probandari, A., Guy, R., Guinness, L., & Wiseman, V. (2021). The costs of scaling up HIV and syphilis testing in low- and middle-income countries: a systematic review. *Health policy and planning*, *36*(6), 939–954. https://doi.org/10.1093/heapol/czab030

Adolf, R., Bercht, F., Aronis, M. L., Lunardi, L. W., Schechter, M., & Sprinz, E. (2012). Prevalence and risk factors associated with syphilis in a cohort of HIV positive individuals in Brazil. *AIDS care*, *24*(2), 252–258. https://doi.org/10.1080/09540121.2011.597706

Baral, S., Beyrer, C., Muessig, K., Poteat, T., Wirtz, A. L., Decker, M. R., Sherman, S. G., & Kerrigan, D. (2012). Burden of HIV among female sex workers in low-income and middle-income countries: a systematic review and meta-analysis. *The Lancet. Infectious diseases*, *12*(7), 538–549. https://doi.org/10.1016/S1473-3099(12)70066-X

Berg, R. C., Weatherburn, P., Marcus, U., & Schmidt, A. J. (2019). Links between transactional sex and HIV/STI-risk and substance use among a large sample of European men who have sex with men. *BMC infectious diseases*, *19*(1), 686. https://doi.org/10.1186/s12879-019-4326-3

Bowring, A. L., van Gemert, C., Vongsaiya, K., Hughes, C., Sihavong, A., Phimphachanh, C., Chanlivong, N., Toole, M., & Hellard, M. (2015). It goes both ways: a cross-sectional study of buying and selling sex among young behaviourally bisexual men in Vientiane, Laos. *Sexual health*, *12*(5), 405–410. https://doi.org/10.1071/SH15053

Callegari, F. M., Pinto-Neto, L. F., Medeiros, C. J., Scopel, C. B., Page, K., & Miranda, A. E. (2014). Syphilis and HIV co-infection in patients who attend an AIDS outpatient clinic in Vitoria, Brazil. *AIDS and behavior*, *18 Suppl 1*(0 1), S104–S109. https://doi.org/10.1007/s10461-013-0533-x

Centers for Disease Prevention and Control. (2022, Feb 10). *Syphilis - CDC Fact sheet*. https://www.cdc.gov/std/syphilis/stdfact-syphilis.htm

Chen, L., Yang, J., Ma, Q., & Pan, X. (2019). Prevalence of Active Syphilis Infection and Risk Factors among HIV-Positive MSM in Zhejiang, China in 2015: A Cross-Sectional Study. *International journal of environmental research and public health*, *16*(9), 1507. https://doi.org/10.3390/ijerph16091507

Chersich, M. F., Luchters, S., Ntaganira, I., Gerbase, A., Lo, Y. R., Scorgie, F., & Steen, R. (2013). Priority interventions to reduce HIV transmission in sex work settings in sub-Saharan Africa and delivery of these services. *Journal of the International AIDS Society*, *16*(1), 17980. https://doi.org/10.7448/IAS.16.1.17980

Doyle, A. M., Ross, D. A., Maganja, K., Baisley, K., Masesa, C., Andreasen, A., Plummer, M. L., Obasi, A. I., Weiss, H. A., Kapiga, S., Watson-Jones, D., Changalucha, J., Hayes, R. J., & MEMA kwa Vijana Trial Study Group (2010). Long-term biological and behavioural impact of an adolescent sexual health intervention in Tanzania: follow-up survey of the community-based MEMA kwa Vijana Trial. *PLoS medicine*, *7*(6), e1000287. https://doi.org/10.1371/journal.pmed.1000287

Gerbase, A. C., & Mertens, T. E. (1998). Sexually transmitted diseases in Africa: time for action. *Africa health*, *20*(3), 10–12.

Gilbert, L., Dear, N., Esber, A., Iroezindu, M., Bahemana, E., Kibuuka, H., Owuoth, J., Maswai, J., Crowell, T. A., Polyak, C. S., Ake, J. A., & AFRICOS Study Group (2021). Prevalence and risk factors associated with HIV and syphilis co-infection in the African Cohort Study: a cross-sectional study. *BMC infectious diseases*, *21*(1), 1123. https://doi.org/10.1186/s12879-021-06668-6

Houle, B., Mojola, S. A., Angotti, N., Schatz, E., Gómez-Olivé, F. X., Clark, S. J., Williams, J. R., Kabudula, C., Tollman, S., & Menken, J. (2018). Sexual behavior and HIV risk across the life course in rural South Africa: trends and comparisons. *AIDS care*, *30*(11), 1435–1443. https://doi.org/10.1080/09540121.2018.1468008

Jary, A., Dienta, S., Leducq, V., Le Hingrat, Q., Cisse, M., Diarra, A. B., Fofana, D. B., Ba, A., Baby, M., Achenbach, C. J., Murphy, R., Calvez, V., Marcelin, A. G., & Maiga, A. I. (2019). Seroprevalence and risk factors for HIV, HCV, HBV and syphilis among blood donors in Mali. *BMC infectious diseases*, *19*(1), 1064. https://doi.org/10.1186/s12879-019-4699-3

John-Stewart G, Peeling RW, Levin C, et al. Prevention of Mother-to-Child Transmission of HIV and Syphilis. In: Holmes KK, Bertozzi S, Bloom BR, et al., editors. Major Infectious Diseases. 3rd edition. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2017 Nov 3. Chapter 6. Available from: https://www.ncbi.nlm.nih.gov/books/NBK525182/ doi: 10.1596/978-1-4648-0524-0_ch6

Kapiga, S., Hansen, C. H., Downs, J. A., Sichalwe, S., Hashim, R., Mngara, J., van Dam, G. J., Corstjens, P., Kingery, J. R., Peck, R. N., & Grosskurth, H. (2021). The burden of HIV, syphilis and schistosome infection and associated factors among adults in the fishing communities in northwestern Tanzania. *Tropical medicine & international health : TM & IH*, *26*(2), 204–213. https://doi.org/10.1111/tmi.13520

Kiene, S. M., Lule, H., Sileo, K. M., Silmi, K. P., & Wanyenze, R. K. (2017). Depression, alcohol use, and intimate partner violence among outpatients in rural Uganda: vulnerabilities for HIV, STIs and high risk sexual behavior. *BMC infectious diseases*, *17*(1), 88. https://doi.org/10.1186/s12879-016-2162-2

Kofoed, K., Gerstoft, J., Mathiesen, L. R., & Benfield, T. (2006). Syphilis and Human Immunodeficiency Virus (HIV)-1 Coinfection: Influence on CD4 T-Cell Count, HIV-1 Viral Load, and Treatment Response. *Sexually Transmitted Diseases*, *33*(3), 143–148. http://www.jstor.org/stable/44966497

Kojima, N., & Klausner, J. D. (2018). An Update on the Global Epidemiology of Syphilis. *Current epidemiology reports*, *5*(1), 24–38. https://doi.org/10.1007/s40471-018-0138-z

Korenromp, E.L., Mahiané, S.G., Nagelkerke, N. *et al.* Syphilis prevalence trends in adult women in 132 countries – estimations using the Spectrum Sexually Transmitted Infections model. *Sci Rep* **8,** 11503 (2018). https://doi.org/10.1038/s41598-018-29805-9

Lynn, W. A., & Lightman, S. (2004). Syphilis and HIV: a dangerous combination. *The Lancet. Infectious diseases*, *4*(7), 456–466. https://doi.org/10.1016/S1473-3099(04)01061-8

Manieri, M., Svensson, H., & Stafström, M. (2013). Sex tourist risk behaviour--an on-site survey among Swedish men buying sex in Thailand. *Scandinavian journal of public health*, *41*(4), 392–397. https://doi.org/10.1177/1403494813480572

Manyahi, J., Jullu, B.S., Abuya, M.I. *et al.* Prevalence of HIV and syphilis infections among pregnant women attending antenatal clinics in Tanzania, 2011. *BMC Public Health* **15,** 501 (2015). https://doi.org/10.1186/s12889-015-1848-5

Mayer, K. H., & Venkatesh, K. K. (2011). Interactions of HIV, other sexually transmitted diseases, and genital tract inflammation facilitating local pathogen transmission and acquisition. *American journal of reproductive immunology (New York, N.Y. : 1989)*, *65*(3), 308–316. https://doi.org/10.1111/j.1600-0897.2010.00942.x

Muhindo, R., Mujugira, A., Castelnuovo, B., Sewankambo, N. K., Parkes-Ratanshi, R., Kiguli, J., Tumwesigye, N. M., & Nakku-Joloba, E. (2020). HIV and syphilis testing behaviors

among heterosexual male and female sex workers in Uganda. *AIDS research and therapy*, *17*(1), 48. https://doi.org/10.1186/s12981-020-00306-y

Muhindo, R., Mujugira, A., Castelnuovo, B., Sewankambo, N. K., Parkes-Ratanshi, R., Tumwesigye, N. M., Nakku-Joloba, E., & Kiguli, J. (2021). "I felt very small and embarrassed by the health care provider when I requested to be tested for syphilis": barriers and facilitators of regular syphilis and HIV testing among female sex workers in Uganda. *BMC public health*, *21*(1), 1982. https://doi.org/10.1186/s12889-021-12095-8

Nnko, S., Changalucha, J., Mosha, J., Bunga, C., Wamoyi, J., Peeling, R., & Mabey, D. (2016). Perceptions, attitude and uptake of rapid syphilis testing services in antenatal clinics in North-Western Tanzania. *Health policy and planning*, *31*(5), 667–673. https://doi.org/10.1093/heapol/czv116

Parmley, L. E., Chingombe, I., Wu, Y., Mapingure, M., Mugurungi, O., Samba, C., Rogers, J. H., Hakim, A. J., Gozhora, P., Miller, S. S., Musuka, G., & Harris, T. G. (2022). High Burden of Active Syphilis and Human Immunodeficiency Virus/Syphilis Coinfection Among Men Who Have Sex With Men, Transwomen, and Genderqueer Individuals in Zimbabwe. *Sexually transmitted diseases*, *49*(2), 111–116. https://doi.org/10.1097/OLQ.0000000000001553

Patel, H. K., Duong, Y. T., Birhanu, S., Dobbs, T., Lupoli, K., Moore, C., Detorio, M., Sleeman, K., Manjengwa, J., Wray-Gordon, F., Yavo, D., Jackson, K., Domaoal, R. A., Yufenyuy, E. L., Vedapuri, S., Ndongmo, C. B., Ogollah, F. M., Dzinamarira, T., Rubinstein, P., Sachathep, K. K., … Parekh, B. S. (2021). A Comprehensive Approach to Assuring Quality of Laboratory Testing in HIV Surveys: Lessons Learned from the Population-Based HIV Impact Assessment Project. *Journal of acquired immune deficiency syndromes (1999)*, *87*(Suppl 1), S17–S27. https://doi.org/10.1097/QAI.0000000000002702

Sachathep, K., Radin, E., Hladik, W., Hakim, A., Saito, S., Burnett, J., Brown, K., Phillip, N., Jonnalagadda, S., Low, A., Williams, D., Patel, H., Herman-Roloff, A., Musuka, G., Barr, B., Wadondo-Kabonda, N., Chipungu, G., Duong, Y., Delgado, S., Kamocha, S., … Justman, J. (2021). Population-Based HIV Impact Assessments Survey Methods, Response, and Quality in Zimbabwe, Malawi, and Zambia. *Journal of acquired immune deficiency syndromes (1999)*, *87*(Suppl 1), S6–S16. https://doi.org/10.1097/QAI.0000000000002710

Sackett D. L. (1979). Bias in analytic research. *Journal of chronic diseases*, *32*(1-2), 51–63. https://doi.org/10.1016/0021-9681(79)90012-2

Salado-Rasmussen K. (2015). Syphilis and HIV co-infection. Epidemiology, treatment and molecular typing of Treponema pallidum. *Danish medical journal*, *62*(12), B5176.

Sherman, C. A., Harvey, S. M., & Noell, J. (2005). "Are they still having sex?" STI's and unintended pregnancy among mid-life women. *Journal of women & aging*, *17*(3), 41–55. https://doi.org/10.1300/J074v17n03_04

Shimelis, T., Lemma, K., Ambachew, H. *et al.* Syphilis among people with HIV infection in southern Ethiopia: sero-prevalence and risk factors. *BMC Infect Dis* **15,** 189 (2015). https://doi.org/10.1186/s12879-015-0919-7

Solomon, H., Moraes, A. N., Williams, D. B., Fotso, A. S., Duong, Y. T., Ndongmo, C. B., Voetsch, A. C., Patel, H., Lupoli, K., McAuley, J. B., Mulundu, G., Kasongo, W., & Mulenga, L. (2020). Prevalence and correlates of active syphilis and HIV co-Infection among sexually active persons aged 15-59 years in Zambia: Results from the Zambia Population-based HIV Impact Assessment (ZAMPHIA) 2016. *PloS one*, *15*(7), e0236501. https://doi.org/10.1371/journal.pone.0236501

Todd, J., Munguti, K., Grosskurth, H., Mngara, J., Changalucha, J., Mayaud, P., Mosha, F., Gavyole, A., Mabey, D., & Hayes, R. (2001). Risk factors for active syphilis and TPHA seroconversion in a rural African population. *Sexually transmitted infections*, *77*(1), 37–45. https://doi.org/10.1136/sti.77.1.37

UNAIDS. (2019). *Women and HIV: A spotlight on adolescent girls and young women.* UNAIDS. https://www.unaids.org/sites/default/files/media_asset/2019_women-and-hiv_en.pdf

UNAIDS. (2019). *Country progress report – United Republic of Tanzania (2019).* https://www.unaids.org/sites/default/files/country/documents/TZA_2020_countryreport.pdf

UNAIDS. (2021). *Fact Sheet – World AIDS Day 2021.* https://www.unaids.org/sites/default/files/media_asset/UNAIDS_FactSheet_en.pdf

UN. (2004, October). *Women: the face of AIDS in Africa.* UN. https://www.un.org/africarenewal/magazine/october-2004/women-face-aids-africa

U.S. Department of State. (n.d.). *PEPFAR-Supported Countries and Regions.* State. https://www.state.gov/pepfar-supported-countries-and-regions/

van Empelen, P., & Kok, G. (2006). Condom use in steady and casual sexual relationships: Planning, preparation and willingness to take risks among adolescents. *Psychology & health*, *21*(2), 165–181. https://doi.org/10.1080/14768320500229898

Yahya-Malima, K. I., Evjen-Olsen, B., Matee, M. I., Fylkesnes, K., & Haarr, L. (2008). HIV-1, HSV-2 and syphilis among pregnant women in a rural area of Tanzania: prevalence and risk factors. *BMC infectious diseases*, *8*, 75. https://doi.org/10.1186/1471-2334-8-75

Zuma, K., Gouws, E., Williams, B., & Lurie, M. (2003). Risk factors for HIV infection among women in Carletonville, South Africa: migration, demography and sexually transmitted

diseases. *International journal of STD & AIDS*, *14*(12), 814–817.

https://doi.org/10.1258/095646203322556147