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Pregnancy outcomes and HIV among women in Northwest Tanzania

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Abstract

Background: Adverse pregnancy outcomes are rampant across Sub Saharan Africa (SSA) and significantly increase the risk of neonatal deaths. HIV infection is a key contributor to adverse pregnancy outcomes and has a disproportionately high burden among women in SSA and Tanzania. Socio-demographic factors and care-seeking behaviors can either exacerbate or prevent HIV infection and adverse pregnancy outcomes.

Objectives: This study aims to determine HIV prevalence by age, residence, marital status, and education and to determine how pregnancy outcomes are impacted by HIV infection, the use of health services, and socio-demographic factors.

Methods: This study utilized secondary data from an epidemiological Serosurvey Round 8 (2015-2016) within the Kisesa HIV cohort in Magu District, Mwanza, Tanzania. All data were analyzed using the statistical software "Stata Version 17.0." The variables were re-coded for operational use and cross-tabulations with chi-squared tests and logistic regression models were conducted.

Results: Data analysis showed an HIV prevalence of 9.5% among women who had been pregnant before. HIV positive women were more likely to lose a child (AOR=1.4; 95% CI: 1.1,1.7). Women with higher education had significantly lower odds of adverse pregnancy outcomes as compared to women with no formal education (AOR=0.5; 95% CI: 0.4, 0.7). Women with more children, especially 10+ children, also had higher odds of adverse outcomes as compared to mothers with 1-3 children (AOR=25.1; 95% CI: 17.0, 37.0). Elderly mothers had seven times the odds of losing a child as compared to young mothers (AOR=6.2; 95% CI: 2.2, 17.6).

Conclusions: This study provides needed insight into factors that contribute to HIV infection and adverse pregnancy outcomes. The results support the implementation of new policies that target HIV prevention and treatment among women and emphasize maternal education to reduce adverse pregnancy outcomes.

Background

The improvement of maternal, reproductive, and child health in Tanzania has been a major goal for the country since the early 21st century. Tanzania's 2022 Demographic and Health Survey (DHS) reported that 10% of pregnancies result in adverse outcomes, including 8% miscarriages and 0.2% stillbirths (1). Factors associated with decreased adverse pregnancy outcomes include higher education, socioeconomic status, and increased antenatal care follow-up (2). Conversely, intimate partner violence, multiparity, anemia during pregnancy, and limited involvement of women in healthcare decision-making have been associated with increased adverse outcomes (3, 4).

HIV infection significantly exacerbates neonatal and maternal mortality (5). HIV-positive pregnant women have increased risks of spontaneous miscarriage, stillbirth, and intrauterine growth restriction (5). They also risk vertical transmission, or the spread of HIV from mother to child during pregnancy, labor, or breastfeeding. Without treatment, 15–45% of HIV-positive women transmit HIV to their infants (6). If transmitted, one-third of HIV-positive children in Sub-Saharan Africa (SSA) die before their first birthday, and over one-half die before their second birthday (7). Given the substantial impact of HIV on pregnancy outcomes, HIV remains a key area of focus for improving reproductive and child health in Tanzania.

Globally, 38.4 million people are living with HIV (PLHIV), with 630,000 HIV-related deaths reported in 2022 (8). However, HIV burden is disproportionately concentrated in SSA, where 67% of PLHIV reside despite the region representing a smaller proportion of the global population (9, 10).Women and girls experience a particularly high burden, with 95% of HIV-positive women living in SSA (7). This disparity is influenced by biological, social, and structural factors, including increased biological susceptibility to transmission, gender-based violence, and economic vulnerabilities that may contribute to transactional sex (11).

Tanzania is among the countries most affected by HIV in SSA, with an estimated HIV prevalence of 4.7% (12, 13). Prevalence is higher among women (6.2%) than men (3.7%) (14). Despite prevention efforts, approximately 25% of HIV-positive women in Tanzania continue to transmit HIV to their infants (15). HIV infection has also been associated with decreased fertility among Tanzanian women compared with HIV-negative women (16).

Antiretroviral therapy (ART) decreases HIV-related morbidity, mortality, and infectiousness among PLHIV (17-19). Prevention of mother-to-child transmission (PMTCT) programs incorporate ART into maternal care and can reduce vertical transmission rates to below 1% (7). However, nearly 50% of HIV-positive pregnant women in SSA do not access PMTCT services due to limited knowledge, inadequate healthcare access, and HIV stigma (7). HIV Counseling and Testing (HCT) can improve knowledge regarding HIV status, transmission, and prevention, while also facilitating linkage to ART care (20). HCT knowledge has additionally been associated with decreased risky sexual behaviors (21). The 2022 Tanzania DHS found that 60.2% of young women aged 15–24 years had undergone HIV testing, although barriers to HCT utilization remain, particularly among men (22, 23).

In Tanzania, integrating PMTCT into maternal, neonatal, and child health services has enabled approximately three-quarters of women with HIV to access PMTCT and reduce vertical transmission (24). This progress has required decentralization of PMTCT services from hospitals to primary care centers (25). However, structural barriers continue to limit utilization, particularly among the 70% of Tanzanian women living in rural areas (26, 27). These barriers include low socioeconomic status, limited antenatal care availability, long travel distances, inadequate obstetric care, and shortages in the healthcare workforce (26-28). Consequently, rural women have lower utilization of skilled birth services compared with urban women, potentially contributing to poorer pregnancy outcomes (27). Tanzania also continues to experience high ART attrition rates, particularly among women after delivery (29).

Given the significant burden of HIV and adverse pregnancy outcomes among women in SSA, this study examined factors associated with HIV prevalence and pregnancy outcomes among women in the Mwanza region of Northwest Tanzania. Understanding sociodemographic characteristics and care-seeking behaviors that influence HIV infection, PMTCT uptake, HCT utilization, and ART continuation may inform interventions to improve maternal and child health outcomes.

This study conducts a uniquely comprehensive analysis of variables that impact pregnancy outcomes in Mwanza, exploring factors from sociodemographic variables to care-seeking behaviors to HIV status. This study aimed to identify such factors associated with HIV prevalence and pregnancy outcomes among women who have been pregnant before in Mwanza, Tanzania. This information is critical for designing targeted interventions to reduce HIV transmission and improve pregnancy outcomes.

Methodology

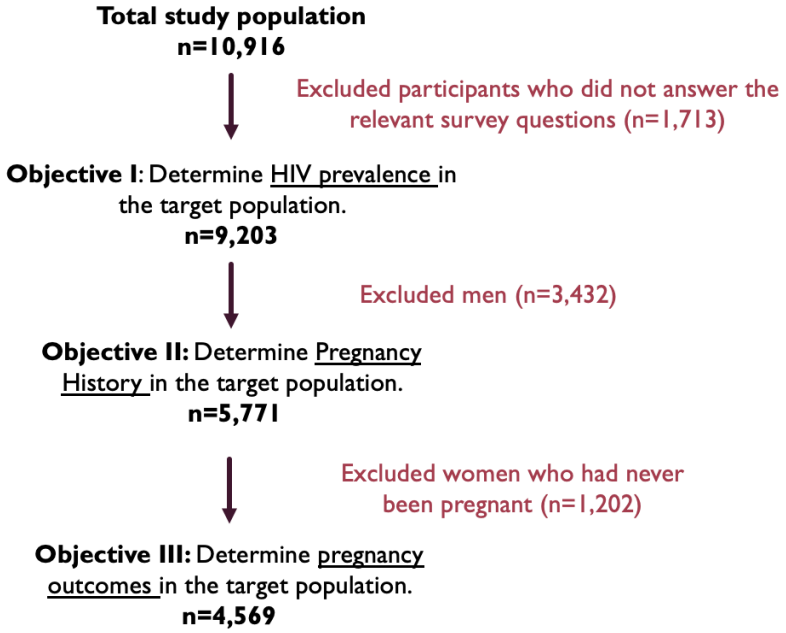
Data collection

The data for this study were obtained from an epidemiological serosurvey implemented during 2015-2016 within the Magu Health and Demographic Surveillance System (HDSS), also known as the Kisesa observational HIV cohort in Mwanza Region, Northwest Tanzania. Details regarding Magu HDSS survey methodology have been published in the International Journal of Epidemiology (30). Briefly, the interviews were conducted in central, private huts and utilized structured questionnaires that were translated from English to Swahili. Participants were asked about their socio-demographic characteristics, sexual behaviors, birthing history, use of family planning and health services, knowledge about HIV, and other related topics.

Inclusion criteria

Figure 1 shows how the total study population (n=10,916 participants) was narrowed down to the target sample (n=4,096).

Figure 1: Flowchart of the Target Study Population Inclusion Criteria



Objectives

The study objectives were two-fold: Firstly, to describe HIV prevalence among women who have been pregnant in Northwest Tanzania including their age, education level, employment status, marital status, and residence status. Second, to determine how pregnancy outcomes are influenced by HIV Status, HIV care-seeking behaviors, and demographic characteristics (residence, age, education level, employment status, marital status, and number of children).

Study variables

Relevant demographic questions covered age, village of residence, sex, marital status, occupation, education level, and number of children. Other relevant survey questions asked about pregnancy history (losses, still-births, miscarriages), use of HCT services, and health service use in the past year. HIV status was determined from lab results. **Table 1** shows the recoding and categorization of study variables.

Table 1: Recording and Categorization of the Variables

Note: Table 1 Located at the end of manuscript per formatting guidelines

Data analysis

All analyses were performed using "Stata Version 17.0" (Stata Corporation, College Station, TX, USA). After variable recoding, descriptive statistics were generated using frequency tabulations. Bivariate analyses using chi-square tests evaluated associations between HIV status and sociodemographic characteristics, including residence, education, employment status, age, and marital status. Similar analyses examined associations between pregnancy outcomes and demographic characteristics, HIV status, and care-seeking behaviors.

Multivariable logistic regression models were used to assess associations between pregnancy outcomes and selected exposure variables. Prior to regression analysis, pregnancy outcomes were dichotomized into two categories: "No Losses" and "Lost 1 or More Children." Statistical significance was defined as a P-value <0.05.

Ethical considerations

Data were accessed from 27 October 2023 to 26 October 2024. A confidentiality contract was signed by the researchers to ensure that the data were stored safely and privately and removed from personal devices following study completion.

Results

Socio-demographic Characteristics of Target Study Participants

Table 2 shows socio-demographic characteristics of target study participants. There were 4,096 women who had been pregnant before who were included. Thirty three percent of women had not received any formal education, while 10% had completed secondary or higher education. For occupation, nearly one quarter of the women (23.8%) did not work, while 70.2% of women were involved in some form of unskilled labor. Sixty one percent of the population were in monogamous marriages and 7.8% were polygamously married. Participants were primarily aged 15-29 years old (38.7%) and 30-44 years old (35.4%). The median age of the survey participants was 33 years (IQR 25 – 45).

Table 2: Socio-Demographic Characteristics of Target Sample of Previously Pregnant Women (N=4,096)

	N= 4,096 **n (%)**
Residence Status	
Semi-Urban	2,066 (50.4)
Rural	2,030 (49.6)
Education	
None	1,373 (33.5)
Primary	2,314 (56.5)
Secondary or Higher	409 (10.0)
Employment Status	
Student	36 (0.9)
Doesn't Work	976 (23.8)
Unskilled Labour	2,877 (70.2)
Skilled Labour	1 (0.0)
Self-Employed	206 (5.0)
Marital Status	
Never Married	312 (7.6)
Monogamously Married	2,507 (61.2)
Polygamously Married	321 (7.8)
Widowed	412 (10.0)
Separated / Divorced	544 (13.3)
Age (Years)	
Young Women (15-29)	1,584 (38.7)
Middle-Aged Women (30-44)	1,452 (35.4)
Older Women (45-59)	721 (17.6)
Elderly Women (60+)	339 (8.3)
	Median Age (IQR) 33 (24 – 45)

HIV Status is significantly associated with Age, Education Level, and Marital Status

HIV status was studied as function of socio-demographic variables in **Table 3**. Nearly ten percent (9.5%) of the women studied were HIV positive. Differences in HIV prevalence by residence were not statistically significant (P=0.142). HIV prevalence was highest among those with no formal education (12.2%) and lowest among those with higher education (3.7%) (P <0.001). Employment status was also found to be significantly associated with HIV, with the highest HIV prevalence amongst those performing unskilled labor (10.4%) or those who were unemployed (8.3%). No HIV positivity was found in students and those performing skilled labor (P = 0.011). HIV prevalence also differed significantly by the age of participants; HIV prevalence was 13.4% among participants in the middle-age group and 11.0% in the older age group, and there were lower prevalences of HIV in the youngest (6.1%) and eldest (5.6%) age groups (P <0.001). Separated or divorced women had the highest HIV prevalence at 15.4%, and women who were monogamously married had the lowest HIV prevalence at 7.1% (P<0.001)

Table 3: HIV Status by Socio-Demographic Characteristics (N=4,096)

	HIV Negative	HIV Positive	Total	P-Value*
	N= 3,707 (90.5%)	N= 389 (9.5%)		
	n (%)	n (%)	n	
Residence Status				
Semi-Urban	1,856 (89.8)	210 (10.2)	2,066	0.142
Rural	1,851 (91.2)	179 (8.8)	2,050	
Education				
None	1,205 (87.8)	168 (12.2)	1,373	
Primary	2,108 (91.1)	206 (8.9)	2,314	< 0.001
Secondary or Higher	394 (96.3)	15 (3.7)	409	
Employment				
Student	36 (100.0)	0 (0.0)	36	
Doesn't Work	895 (100.0)	81 (8.3)	976	
Unskilled Labour	2,579 (89.6)	298 (10.4)	2,877	0.011
Skilled Labour	1 (100.0)	0 (0.0)	1	
Self-Employed	196 (95.2)	10 (4.9)	206	
Age (Years)				
Young Women (15-29)	1,488 (93.9)	96 (6.1)	1,584	
Middle-Aged Women (30-44)	1,257 (86.6)	195 (13.4)	1,452	
Older Women (45-59)	642 (89.0)	79 (11.0)	721	< 0.001
Elderly Women (60+)	320 (94.4)	19 (5.6)	339	
Marital Status				
Never Married	277 (88.78)	35 (11.22)	312	
Monogamously Married	2,329 (92.90)	178 (7.10)	2,507	
Polygamously Married	291 (90.65)	30 (9.35)	321	< 0.001
Widowed	350 (84.95)	62 (15.05)	412	
Separated / Divorced	460 (84.56)	84 (15.44)	544	

*P-value measures if there is a significant difference in HIV prevalence as a function of sociodemographic characteristics.

Pregnancy outcomes are significantly associated with key demographic variables and HIV status.

Table 4 presents pregnancy outcomes by demographic characteristics, HIV status, and care-seeking behaviors. Education level was significantly associated with pregnancy outcomes, with higher educational attainment associated with fewer adverse outcomes and a greater proportion of women reporting no losses ($P<0.001$). Older maternal age at last pregnancy was also associated with increased adverse outcomes, with older mothers experiencing higher rates of child loss compared with younger mothers (21.4% vs. 2.8%; $P<0.001$).

Marital status and parity were significantly associated with pregnancy outcomes ($P<0.001$). Widowed women experienced the highest proportion of child loss and multiple adverse events, while never-married women had the highest proportion of no losses. Increasing number of children was associated with progressively fewer women reporting no losses, declining from 77.5% among women with 1–3 children to 9.2% among women with 10+ children ($P<0.001$).

HIV status was also significantly associated with pregnancy outcomes ($P=0.013$), with HIV-positive women reporting fewer pregnancies without losses and a higher proportion of child loss compared with HIV-negative women. Although residence status, employment status, HCT use, and general health service use were significantly associated with pregnancy outcomes, no consistent trends were observed across categories.

Table 4: Pregnancy Outcomes by HIV Status, Demographic Variables, and Care-Seeking Behaviors (N=4,096)

Note: Table 1 Located at the end of manuscript per formatting guidelines

Logistic regression shows that dichotomized pregnancy outcomes are associated with education level, age at last pregnancy, number of children, and HIV status.

Table 5 presents univariate and multivariable logistic regression analyses examining dichotomized pregnancy outcomes ("No Losses" vs. "Lost 1+ Child"). In adjusted analyses, education level, age at last pregnancy, number of children, separated/divorced marital status, and HIV status were significantly associated with pregnancy outcomes. Compared with women with no formal education, women with primary education (AOR=0.8; 95% CI: 0.7, 0.9) and secondary education or higher (AOR=0.5; 95% CI: 0.4, 0.7) had lower odds of child loss. Older maternal age at last pregnancy was associated with increased odds of loss (AOR=6.2; 95% CI: 2.2, 17.6), as was higher parity, with women reporting 10+ children having substantially higher odds of loss compared with women with 1–3 children (AOR=25.1; 95% CI: 17.0, 37.0). Separated or divorced women had higher odds of child loss compared with married women (AOR=1.6; 95% CI: 1.1, 2.3), while other marital statuses were not significantly associated with outcomes. HIV-positive women also had higher odds of child loss compared with HIV-negative women (AOR=1.4; 95% CI: 1.1, 1.7).

Table 5: Logistic Regression Associations between Dichotomized Pregnancy Outcomes ("No Losses" vs "Lost 1+ Child Ever") and Sociodemographic Variables, HIV Status, and Health Service Use (N=4,096)

	OR (95%CI)	P-Value	AOR (95%CI)	P-Value*
Residence Status				
Rural	*ref.*	0.938		
Semi-Urban	1.0 (0.9 – 1.1)			
Education				
None	*ref.*			
Primary	0.5 (0.4 – 0.6)	<0.001	0.8 (0.7 – 0.9)	0.006
Secondary or Higher	0.2 (0.2 – 0.3)		0.5 (0.4 – 0.7)	<0.001
Age At Last Pregnancy (Years)				
Young Women (15-29)	*ref.*			
Middle-Aged Women (30-44)	2.4 (1.8 – 3.3)	<0.001	2.1 (1.7 – 2.6)	<0.001
Older Women (45-59)	4.2 (2.9 – 6.2)		4.5 (3.1 – 6.6)	
Elderly Women (60+)	5.6 (2.2 – 13.9)		6.2 (2.2 – 17.6)	
Employment Status				
Doesn't Work	*ref*			
Unskilled Labour	1.2 (1.0 – 1.4)	0.014	1.1 (1.0 – 1.4)	0.154
Self-employed	0.7 (.5 – 1.0)	0.036	1.2 (0.9 – 1.8)	0.260
Student	0.7 (0.4 – 1.5)	0.399		
Skilled Labour	*Omitted*^			
Marital Status				
Never Married	r*ef.*			
Monogamously Married	2.2 (1.7 – 2.93)		1.2 (0.9 – 1.6)	0.254
Polygamously Married	3.4 (2.4 – 4.8)	<0.001	1.3 (0.9 – 2.0)	0.141
Widowed	9.7 (6.9 – 13.8)		1.5 (1.0 – 2.2)	0.074
Separated / Divorced	3.9 (2.9 – 5.4)		1.6 (1.1 – 2.3)	0.007
Number of Children				
1-3	Ref.			
4-5	2.8 (2.3 – 3.3)	<0.001	2.6 (2.2 – 3.1)	<0.001
6-9	6.0 (5.1 – 7.0)		4.9 (4.1 – 5.8)	
10+	43.8 (30.8 – 62.2)		25.1 (17.0 – 37.0)	
HIV Status				
Negative	*ref.*			0.035
Positive	1.4 (1.1 – 1.7)	0.002	1.4 (1.1 – 1.7)	
HCT Use				
No	*ref.*			
Yes	1.0 (0.9 – 1.1)	0.848		
General Health Service Use				
Infrequent	*ref.*			
Moderate	1.0 (0.9 – 1.2)	0.816		
Consistent	1.0 (0.8 – 1.1)	0.636		

OR=Odds ratio; AOR=Adjusted odds ratio; ref=reference group

*P-value measures if there is a significantly higher risk of "Losing 1 or More Children" as a function of the exposure variables.

^ The category of "Skilled Labor" perfectly predicted the outcome; The single participant in this group "Lost 1 or more child" (100%). Consequently, this category was omitted from the logistic regression model due to perfect prediction.

Discussion

In all, the study found many associations between HIV status, pregnancy outcomes, and key sociodemographic variables and care-seeking behaviors among previously pregnant women. HIV status was found to be significantly associated with age, education level, and marital status **(Table 3).** Evidence from regression analysis showed that pregnancy outcomes were associated with education level, age at last pregnancy, number of children, HIV status, and a marital status of divorced or separated **(Table 5).**

HIV Status

This study reported an HIV prevalence of 9.5% among women who had previously been pregnant. National data from UNAIDS Tanzania estimate HIV prevalence at 6.2% among women and 4.6% in the general population (31). Additionally, prior research from the Magu HDSS has demonstrated similar HIV prevalence trends compared with national surveys (30). Therefore, the higher HIV prevalence observed among women with prior pregnancies suggests the need for targeted HIV prevention and treatment strategies within this population.

HIV infection was significantly associated with education level ($P<0.001$), with lower HIV prevalence among women with higher educational attainment. These findings align with studies from other East African countries (32), although they differ from a Tanzanian health survey that reported higher HIV prevalence among individuals with greater education (33). Notably, education may serve as a proxy for socioeconomic status and related disparities in healthcare knowledge, access, and quality, which may contribute to differences in HIV risk (34).

Employment status was also significantly associated with HIV status ($P=0.011$), with the highest HIV prevalence among women engaged in unskilled labor (10.4%) and those not employed (8.3%). These findings differ from previous Tanzanian research showing higher HIV risk among women in professional

occupations; however, interpretation of skilled employment in our study is limited by the small number of participants in this category (n=1) (35).

Age was significantly associated with HIV status (P<0.001), with the highest prevalence among women aged 30–44 years. This finding is consistent with previous studies reporting peak HIV prevalence among middle-aged adults (13). The increased prevalence among this age group may relate to relative exposure to HIV risk factors, including higher prevalence of polygynous relationships in middle-aged Tanzanians (35-49 years), which have been associated with increased HIV risk in SSA (36, 37). Similarly, this study observed higher HIV prevalence among women in polygamous marriages compared with monogamous marriages (9.35% vs. 7.10%; P<0.001), although polygamous marriage was not significantly associated with pregnancy outcomes after adjustment (AOR=1.3; 95% CI: 0.9, 2.0; P=0.141).

Finally, HIV prevalence was highest among separated/divorced women (15.55%) and widowed women (15.05%). Similar findings have been reported in South Africa, where widowed women had nearly twice the risk of HIV infection compared with married women (37). These findings suggest that marital status may represent an important social determinant of HIV risk among women in SSA.

Pregnancy Outcomes

Education level was significantly associated with pregnancy outcomes in both chi-squared and logistic regression analyses (P<0.001). Women with higher education had lower odds of child loss compared with women with no formal education (AOR=0.5; 95% CI: 0.4, 0.7). These findings align with previous research demonstrating that maternal education improves birth preparedness and reduces risk factors associated with neonatal mortality (38, 39), supporting the importance of expanding educational opportunities for women.

Maternal age at pregnancy was also significantly associated with adverse pregnancy outcomes (P<0.001). Older mothers had substantially higher odds of child loss compared with younger mothers (AOR=6.2;

95% CI: 2.2, 17.6). Similar findings have been reported in Tanzania, where prenatal complications and stillbirths were highest among women aged 35–50 years (40). However, additional research is needed to clarify the risk associated with younger maternal age, as adolescent pregnancies may also contribute to adverse outcomes due to increased risk of obstetric complications (41, 42).

HIV status was significantly associated with adverse pregnancy outcomes, with HIV-positive women having higher odds of child loss compared with HIV-negative women (AOR=1.4; 95% CI: 1.1, 1.7; P=0.035). These findings are consistent with studies from Tanzania and other SSA settings demonstrating increased risks of perinatal mortality among HIV-positive mothers (43-45).

Parity was strongly associated with adverse pregnancy outcomes, with women reporting 10 or more children having substantially higher odds of child loss compared with women with 1–3 children (AOR=25.1; 95% CI: 17.0, 37.0). This finding is consistent with prior research from Northern Tanzania showing that grand multiparity is associated with increased adverse pregnancy outcomes (46).

Regarding marital status, divorced or separated women had significantly higher odds of losing a child (AOR=1.6; 95% CI: 1.1, 2.3). These findings align with DHS data from East Africa demonstrating higher rates of stillbirth among divorced/separated and widowed women (47). Although widowed women in our study had a higher prevalence of stillbirth, this association was not significant after adjustment, potentially due to the smaller sample size of widowed participants (n=421). Similarly, a case-control study in the Southern Highlands of Tanzania found that pregnant women without partners had higher rates of hypertensive and hemorrhagic disorders (48). However, these findings do not fully explain the lower or nonsignificant odds of adverse pregnancy outcomes observed among other non-married and widowed women in our study. Additionally, while polygynous marriage was not associated with pregnancy outcomes in our analysis, prior studies have reported conflicting associations between polygyny and reproductive outcomes in SSA (49, 50) (52, 53). Further research with larger sample sizes is needed to clarify the relationship between polygynous marital status and pregnancy outcomes in Tanzania.

Although chi-squared analyses identified significant differences in pregnancy outcomes by residence, employment status, general health service use, and HCT use, these associations were not significant after adjustment in logistic regression. Residence status may be particularly complex in Tanzania, where urban areas paradoxically experience higher neonatal mortality despite greater healthcare access, potentially due to differences in mortality reporting and healthcare utilization patterns (27, 51, 52). Employment-related factors, including agricultural work and physically demanding occupations, have been associated with adverse pregnancy outcomes in Tanzania and other settings (53, 54). Similarly, antenatal care utilization is generally associated with improved maternal and neonatal outcomes, and HCT may indirectly improve pregnancy outcomes through prevention of HIV-related complications and increased access to care (55, 56) (57). However, limited research has directly evaluated the relationship between HCT and pregnancy outcomes. Future studies with larger samples are needed to further investigate these relationships.

Strengths and Limitations

This study has several limitations worth mentioning. First, as a secondary analysis of serosurvey interviews relying on participant recall, the data are subject to recall and response bias. Additionally, the serosurvey did not distinguish between preventative and curative healthcare visits. Therefore, although increased healthcare utilization may reduce adverse outcomes, frequent healthcare use may also reflect underlying illness severity, potentially contributing to the nonsignificant findings for the "General Health Service Use" variable in logistic regression.

The serosurvey also lacked information on maternal mortality and socioeconomic status, limiting the ability to assess these important determinants of pregnancy outcomes and HIV status. Furthermore, few existing studies use a similar reference population of women who have previously been pregnant, limiting direct comparison with prior literature while highlighting the need for further research in this population. Finally, rural and semi-urban residence classifications may not fully capture the diversity of environments within the study districts, potentially limiting comparisons with other studies.

Despite these limitations, this study provides valuable insight through the analysis of self-reported pregnancy histories, child survival outcomes, and healthcare behaviors among women in Northwest Tanzania, a population with limited representation in existing literature. Additionally, this study is among the first to examine the relationship between HCT and pregnancy outcomes in SSA. These findings may inform future research and policies aimed at improving pregnancy outcomes and reducing the burden of HIV in Tanzania.

Conclusion and Future Directions

This study contributes to the growing body of HIV research by providing insight into the relationship between HIV infection, pregnancy outcomes, and sociodemographic factors among women in Northwest Tanzania. The findings support continued prioritization of HIV prevention and care for women, including expansion and decentralization of PMTCT and HCT services to primary healthcare centers and strengthening of community health worker programs to address rural healthcare workforce shortages.

Future research should further investigate sociocultural factors influencing HIV transmission, including sexual practices within polygamous, widowed, and divorced populations, and evaluate community-based interventions promoting HIV prevention and safe sexual practices. Additionally, further studies should explore how maternal education and reproductive health counseling may reduce adverse pregnancy outcomes associated with advanced maternal age and grand multiparity, including through community-based outreach programs targeting women of reproductive age.

Larger longitudinal and experimental studies are needed to evaluate these relationships over time and determine the effectiveness of interventions. For example, prospective evaluations of expanded HCT or PMTCT services across rural and semi-urban districts could assess their effects on HIV status, healthcare utilization, and pregnancy outcomes. Future studies should also incorporate information from additional family members to better capture maternal mortality outcomes, which may be missed when relying solely

on maternal interviews. Such research can help establish evidence-based strategies for improving maternal health services and HIV care in Tanzania, ultimately informing policies regarding healthcare workforce capacity and resource allocation.

Declarations

Ethics approval, consent to participate, and consent for publication: The original survey study obtained informed consent from all its participants and provided follow-up testing, counseling, and treatment to better participants' health following the survey. The serosurvey received approval from the Tanzania Medical Research Review Committee, through a certificate with reference number: NIMR/HQ/R.8a/Vol.IX/1489. The current study conducted secondary data analysis using anonymized data from the serosurvey, round 8. No contact was made with the original survey participants. As such, no consent for publication needed to be obtained. This study received ethical clearance from the Tanzania Medical Research Coordinating Committee, with certificate number: NIMR/HQ/R.8a/Vol.IX/4444.

Availability of data and materials: The Magu HDSS data that support the findings of this study can be found at the National Institute for Medical Research office in Mwanza. Data can also be accessed through the INDEPTH Network's repository operator, at https://www.indepth-ishare.org/index.php/catalog/78. Demographic surveillance data and data from the epidemiological sero-survey can also be found at the "Data First" repository of the ALPHA research network, at https://www.datafirst.uct.ac.za/dataportal/index.php/catalog/903. If collaborative analyses of the data through a data-sharing agreement is desired, please contact the Centre Manager, Dr Safari Kinung'hi at (kinunghi_csm@hotmail.com).

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contributed to manuscript editing and provided feedback on the methodology. All authors read and approved the final manuscript.

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List of Abbreviations

SSA: Sub Saharan Africa

DHS: Demographic and Health Survey

PLHIV: People are living with HIV

ART: Antiretroviral therapy

PMTCT : Prevention of mother-to-child transmission

HCT: HIV Counseling and Testing

HDSS: Health and Demographic Surveillance System

OR: Odds ratio

AOR: Adjusted odds ratio

Ref: reference group

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508 **Table 1:** Recording and Categorization of the Variables

Variable	Description	Categories
Pregnancy Outcomes	Number of miscarriages, still births, or loss of children after birth that the participant has experienced	No Child(ren) Lost Spontaneous Miscarriage(s) *Defined as born early or not properly formed Still Birth(s) *Defined as born dead at the end of the pregnancy 1+ Children Lost After Live Birth *In Table 4, defined as children who died after being born alive Lost 1+ Child *In Table 5, defined as any record of child loss before, during, or after birth Multiple adverse event types *Defined as experiencing one or more of different adverse outcomes *(i.e. 1 stillbirth and 1 miscarriage, not 2 stillbirths)*.
Number of Children	Participant's total number of live births as categorized by collapsing United Nations categories (58)	1 - 3, 4 - 5, 6 - 9, or 10+ Children
HIV Status	Participant's HIV status as determined by lab results	HIV Negative or HIV Positive
HCT Use	Has the participant used HIV Counseling and Testing (HCT) before?	Yes or No
General Health Service Use	Participant's frequency of use of health services in the last year	"Infrequent Use" for 0-3 visits in the last year "Moderate Use" for 4-7 visits in the last year "Consistent Use" for 8+ visits in the last year
Residence	Participant's residence area	Rural (Igekemaja or Kitumba or Isangijo or Ihayabuyaga or Welamasonga) or Semi-urban (Kanyama or Kisesa or Wita or Bujora)
Education	Level of education that the participant has either started or completed	No formal education Attended of Completed Primary School Attended or Completed Secondary School or Higher Education
Age	Participant's age group classification per the National Institute of Health's Age Group Classifications (59)	Young Women (15-29) Middle-Aged Women (30-44) Older Women (45-59) Elderly Women (60+)
Marital Status	Marital status of participant	Never Married Monogamously Married Polygamously Married Widowed Separated / Divorced

Employment Status	Participant's employment/ occupation per the International Standard Classification of Occupations(60).	Students, Individuals Who Do Not Work, Individuals who Perform Unskilled Labor Jobs, Individuals who Performed Skilled Work, or Self-Employed Individuals (including business owners and professionals)

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510 **Table 4:** Pregnancy Outcomes by HIV Status, Demographic Variables, and Care-Seeking Behaviors

511 (N=4,096)

	Pregnancy Outcome(s)						
	No Losses N=2,330 (56.9%)	**Miscarriage (s)** N=320 (7.8%)	**Stillbirth(s)** N=64 (1.6%)	**Lost 1+ Child After Live Birth** N=1,016 (24.8%)	**Multiple Adverse Event Types*** N=366 (8.9%)	**Total n (%)**	**P-Value****
	n (%)	**n (%)**	**n (%)**	**n (%)**	**n (%)**		
Demographic Variables							
Residence Status							
Semi-Urban	1,174 (56.8)	183 (8.9)	41 (2.0)	451 (21.8)	217 (10.5)	2,066	<0.001
Rural	1,156 (57.0)	137 (6.8)	23 (1.1)	565 (27.8)	149 (7.3)	2,030	
Education							
None	603 (43.9)	80 (5.8)	21 (1.5)	499 (36.3)	170 (12.4)	1,373	<0.001
Primary	1,402 (60.6)	206 (8.9)	38 (1.6)	484 (20.9)	184 (8.0)	2,314	
Secondary or Higher	325 (79.5)	34 (8.3)	5 (1.2)	33 (8.1)	12 (2.9)	409	
Age at Last Pregnancy (Years)							
Young Women (15-29)	3,101 (95.3)	47 (1.4)	14 (0.4)	91 (2.8)	NA***	3,253	<0.001
Middle-Aged Women (30-44)	531 (89.4)	7 (1.2)	3 (0.5)	53 (8.9)	NA	594	
Older Women (45-59)	183 (82.8)	0 (0.0)	0 (0.0)	38 (17.2)	NA	221	
Elderly Women (60+)	22 (78.6)	0 (0.0)	0 (0.0)	6 (21.4)	NA	28	
Employment Status							
Student	24 (66.67)	3 (8.33)	0 (0.0)	5 (13.9)	4 (11.1)	36	<0.001
Doesn't Work	582 (59.6)	67 (6.9)	17 (1.7)	213 (21.8)	97 (9.9)	976	
Unskilled Labour	1,585 (55.1)	231 (8.0)	43 (1.5)	762 (26.5)	256 (8.9)	2,877	
Skilled Labour	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1	
Self-Employed	139 (67.5)	19 (9.2)	3 (1.5)	36 (17.5)	9 (4.4)	206	
Marital Status							
Never Married	244 (78.2)	21 (6.7)	4 (1.3)	28 (9.0)	15 (4.8)	312	<0.001
Monogamously Married	1,550 (61.8)	219 (8.7)	40 (1.6)	510 (20.3)	188 (7.5)	2,507	
Polygamously Married	165 (51.4)	22 (6.9)	4 (1.3)	89 (27.7)	41 (12.8)	321	
Widowed	111 (26.9)	14 (3.4)	6 (1.5)	214 (51.9)	67 (16.3)	412	
Separated / Divorced	260 (47.8)	44 (8.1)	10 (1.8)	175 (32.2)	55 (10.1)	544	
Number of Children							
1-3	1,411 (77.5)	163 (9.0)	27 (1.5)	171 (9.4)	48 (2.6)	1,820	<0.001
4-5	505 (55.7)	79 (8.7)	23 (2.5)	222 (24.5)	77 (8.5)	906	
6-9	382 (37.3)	66 (6.5)	12 (1.2)	429 (41.9)	134 (13.1)	1,023	
10+	32 (9.2)	12 (3.5)	2 (0.6)	194 (55.9)	107 (30.8)	347	
HIV Status							
Negative	2,138 (57.7)	286 (7.7)	59 (1.6)	897 (24.2)	327 (8.8)	3,707	0.023
Positive	192 (49.4)	34 (8.7)	5 (1.3)	119 (30.6)	39 (10.0)	389	
Care-Seeking Behaviours							

HCT Use															
No	731	(56.7)	69	(5.4)	15	(1.2)	348	(26.7)	127	(9.8)	1,290	<0.001			
Yes	1,599	(57.0)	251	(9.0)	49	(1.8)	668	(23.8)	239	(8.5)	2,806				
General Health Service Use															
Infrequent	992	(56.7)	115	(6.6)	26	(1.5)	469	(26.8)	147	(8.4)	1,749				
Moderate	566	(56.3)	87	(8.7)	12	(1.2)	254	(25.3)	87	(8.7)	1,006	0.022			
Consistent	772	(57.6)	118	(8.8)	26	(1.9)	293	(21.9)	143	(9.8)	1,341				

*Where “Multiple adverse event types” means one or more of different outcomes (i.e. one stillbirth and one miscarriage, not two stillbirths).

**P-value measures if there is a significant difference in pregnancy outcomes as a function of the exposure variables.

***The pregnancy outcome of “Multiple adverse event types” was not applicable for the demographic variable of “Age at last pregnancy” because this variable only applied to one pregnancy, meaning that multiple adverse events could not be reported.

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