



## ORIGINAL RESEARCH

## Sexual Behaviors and HIV Status: A Population-Based Study among Youths and Adults in Tanzania

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### Abstract

**Introduction:** HIV remains a global epidemic in the world, especially in African countries, despite various efforts to reduce the spread of this disease. Tanzania, an Eastern Africa nation, is one of the top ten HIV infected countries with approximately 80% of its population living with HIV. Heterosexual intercourse remains the most common method of HIV transmission in these countries, and efforts that improve responsible sexual intercourse would help limit the spread of the virus.

**Method:** We used the publicly available Tanzania HIV Impact Survey, a population-based cross-sectional national household survey, collected between 2016 and 2017. A total of 35,588 youths and adults aged 15 years and above were used for analysis. The outcome measure was prior knowledge of HIV status, coded as positive, negative, or unknown. Independent variables were various sexual behaviors. Multinomial logistic regression analysis was used to assess the relationship between sexual behaviors and the outcome variable in the crude model. We controlled for sociodemographic characteristics in the final model.

**Results:** The mean age of the respondents was about 32 years and they mostly had primary level of education. We found gender differences in sexual behaviors, including engaging in anal and transactional sex. In the demographic-adjusted model, compared to those with unknown HIV status, people who use condoms during sexual intercourse were 36% more likely to be known HIV status (OR = 1.36,  $p < 0.05$ ) and 5.9 times more likely to be known HIV positive status (OR = 5.85,  $p < 0.05$ ) than those who do not use

condoms. Also, individuals in polygamous (OR = 3.31,  $p < 0.05$ ) or non-polygamous (OR = 3.15,  $p < 0.05$ ) relationships were 3.3 and 3.2 times more likely to be known HIV negative status than single people. Similarly, being in a polygamous (OR = 1.54,  $p < 0.05$ ) or non-polygamous (OR = 2.00,  $p < 0.05$ ) union increases the likelihood of knowing one's HIV status as positive when compared to those who do not know their status.

**Conclusions:** Since socio-economic factors played a major role in determining how sexual behaviors are affected by the knowledge of HIV status, we recommend more interventions targeted at the following: Increasing HIV counseling and testing among men, people with low level of education (primary or less), low income, and people not in committed sexual unions. Furthermore, addressing the social determinants of health would help improve sexual behaviors and increase the uptake of HIV testing in this region.

### Keywords

Sexual behaviors, Africa, Tanzania, HIV acquisition risks, HIV transmission risks

### Introduction

Despite various efforts to reduce the spread, human immunodeficiency virus (HIV) remains a global epidemic, especially in African countries. There is still no vaccine or treatment to completely eradicate HIV. However, healthcare organizations and other stakeholders

continue to develop strategies and policies to decrease its continuous spread. Pursuant to these preventive efforts, the World Health Organization has initiated a “global health sector strategy on HIV for 2016-2021” [1] whose aim is to increase HIV status awareness, provide interventions for those individuals affected, increase financial resources directed towards HIV prevention among other goals. The 2019 Global AIDS update by the Joint United Nations Programme on HIV and AIDS (UNAIDS) showed that the pace of progress in reducing new HIV infections, increasing access to treatment, and ending AIDS-related deaths was slowing down per the ambitious 90-90-90 targets set by the organization for year 2020. Though some countries had seen improvements, others had experienced decline or stagnancy.

Sub-Saharan Africa, which constitutes only 12% of the world’s population bears 71% of the global HIV burden. Although there seems to be a decline in the incidence of HIV infection in these areas, the rates of infection remain remarkably high compared to the rest of the world. Tanzania, a country in eastern Africa, is one of the top ten HIV infected countries with approximately 80% of its population living with HIV [2]. In 2018, a study done by the UNAIDS revealed that there were roughly 1.6 million people living with AIDs in Tanzania [3]. However, the 2019 Global AIDS update reports that eastern and southern Africa, the regions most affected by HIV, have made significant progress towards achieving the 90-90-90 goals but still have a long way to go [4].

HIV is transmitted through exposure to bodily fluids [3,5,6]. One of the ways an individual can be readily exposed to these bodily fluids is by engaging in risky sexual behaviors. Sexual behaviors are typically described as risky actions by individuals that expose them to contracting infectious diseases. These sexual behaviors include having unprotected sexual intercourse, having multiple sexual partners, participating in anal sex or transactional sex, drinking alcohol before sex [7]. Risky sexual behavior increases an individual’s risk of contracting HIV from a HIV positive person or spreading HIV to HIV negative partners. Understanding the relationship between risky sexual behaviors and the prevalence of HIV infection is paramount as this will guide the development of more effective preventive strategies to further reduce HIV transmission.

Empirical evidence reveals that the most common mode of HIV transmission in Tanzania is heterosexual sex [2]. There is an increasing shift in sexual behaviors amongst adults in Tanzania, especially cohabiting couples. Of note is an increase in HIV counselling and testing (HCT) [8]. If this trend persists, HIV spread will become limited by responsible sexual behavior. The 2008 Tanzania HIV/AIDS and Malaria Indicator Survey (THMIS) revealed that about 91%, 4%, and 6% of married couples were HIV-concordant negative, HIV-

concordant positive and HIV-discordant, respectively. In sero-discordant relationships, about 4% of cases showed the men were infected while the women were not [9]. Such sero-discordance increases the chances of infections especially among couples who avoid the use of protection for reasons such as child conception.

The Population-based HIV Impact Assessment (PHIA), branded the Tanzania HIV Impact Survey 2016-2017 (THIS) in Tanzania, is a multi-country project funded by the United States (U.S.) President’s Emergency Plan for AIDS Relief (PEPFAR) to conduct national HIV-focused surveys that describe the status of the HIV epidemic in the involved nations and guide policy and funding priorities. Using this survey data, the aims of our study were to examine the sexual behavior of adults in Tanzania, report the relationship between sexual behavior and awareness of their HIV status. These will provide an objective basis for targeted HIV prevention services for the Tanzanian adult population.

## Methodology

### Study design

This study utilized the publicly available 2016-2017 THIS secondary data. THIS is a cross-sectional nationwide population-based survey of households in Tanzania. The survey sought to examine HIV risk, prevalence, impact of HIV preventive and treatment measures, and viral suppression among individuals of all ages. Information on the sexual behavior and knowledge of HIV transmission among the adults were also collected. Although, the THIS covered all ages, our population of interest for this study were individuals who were 15 years and older. Survey questionnaires were administered to eligible individuals and biomarkers, including HIV and syphilis, were taken.

### Sampling method and sample size

A two-staged stratified cluster sampling of the 31 regions of Tanzania was used. A total of 14,811 households were interviewed. The detailed sampling methodology is described elsewhere [9]. Eligible households within predefined enumeration areas were randomly selected and eligible individuals within the households were interviewed by trained personnel after informed consent was obtained. Eligible individuals included persons who are 18 years and older who slept in the household the night before the survey was conducted and were willing to participate. Persons within the age of 10-17 years who slept in the household the night before the survey and were willing to participate were also interviewed after an informed consent was obtained from them and their willing parents. A total of 31,579 out of eligible 36,087 adults who were older than 15-years-old participated in the survey. Response rates were 88.5% and 93.2% among eligible males and females, respectively. However, data for individuals who are 15 years was also included.

Therefore, a total of 38,680 youths and adults aged 15 years and older were contained in the data set. Being a publicly available secondary data, ethical approval was not required.

## Measures

Outcome measure was prior knowledge of HIV status. Respondents were asked if they have ever been tested for HIV? Their responses were: "Yes", "No", and "Don't know". They were further asked: "what was the result of that HIV test?", responses include "Negative", "Positive", "Uncertain/Don't know/Did not receive the results". The two items were merged to form a composite variable "Known HIV status". People who had had testing done before and tested positive were coded 1 while people who tested negative were coded 2. Participants who had not had testing done before or responded Uncertain/Don't know/Did not receive the results to the second questions were merged and coded 3 representing "Unknown Status".

Independent variables were items that measured sexual behaviors among these adult age group. These include: (i) Transactional sex in the last 12 months, (ii) Alcohol use before sex, (iii) Number of sexual partners in last year, (iv) Condom use at last intercourse in last year, (v) Kind of sexual union, and (vi) Engagement in anal sex. For transactional sex, respondents were asked two sets of questions: "in the last 12 months, have you ever paid money for sex?" and "in the last 12 months, have you received payment for sex?". Responses to both questions were "Yes", "No", or "Don't know". Both questions were merged to a single dichotomous composite variable, transactional sex, which assessed if they bought or sold sexual intercourse in the last 12 months. For alcohol use before sex, respondents were asked if they drank alcohol before last sexual intercourse. Responses were coded: 1- Only I was drinking, 2- Only partner was drinking, 3- Both were drinking, and 4- Neither was drinking. Responses 1 through 3 were recoded to 1 to represent consumption of alcohol before sex and response 4 was recoded to 0 to represent no alcohol use before sex.

Respondents were asked about the number of people they had sex with in the last 12 months and integer numbers were inputted. Item was recoded to 0- none, 1- Single, and 2- Multiple. Condom use at last intercourse in last year was measured by asking if they used condoms during the last sex in the last 12 months. Responses were coded as 1- Used condoms and 2- Did not use condoms, and 3- No sex in the past 12 months. The kind of union or marriage the respondents are into could be either 1- Polygamous, 2- Non-polygamous, or 3- Not in any relationship. Likewise, their engagement in anal sex was assessed by asking if they have ever had anal sex before and response was recoded dichotomously, 0- No and 1- Yes.

The relationship between the independent

and outcome variables was controlled for using sociodemographic characteristics such as age, gender, wealth quintile, educational attainment, geographical location, and age of sexual debut. Age was a continuous variable with minimum age of 15 years. Gender was coded 1- Males and 0- Females. Wealth quintile was categorized into 1- Lowest, 2- Second, 3- Middle, 4- Fourth, and 5- Highest. The respondent's educational attainment was initially classified into 9 classes but recoded to 1- No education, 2- Primary education, 3- Secondary education, and 4- University education. Their geographical location was classified as either 1- Urban or 2-Rural. The age of sexual debut was recoded into a categorical variable with 1 representing those who had their first sexual experience before the age of 15 years, 2 representing sexual debut during young adulthood (15-24 years), and 3 representing those who had sexual debut after the age of 25 years. Lastly, the HIV status of the respondents was also determined by blood testing during the survey period and results of the tests categorized them as either positive or negative.

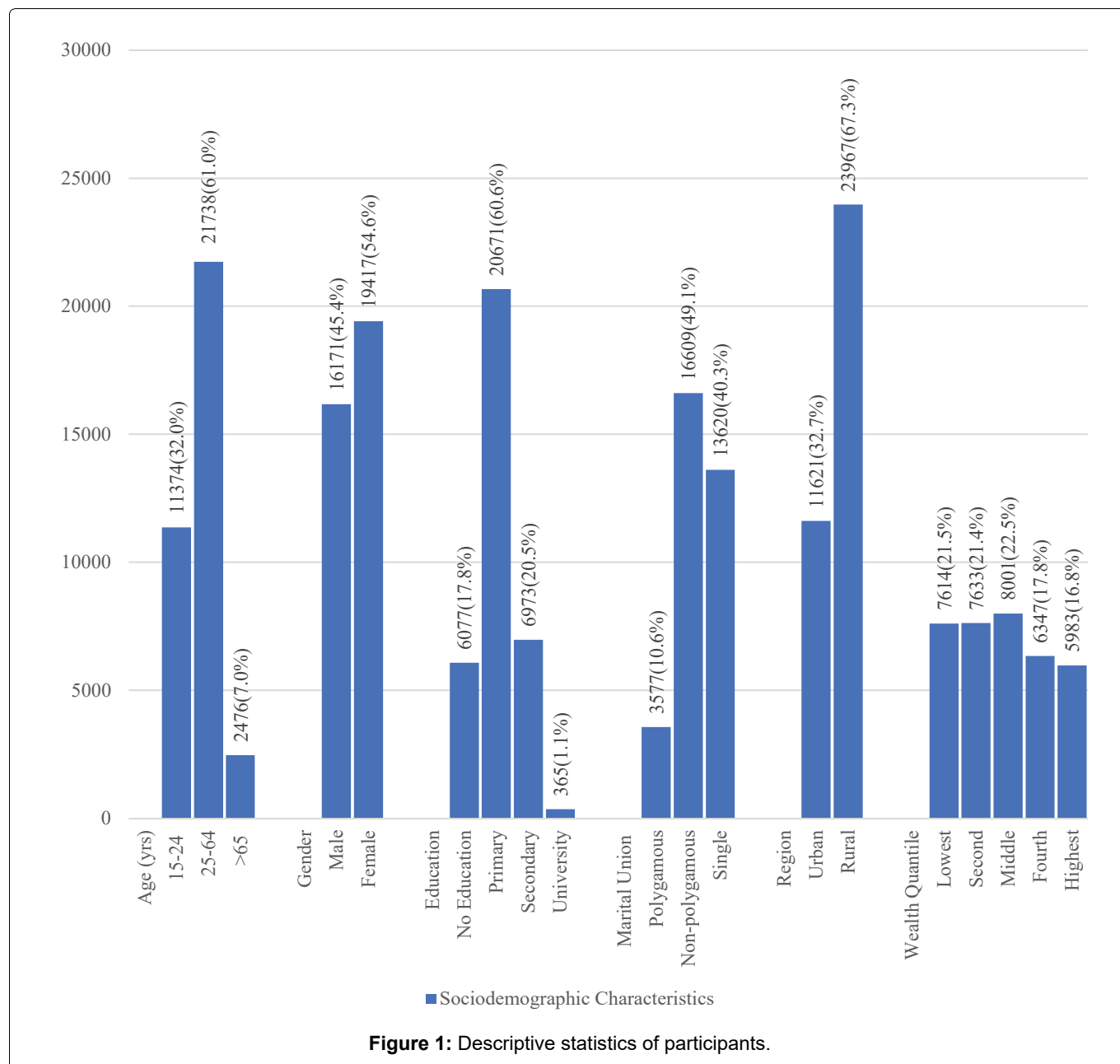
## Missing data

Because of the sensitive nature of the study (sexual behaviors and HIV), we expected missing data to be present systematically. We cleaned the data and ran a descriptive statistic on the variable of interests to assess the distribution of missing data. Majority of the sociodemographic variables had complete data. However, all independent and outcome variables had missing cases. Percentage of missing data ranged from 3-36%. Patterns of missing data were systematic, i.e., many individuals did not respond to any of the sexual behavior/HIV-related questions. These cases were deleted from the data using the outcome variable (known HIV status) as the reference. This resulted in deletion of 8% of all the cases and the total number of cases was at 35,588. Pattern of missing data analysis was redone which showed that only 14.8% of values were missing and the pattern is non-monotone.

## Data analysis

Descriptive statistics were done to characterize the participants' sociodemographic characteristics. Because the dependent variable was nominal and independent variables were continuous, ordinal, or nominal (including dichotomous variables), a multinomial logistic regression analysis was done. Accordingly, the assumption of no multicollinearity was tested by calculating the variance inflation factor (VIF). The VIF for the independent variables ranged from 1.003 - 1 [10].

The quality of the multinomial logistic regressions was interpreted using the Goodness-of-Fit statistics. Pearson chi-square statistic, Deviance chi-square statistic, and Model-Fitting Information (MFI) were used to assess if the model fits the data well. The pseudo R<sup>2</sup> measured the proportion of variance explained by the



overall model. There were two models in this study. The first was a crude multinomial logistic regression model of the independent variables (sexual behavior) and the outcome (known HIV status) whereas the second model sociodemographic variables adjusted for. The two models were compared for best fitting. All analyses were performed with IBM SPSS version 24.0, using an  $\alpha$  level of 0.05 to determine significance.

## Results

This population-based cross-sectional study of sexual behaviors and HIV status of adults in Tanzania had the majority (61%) of the sample within the age of 25-64 years (Figure 1). The mean age of the population was  $35.2 \pm 16.1$  years. 54.6% were females, 61% had primary level of education only. 67% were rural dwellers. Only about 11% were engaged in a polygamous union.

### Gender difference in sexual behaviors

When sexual behaviors were stratified by the

gender of the participants (Table 1), compared to the population with no anal sex experience, those with anal sex experience had 46% higher odds of being men (OR = 1.46, CI = 1.19-1.79). Similarly, individuals who engaged in transactional sex in the past year, compared to those who did not, were more likely to be male (OR = 1.83, CI = 1.67-2.10). A higher percentage of women (64%) than men were in a polygamous marital/sexual union. There was a stark gender disparity in the number of sexual partners adults in Tanzania have. Contrastingly, the use of alcohol before sexual intercourse in the preceding 12 months was higher among women (54.2% versus 45.8%) though the gender difference was not statistically significant.

### Sexual behaviors as correlates of HIV status

Table 2 shows the crude or unadjusted logistic regression model of sexual behaviors and HIV status. The odds ratio was statistically significant for all the independent variables except the experience of anal



**Table 1:** Sexual Behaviors by Gender.

Sexual Behaviors	Females (%)	Males (%)	Total	OR	CI
Anal sex experience					
No	18,531 (55.6)	14,820 (44.4)	33,351	1.46**	1.19-1.79
Yes	179 (46.1)	209 (53.9)	388		
Kind of sexual union					
Polygamous	2,285 (63.9)	1,292 (36.1)	3,577	-	-
Non-polygamous	8,759 (52.7)	7,850 (47.3)	16,609		
Not in any union	7,687 (56.4)	5,933 (43.6)	13,620		
Transactional sex in the last 12 months					
No	11,653 (55.4)	9,395 (44.6)	21,048	1.83**	1.67-2.01
Yes	847 (40.4)	1,252 (59.6)	2099		
Number of sexual partners:					
None	5,210 (52.7)	4,673 (47.3)	9,883	-	-
One	11,145 (62.3)	6,743 (37.7)	17,888		
Multiple	316 (17.2)	1,520 (83.8)	1,836		
Alcohol use before sex					
No	10,453 (53.8)	8,990 (46.2)	19,443	0.98	0.91-1.06
Yes	1,759 (54.2)	1,486 (45.8)	3,245		
Condom use for last sex in 12 months					
Not used	10,622 (56.9)	8,051 (43.1)	18,673	-	-
Used	1,298 (48.3)	1,390 (51.7)	2,688		
Did not have sex	4,253 (64.8)	2,311 (35.2)	6,564		

**Note:** OR = Odds Ratio, CI = 95% Confidence Interval; \*\*p < 0.05

**Table 2:** Multinomial Logistic Regression for Model 1.

	Negative					Positive				
	B	SE	Wald	p.	Exp (B)	B	SE	Wald	p.	Exp (B)
Intercept	-0.17	0.15	1.26	0.262		-2.44	0.35	47.61	0.000	
Anal sex (No)	0.23	0.14	2.90	0.089	1.26	-0.11	0.31	0.12	0.728	0.90
Transactional sex (No)	0.15	0.06	5.70	0.017	<b>1.16</b>	0.11	0.16	0.52	0.471	1.12
Alcohol before sex (No)	0.24	0.05	25.53	0.000	<b>1.27</b>	-0.80	0.10	68.22	0.000	<b>0.45</b>
Condom use (Used)	0.44	0.06	65.55	0.000	<b>1.56</b>	1.66	0.10	255.37	0.000	<b>5.24</b>
Number of partners (None)	-0.19	0.08	5.64	0.018	<b>0.82</b>	0.08	0.22	0.14	0.712	1.08
Number of partners (One)	0.21	0.05	16.77	0.000	<b>1.23</b>	0.47	0.14	10.80	0.001	<b>1.59</b>
Union (Polygamous)	0.68	0.06	138.31	0.000	<b>1.97</b>	0.46	0.15	9.07	0.003	<b>1.59</b>
Union (Non-polygamous)	0.71	0.04	319.35	0.000	<b>2.023</b>	0.56	0.10	31.42	0.000	<b>1.76</b>

**Note:** p < 0.05 is significant. The reference category for the outcome is unknown HIV status. Reference categories for the independent variables are those not in parentheses. Final Model Fitting Chi-square = 784.97, p = 0.000; Pearson  $\chi^2$  (212, N = 20,848) = 494.431, p < .05; Deviance  $\chi^2$  (212, N = 20,848) = 440.596, p < 0.05; Cox and Snell = 0.037; Nagelkerke pseudo R<sup>2</sup> = 0.049; McFadden = 0.027.

sexual intercourse for individuals who claimed to be HIV negative. Being HIV negative compared to not knowing one's status, people who do not engage in transactional sex and do not consume alcohol before sex have 16% and 27% more likelihood of being HIV negative than those who engage in such behaviors, respectively. Likewise, people who are HIV negative compared to those with unknown status, those who used condoms for sex have an odds 1.56 higher than those who did not. Comparing

HIV negative to unknown status, individuals who have no sexual partner were less likely to be HIV negative (OR = 0.82, p < 0.05) than those with multiple sexual partners. Conversely, those with one sexual partner were more likely to be negative, the odd was 1.23 times higher than those with multiple sexual partners.

For people who were HIV positive versus those whose status are unknown, not consuming alcohol before sex reduces the likelihood of being HIV positive (OR = 0.45, p

**Table 3:** Multinomial Logistic Regression for Model 2.

	Negative					Positive				
	B	SE	Wald	p.	Exp (B)	B	SE	Wald	p	Exp (B)
Intercept	2.19	0.29	57.72	0.000		-4.96	1.12	19.76	0.000	
Anal sex (No)	0.10	0.14	0.51	0.477	1.11	-0.24	0.32	0.58	0.448	0.79
Transaction sex (No)	0.10	0.07	2.05	0.152	1.10	0.16	0.16	1.03	0.310	1.18
Alcohol before sex (No)	0.01	0.05	0.05	0.827	1.01	-0.69	0.10	47.04	0.000	<b>0.50</b>
Condom use (Frequent use)	0.31	0.06	28.10	0.000	<b>1.36</b>	1.77	0.11	268.70	0.000	<b>5.85</b>
Number of partners (None)	-0.12	0.08	1.99	0.158	0.89	0.28	0.22	1.55	0.213	1.32
Number of partners (One)	-0.09	0.06	2.59	0.108	0.92	-0.13	0.15	0.70	0.402	0.88
Union (Polygamous)	1.20	0.07	336.11	0.000	<b>3.31</b>	0.43	0.16	7.11	0.008	<b>1.54</b>
Union (Non-polygamous)	1.15	0.04	663.15	0.000	<b>3.15</b>	0.69	0.11	42.53	0.000	<b>2.00</b>
Age	-0.02	0.00	312.19	0.000	<b>0.98</b>	0.02	0.00	23.67	0.000	<b>1.02</b>
Gender (Female)	0.80	0.04	438.57	0.000	<b>2.22</b>	1.61	0.10	255.91	0.000	<b>5.01</b>
Education: University	1.54	0.23	46.26	0.000	<b>4.65</b>	-0.80	1.04	0.60	0.438	0.45
Education: Secondary	0.84	0.07	150.98	0.000	<b>2.31</b>	0.10	0.19	0.30	0.587	1.11
Education: Primary	0.47	0.05	93.49	0.000	<b>1.56</b>	0.67	0.12	29.49	0.000	<b>1.96</b>
Region (Urban)	0.09	0.05	2.94	0.087	1.10	0.60	0.12	27.1	0.000	<b>1.82</b>
Wealth Quantile 1	-0.62	0.08	61.77	0.000	<b>0.54</b>	-0.43	0.19	5.25	0.022	<b>0.65</b>
Wealth Quantile 2	-0.41	0.08	28.80	0.000	<b>0.66</b>	-0.12	0.18	0.47	0.495	0.89
Wealth Quantile 3	-0.22	0.07	9.38	0.002	<b>0.80</b>	0.33	0.16	4.53	0.033	<b>1.39</b>
Wealth Quantile 4	-0.01	0.07	0.04	0.839	0.99	0.16	0.15	1.08	0.298	1.17
Age sex debut (< 15 years)	-0.53	0.10	29.91	0.000	<b>0.59</b>	0.25	0.25	0.95	0.33	0.78
Age sex debut (15-24 years)	-0.19	0.09	5.08	0.024	<b>0.83</b>	-0.06	0.22	0.08	0.781	0.94

**Note:**  $p < 0.05$ . The reference category for the outcome is unknown HIV status. The reference categories for the independent variables are those not in parentheses. Final Model Fitting  $\chi^2 = 2804.30$ ,  $p = 0.000$ ; Pearson  $\chi^2$  (21636,  $N = 20,831$ ) = 23748.6,  $p = 0.000$ ; Deviance  $\chi^2$  (21636,  $N = 20,831$ ) = 16438.6,  $p = 1.000$ ; Cox and Snell = 0.126; Nagelkerke pseudo  $R^2 = 0.169$ ; McFadden = 0.098.

< 0.05). However, the use of condoms for sex increases the odds of being HIV positive by 5.24 times than those who do not (OR = 5.24,  $p < 0.05$ ). Also, individuals with one sexual partner are 1.59 times more likely to be HIV positive, compared to having an unknown status, than those with multiple sexual partners. Comparably, people in a polygamous and non-polygamous union were 1.59 and 1.76 times more likely to have an HIV negative status than those who are single, respectively.

Table 3 shows the sociodemographic-adjusted logistic regression model between the sexual behaviors and HIV status. The Nagelkerke's pseudo  $R^2$  increased from 4.9% to 16.9% in this model. Therefore, this adjusted model performed better than the crude model in Table 3, indicating the significant effect of sociodemographic characteristics on the relationship between sexual behaviors and HIV status in Tanzania. Compared to those with unknown HIV status, people who use condoms during sexual intercourse were 36% more likely to be known HIV status (OR = 1.36,  $p < 0.05$ ) and 5.9 times more likely to be known HIV positive status (OR = 5.85,  $p < 0.05$ ) than those who do not use condoms. Also, with being single as the reference, individuals in polygamous (OR = 3.31,  $p < 0.05$ ) or non-polygamous (OR = 3.15,  $p$

< 0.05) relationships were 3.3 and 3.2 times more likely to be known HIV negative status compared to those with unknown status. Similarly, being in a polygamous (OR = 1.54,  $p < 0.05$ ) or non-polygamous (OR = 2.00,  $p < 0.05$ ) union increases the likelihood of knowing one's HIV status as positive when compared to those who do not know their status.

We found that increasing age reduces the odds of knowing one's HIV status as negative (OR = 0.98,  $p < 0.05$ ) when compared to unknown status, whereas it increases the odds of being known HIV positive (OR = 1.02,  $p < 0.05$ ). Among people who were HIV negative and positive, respectively compared to those with unknown status, females were more likely to know their HIV status (OR = 2.22,  $p < 0.05$  for HIV negative and OR = 5.01,  $p < 0.05$  for HIV positive individuals). Concerning education, the awareness of HIV status compared to unawareness was higher among those with primary education versus no education (OR = 1.56 and 1.96 for HIV negative and positive individuals, respectively). The odds of knowing one's HIV status was even higher for individuals with secondary (OR = 2.31,  $p < 0.05$ ) and university (OR = 4.65,  $p < 0.05$ ) education for HIV negative people.

**Table 4:** HIV Concordance.

	HIV Test Results		
	No (%)	Yes (%)	Total
<b>Known HIV Status</b>			
Positive	13 (1.2)	1114 (98.8)	1127
Negative	20,178 (97.7)	480 (2.3)	20,658
Unknown	10,549 (97.2)	301 (2.8)	10,850

Also, with wealth in the fifth quintile as the reference, being HIV negative compared to unknown status, people in lower quintiles of wealth were more likely to know their HIV status as negative (OR = 0.54, 0.66, and 0.80 for lowest, second and middle wealth quintiles, in that order). We also found that people who had early sexual debut were less likely to be known HIV negative. The odds were 0.59 and 0.83 lower than those whose sexual debut was after 25 years for people younger and 15 years and those 15-24 years, respectively.

Table 4 shows the concordance between the knowledge of HIV and testing results among the respondents. About 99% of those who claimed that they were HIV positive had a positive testing result. Similarly, about 98% of those who reported a negative HIV status also tested negative, and only 2.8% of individuals with unknown HIV status tested as positive.

## Discussion

This is a population-based study that focused on the knowledge of HIV status among adults and how it is influenced by their sexual behaviors. In our study, we categorized the participants into three: HIV positive, HIV negative, unknown HIV status. These categories of HIV status correspond with the HIV test result from biomarkers taken during the survey (Table 4). A meta-analysis study by Funnor, et al. [11] revealed that voluntary testing (VCT) and awareness of status improved sexual behaviors in both positive and negative individuals, that is, VCT can have a significant effect on reducing HIV-related risky behavior for all participants, regardless of serostatus. Given that most of the participants in our study who reported knowledge of their HIV status were correct, we expected this to influence their sexual behaviors.

We found that men were more likely to have experienced anal sex, transactional sex, have multiple sexual partners, and use condoms (Table 1). Gender differences in sexual practices have been established in similar populations [12]. The influence of sociodemographic characteristics on the relationship between sexual behavior and HIV status was explored in a better fitting model that adjusted for these characteristics. In the adjusted model, the odds of knowing one's HIV status (negative or positive) with increasing age is approximately one. That this was statistically significant can mean a closing gap in HIV testing and status awareness across age groups in

Tanzania. The disease burden of HIV among adolescents and young people is higher as it has been established that young people continue to be disproportionately affected by HIV [13]. Empowering this vulnerable population with the knowledge of their HIV status is key to promoting safer sexual practices that will invariably reduce transmission rates. This study showed no difference in the knowledge of HIV status across ages suggesting a balanced effort towards achieving the 1<sup>st</sup> of the UNAIDS 90-90-90 targets across age groups in this population.

When compared with men, women were two times and five times more likely to be HIV negative and HIV positive, respectively. Existing literature establishes higher testing and positive rates among women, congruent with our findings in this study [8,14,15]. Besides from the possibility that women have better health seeking behavior than men, the role of HIV testing in antenatal care may be magnified here. In the Tanzanian population and indeed in Sub-Saharan Africa, women's economic dependence on men, and their limited power in negotiating safe sex have been noted to account for low condom use and other unsafe sexual practices among women [2]. While interventions to increase testing among men are key, women must remain high priority targets for HIV prevention efforts.

Comparing the wealth quintiles, we found a lower chance of knowing one's HIV status among individuals in the lower wealth quintile. Our study also revealed that among those who knew their HIV status, those with university education had five times a higher odd of being HIV negative than those with no education. Though not statistically significant, the odds of being HIV positive was 50% lower comparing the same education levels. In addition, we found a statistically significant increase in the likelihood of being negative with increasing level of education. These findings are consistent with studies that endorse higher testing rates and lower HIV positivity among wealthier and better educated populations [16-19]. If the targets set by UNAIDS must be met in Tanzania, there must be more strategies to address these inequalities [20].

Safer sexual practices were significantly associated with the knowledge of HIV status. In the crude model, people who engage in transactional sex or consume alcohol before sex were less likely to be HIV negative individuals. Additionally, having multiple sexual partners (not statistically significant in the adjusted model), the use condoms for sex, and being in a form of sexual union (polygamous and non-polygamous) were associated with increased odds of being HIV negative or positive individuals. After adjusting for sociodemographic characteristics, there remained evidence of these safer sexual practices among those who knew their HIV status compared with those who did not know their status. This is in keeping with existing literature that

knowledge of one's HIV status helps individuals to make better choices with regards to practicing safe sex [11]. Therefore, concerted efforts to promote testing must continue to be pursued to achieve and even, surpass the target set by UNAIDS.

Our study revealed that people who use alcohol before sex were more likely to HIV positive than those who do not when compared with unknown HIV status. Certain studies have shown a correlation between alcohol use and unsafe sexual practices among HIV positive men [21]. Alcohol use is also associated with increased risk of HIV acquisition in adults [22]. In our study population, it is possible that the association with alcohol use is reactive to being HIV positive as some may use alcohol to drown their perceived misfortune of being HIV positive. However, we also acknowledge that alcohol intoxication may have been a risk factor in the acquisition of HIV among these positive individuals. Either way, it is important to promote the integration of services that address alcohol use disorder in routine HIV care given known association between alcohol use disorder, incomplete adherence, and antiretroviral (ART) treatment failure among HIV positive individuals [15,23,24].

We found a strong association between knowledge of HIV status and condom use. People who use condoms during intercourse had a two-times likelihood of being HIV negative compared to people with unknown HIV status. Moreover, the use of condoms also increased the likelihood of being HIV positive, compared to those who do not know their HIV status, by at least five times more than those who do not use condoms. Empirical evidence from two African countries have shown that knowing one's HIV status leads to increased condom use as a means of reducing HIV transmission [2]. Our findings are consistent with this in the Tanzanian population studied indicating that condom use remains well-accepted among people informed about HIV. Given that people with unknown HIV status in our study population used condoms less, concern remains that those who do not use condoms regularly are less informed about HIV preventive measures. Hence, there is room for more HIV education in sub-Saharan Africa.

We found that being in any form of sexual union significantly increased the odds of knowing one's HIV status. Though some were in polygamous unions, commitment to the same set of sexual partners likely limits the spread of HIV. Moreover, it is possible that having faithful sexual partners fostered a commitment to regular HIV testing. Analyses of survey data from Malawi and Uganda revealed higher HIV prevalence among people who were not in marital unions [8,22,25,26]. This is consistent with our findings and suggests a need to encourage more testing and safer sexual practices among sexually active individuals who are not in committed relationships.

Though only the association with negative status was statistically significant, our analysis revealed decreased odds of known HIV status with decreasing age at sexual debut. Less sexual health education and sexual coercion, especially among female adolescents, are associated with younger age of sexual debut [27,28]. Age at sexual debut has also been shown to correlate with subsequent risky sexual behavior. On average, those with younger ages at debut have more partners and a higher risk of HIV [29-31]. In our study population, it is possible that individuals in our study who experienced sexual debut at a younger age were less likely to subject themselves to HIV testing perhaps, out of fear of knowing their status in the setting of likely risky sexual behavior. Our findings support emphasizing later age of sexual debut as part of routine sexual health education for adolescents and young adults [31].

Indeed, the 2020 Global AIDS Update reported that many countries, though making valiant strides, are yet to achieve the 90-90-90 targets set for 2020 [32]. There is evidence of remarkable but highly unequal progress, notably in expanding access to antiretroviral therapy. Because the achievements have not been shared equally within and between countries, the global HIV targets set for 2020 were not reached [33]. This survey analysis has revealed important findings that can guide HIV policies and interventions in Tanzania to facilitate achieving the newly set 95-95-95 goals for 2030.

Though useful insights were gained from this study, we identified some limitations. First, secondary data was used, which constrained the variables of interest. For instance, our intention was to examine the association between the frequency of condom use and HIV status, however, the variable was not available in the dataset. Second, causality could not be established because the results from this study were from cross-sectional data collection. Longitudinal studies on how HIV status awareness influences the sexual behaviors of adults are needed to establish causality. Third, being a cross-sectional design, the study is susceptible to recall bias, interviewer bias or social acceptability bias. Despite these limitations, this is one of the few studies that utilized nationally representative data to assess HIV status and sexual behaviors in Africa. Therefore, future interventions can leverage the findings here to proffer population-scale solutions to the gaps identified in Tanzania.

## Conclusion

In summary, our findings reveal that there were gender differences in sexual behaviors, including engaging in anal and transactional sex. We also found that people who use condoms during sexual intercourse and those in any form of sexual relationships were more likely to know their HIV status than those who do not use condoms for sex and single individuals. We recommend more interventions targeted at the



following: increasing HIV testing among men, people with low level of education (primary or less), low income, and people not in committed sexual unions; providing preventive HIV education to adolescents and young adults, women (especially those who are not in committed sexual unions), and people with low level of education and income; providing treatment services for alcohol use disorder as part of routine HIV care. These concerted efforts must continue to ensure the incidence and prevalence of HIV in sub-Saharan Africa is driven downward significantly as soon as possible.

## Competing Interests

The authors declare that they have no competing interests.

## Authors' Contributions

A.A.A, O.A., S.C.O., O.E.E., and N.A.U. contributed to this research. All authors have read and approved the final manuscript. They all conceptualize the research. A.A.A. designed the research methodology, data analysis, and results. O.A had major contributions to the introduction and discussions sections. Also did the final editing of the manuscript for journal submission. SCO prepared the introduction section. OEE and NAU prepared the discussion and conclusion sections.

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