

Trends and Determinants of HIV Prevalence Among Female Sex Workers in Ghana: A Decade of Evidence from National Bio-Behavioural Surveys

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Abstract

Background

Female sex workers (FSWs) in sub-Saharan Africa continue to experience a disproportionately high burden of HIV. In Ghana, national Bio-Behavioural Surveys (BBS) have documented declines in HIV prevalence among FSWs over the past decade; however, the extent to which these trends reflect programmatic gains or shifts in the composition of the sex work population remains unclear. This study assessed temporal trends in HIV prevalence, examined consistent predictors of infection, and evaluated the influence of population dynamics including duration in sex work using three rounds of nationally representative BBS data.

Methods

We conducted a pooled analysis of secondary data from the 2011, 2015, and 2020 BBS rounds. Eligible participants were biological females aged ≥ 16 years who had exchanged sex for money or gifts within the previous 6 months. Variables common to at least two survey rounds were harmonized across datasets. Descriptive statistics summarized sociodemographic, behavioural, and programmatic indicators. Bivariate analyses explored associations with HIV status, and multiple logistic regression identified independent predictors of HIV infection. A period-cohort analysis assessed changes in HIV prevalence by duration in sex work (< 5 , $5-9$, $10-14$, ≥ 15 years).

Results

The analysis included 2,707 FSWs in 2011, 4,751 in 2015, and 7,000 in 2020. HIV prevalence declined by more than half over the decade, from 10.9% in 2011 to 5.3% in 2020. The proportion of new entrants (< 5 years in sex work) increased substantially, rising from 19% in 2011 to 56% in 2020. Education remained a consistent protective factor; FSWs with tertiary education had 57% lower odds of HIV infection (AOR = 0.43, 95% CI: 0.26–0.72). Divorced and widowed FSWs exhibited significantly higher odds of infection compared with those currently married (AOR = 2.84 and 5.12, respectively). Seater FSWs were significantly more likely to test HIV-positive than roamers (AOR = 1.79, 95% CI: 1.51–2.12). Duration in sex work was strongly associated with HIV risk; those with ≥ 15 years of experience had more than double the odds of infection relative to new entrants (AOR = 2.28, 95% CI: 1.80–2.89). Cohort analysis demonstrated a consistent increase in HIV prevalence with longer duration in sex work, despite an overall decline across cohorts over time.

Conclusion

HIV prevalence among FSWs in Ghana declined markedly between 2011 and 2020; however, this trend is partly attributable to population turnover driven by an influx of newer entrants who have had less cumulative exposure to HIV risk. Persistent predictors including limited education, marital dissolution, seater-based sex work, and longer duration in sex work highlight the need for differentiated, equity-

focused HIV prevention strategies. Programmes must prioritize long-term sex workers and other structurally vulnerable subgroups to sustain progress toward epidemic control among FSWs.

Introduction

Human immunodeficiency virus (HIV) remains a major global public health concern, with 40.8 million people living with HIV worldwide in 2024, alongside 1.3 million new infections and 630,000 AIDS-related deaths recorded during that year. Despite global reductions in incidence since the late 1990s, the burden of HIV remains unevenly distributed across regions [1]. The WHO African Region carries more than two-thirds of the global HIV burden, where approximately 3.1% of adults aged 15–49 years are living with HIV, compared with the global adult prevalence of around 0.7% [2–4]. Within sub-Saharan Africa, female sex workers (FSWs) remain one of the most disproportionately affected key populations. A comprehensive meta-analysis found that HIV incidence among FSWs is approximately 7.8 times higher than among women in the general population, confirming persistent excess risk across the region [5]. Further evidence from Eastern and Southern Africa indicates a pooled HIV prevalence of 36% among FSWs, with markedly higher prevalence in some Southern African settings [6]. Although incidence among sex workers has declined in parallel with broader regional trends, data suggest that the relative burden among this population has not substantially diminished over time [7].

Globally, sex workers remain at heightened risk, with UNAIDS reporting that in 2022 the relative risk of acquiring HIV was nine times higher for sex workers compared with the general population a decline from twelve times higher in 2010 but still reflecting significant vulnerability. Structural determinants including criminalization, gender-based violence, punitive policing practices, stigma, and discrimination continue to impede access to prevention, testing, and treatment services. Global modelling work suggests that interventions addressing structural barriers, such as eliminating sexual violence or decriminalizing sex work, could avert 17–46% of HIV infections among FSWs in the coming decade across different settings, underscoring the central role of structural factors in shaping HIV risk [8].

In Ghana, HIV prevalence in the general adult population has stabilized at relatively low levels in recent years. However, FSWs continue to bear a disproportionate share of the burden, similar to trends observed elsewhere in sub-Saharan Africa [9, 10]. Although declines in HIV prevalence have been observed among FSWs over the past decade, the extent to which these reductions reflect true declines in HIV transmission versus changes in the composition of the sex work population remains unclear [11]. In particular, increases in the number of new entrants typically with shorter cumulative exposure to HIV risk may reduce overall prevalence even in the absence of substantive programmatic gains.

Understanding these dynamics is essential for designing effective and equitable HIV prevention strategies. Factors such as duration in sex work, educational attainment, marital history, and type of sex work (e.g., roamer vs. seater) have been consistently associated with differential HIV risk in multiple contexts, yet their stability and relative importance in Ghana over time have not been comprehensively assessed. Given the evolving demographic and behavioural profile of FSWs in Ghana, strengthened

evidence on the determinants of HIV infection and how these factors shift over time is urgently needed to inform national HIV response efforts.

This study therefore aimed to: (i) assess trends in HIV prevalence among FSWs in Ghana across three BBS rounds; (ii) identify factors consistently associated with HIV infection over time; and (iii) evaluate the role of population turnover particularly the influx of new entrants through a period-cohort analysis of duration in sex work.

Methods

Study design and setting

We conducted a secondary analysis of cross-sectional data from the 2011, 2015, and 2020 rounds of Ghana's Biological and behavioural Surveys (BBS) among female sex workers (FSWs). Each round was designed to be nationally representative and implemented across all administrative regions 10 regions in 2011 and 2015, and 16 regions in 2020 following national re-demarcation. The BBS comprises two components: (i) a behavioural survey administered via structured questionnaires; and (ii) a biological component involving collection and laboratory testing of blood (and urine where applicable) for HIV and selected sexually transmitted infections (STIs).

Study population and eligibility criteria

Participants were eligible if they were biologically female, ≥ 16 years of age (the minimum age for consensual sex in Ghana), and reported exchanging sex for money or gifts within the previous six months. Both roamer (street/venue-based) and seater (brothel/establishment-based) FSWs were included.

Data sources and variable harmonization

We obtained the anonymized BBS datasets for 2011, 2015, and 2020. Prior to merging, we reviewed codebooks and questionnaires for each round to identify variables available in at least two survey years and relevant to the study objectives. Because variable names, labels, and coding schemes varied across rounds, we harmonized the data in a multi-step process:

1. Standardization of variable names (e.g., recoding *ANALSX410* in 2011 and *Q410* in 2015 to a common variable, *anal_sex*, consistent with 2020).
2. Alignment of response categories across years (e.g., mapping binary and ordinal responses so that "yes/no", frequency scales, and categorical levels were consistent).
3. Construction of a survey-year identifier (*study_year*: 2011, 2015, 2020) and appending the three harmonized files into a single pooled dataset.

All data management and transformations were performed using Stata/IC version 16 (StataCorp, College Station, TX, USA).

Measures

Primary outcome

The primary outcome was HIV serostatus (positive vs. negative) based on the BBS laboratory testing protocol for each year. The analysis focused on HIV prevalence.

Independent variables

We examined socio-demographic, behavioural, and programmatic exposure variables that were consistently available across survey rounds:

- **Socio-demographic factors:** age (years), nationality, region of residence, educational attainment (no education, primary, middle, junior high school [JHS], senior high school [SHS], higher/tertiary), marital/relationship status (currently married, never married/single, divorced, widowed, separated, co-habiting), type of sex work (roamer vs. seater), and duration in sex work categorized as < 5, 5–9, 10–14, and ≥ 15 years.
- **Behavioural factors:** number of sexual partners (where available), anal sex (ever/yes vs. no), consistent condom use with paying and intimate partners (frequency categories harmonized to “every time,” “almost every time,” “sometimes,” “never”), alcohol use before sex (yes/no), recreational drug use (yes/no), and needle sharing (where available).
- **Exposure to prevention services:** prior HIV testing, HIV self-testing (if available), contact with peer educators, and condom/lubricant access and use.

A detailed mapping of variable recoding and cross-walks is provided in the supplementary material.

Sample size and analytic populations

The pooled dataset included 2,707 participants (2011), 4,751 (2015), and 7,000 (2020). For the period-cohort analysis focusing on duration in sex work, we restricted to participants with non-missing duration data: 1,336 (2011), 4,614 (2015), and 6,558 (2020).

Statistical analysis

Analyses were conducted on unweighted data, as design weights were unavailable for two rounds (2011 and 2015). We:

1. Described sample characteristics by survey year using medians with interquartile ranges (IQRs) for continuous variables and frequencies with percentages for categorical variables.
2. Estimated HIV prevalence overall and by key subgroups for each survey year.
3. Assessed bivariate associations between covariates and HIV status using Pearson's χ^2 tests (two-sided; $\alpha = 0.05$).
4. Identified independent predictors of HIV infection using multiple logistic regression on the pooled dataset, reporting adjusted odds ratios (AORs) with 95% confidence intervals (CIs). Covariate selection was theory- and evidence-informed, emphasizing variables consistently measured across rounds (education, marital/relationship status, type of sex work, and duration in sex work). We included study year as a fixed effect to account for secular trends.

Where applicable, we inspected model diagnostics (e.g., multicollinearity via variance inflation factors) and assessed goodness-of-fit. Statistical significance was set at $p < 0.05$.

Period-cohort analysis of duration in sex work

To examine how cumulative exposure relates to HIV prevalence over time, we conducted a period-cohort analysis stratified by duration in sex work (< 5, 5–9, 10–14, ≥ 15 years). Individuals in the < 5 years category were considered new entrants (i.e., not engaged in sex work in the previous BBS round). While the cross-sectional design precludes tracking individuals longitudinally, the structured duration bands allow for a pseudo-cohort view: as survey periods progress, the composition of duration categories reflects population turnover, thereby enabling comparison of within-duration and between-duration prevalence patterns across rounds.

Missing data

Variables with non-substantial missingness were analysed using available-case (complete-case) approaches consistent with the BBS reporting conventions. For duration-based analyses, we explicitly excluded participants with missing duration data.

Reporting

We adhered to STROBE guidelines for cross-sectional studies where applicable and present estimates with corresponding 95% CIs.

Results

Sociodemographic characteristics of participants

A total of 2,707 FSWs were surveyed in 2011, 4,751 in 2015, and 7,000 in 2020. Across survey rounds, the median age increased slightly from 24 years (IQR: 21–30) in 2011 to 26 years (IQR: 22–30) in 2020. The majority of participants were Ghanaian nationals in all years, although the proportion declined from 89.8% in 2011 to 78.9% in 2020, reflecting a growing presence of FSWs from neighbouring countries, most notably Nigeria (Table 1).

Regional distribution shifted over time. In 2011, the largest shares of participants were recruited from the Ashanti and Central regions, whereas in 2015 and 2020, Greater Accra accounted for the highest proportion. Educational attainment improved slightly over time; more than 85% of participants reported having attended school in each round, with junior high school (JHS) being the most common level.

Across all years, most respondents identified as Christians (> 75%). Marital status patterns also changed: the proportion who reported being single/never married increased from 66.6% in 2011 to 76.1% in 2015, before decreasing to about 60% in 2020, corresponding with increases in cohabitation and separation categories.

Most FSWs were roamers, ranging from 70% to nearly 80% across survey years. A striking demographic shift was observed in duration of sex work: the proportion of new entrants (< 5 years) rose sharply from 19.1% in 2011 to 56.2% in 2020, suggesting growing population turnover within the sex work landscape.

Trends in HIV prevalence

Overall HIV prevalence declined markedly across the decade, from 10.9% in 2011 to 6.6% in 2015 and 5.3% in 2020, representing a 52% reduction over the study period (Fig. 1). Patterns differed by type of sex work. Seaters consistently exhibited higher HIV prevalence than roamers, although both groups experienced declines. Among seaters, prevalence dropped from 21.2% in 2011 to 7.1% in 2020 while among roamers, prevalence dropped from 6.5% in 2011 to 4.7% in 2020. Regional analyses revealed substantial heterogeneity: regions such as Ashanti, Greater Accra, and Northern Region, which had the highest prevalence in 2011, experienced significant declines by 2020. In contrast, Upper East, Upper West, and Western regions recorded increases over the same period (Table 2).

Bivariate associations with HIV prevalence

Across all survey years, several factors demonstrated significant associations with HIV infection:

- **Educational attainment:** Participants with no formal education exhibited consistently higher HIV prevalence compared with those with secondary or higher education.
- **Marital status:** Divorced, widowed, and separated FSWs had significantly higher prevalence than those who were married or single.
- **Type of sex work:** Seaters (brothel-based) had significantly higher prevalence than roamers in all years.
- **Duration in sex work:** Prevalence increased progressively with longer duration. In 2020, prevalence ranged from 4.9% (< 5 years) to 9.0% (≥ 15 years).
- **behavioural factors:** Associations for condom use, alcohol before sex, and anal sex were inconsistent across survey rounds, with some significant but non-uniform patterns.

Detailed frequencies and statistical tests are presented in Table 3.

Multivariable analysis

The pooled logistic regression identified four factors that remained strong and consistent predictors of HIV infection across all survey rounds (Table 4):

Educational attainment: Higher education was protective. FSWs with tertiary education had 57% lower odds of HIV infection compared with those with no formal education (AOR = 0.43; 95% CI: 0.26–0.72; $p = 0.001$).

Marital/relationship status: Widowed FSWs had higher (up to five times) odds of HIV infection compared with those currently married (AOR: 5.06, 95% CI: 2.87–8.92).

Type of sex work: Seaters had significantly 79% higher odds of HIV infection than roamers (AOR = 1.79; 95% CI: 1.51–2.12; $p < 0.001$).

Duration in sex work: Duration was strongly and positively associated with HIV prevalence - long-term FSWs (≥ 15 years) had more than double the odds of HIV infection compared with new entrants (AOR = 2.28 (95% CI: 1.80–2.89; $p < 0.001$). Results are summarized in Table 4.

Period-cohort analysis of duration in sex work

In Table 5, cohort patterns demonstrated a consistent gradient: HIV prevalence increased with length of time in sex work in all survey years. In 2011, prevalence ranged from 6.6% among new entrants to 32.8% among those with ≥ 15 years of experience. Similar gradients were observed in 2015 and 2020.

Across cohorts, prevalence declined over time, but the relative differences between duration groups persisted, indicating cumulative exposure risk. For example, in 2020: <5 years: 4.87%; 5–9 years: 4.80%; 10–14 years: 7.81% and ≥ 15 years: 8.96%

These trends suggest that while population-level prevalence is declining, risk accumulates with prolonged participation in sex work, and population turnover (newer entrants with lower prevalence) may contribute substantially to the downward trend.

Discussion

This study examined HIV prevalence trends and determinants among female sex workers (FSWs) in Ghana across three rounds of nationally representative bio-behavioural surveys conducted over a decade. The findings provide important insights into both epidemiological progress and persistent vulnerabilities among this key population. Overall, HIV prevalence declined by more than half between 2011 and 2020. This encouraging trend mirrors broader global and regional declines in HIV incidence and mortality observed over the past decade, driven in part by expanded access to antiretroviral therapy (ART), prevention services, and strengthened public health systems [9, 12]. Yet, as shown in this study, declining prevalence among FSWs must be interpreted within the context of dynamic changes in population composition, structural vulnerabilities, and longstanding disparities affecting sex workers in sub-Saharan Africa [4, 13].

Globally, the burden of HIV remains concentrated in low- and middle-income countries, with the WHO African Region accounting for more than two-thirds of individuals living with HIV and reporting an adult prevalence of approximately 3.1%, substantially higher than the global adult average of 0.7%. FSWs consistently exhibit disproportionate risk: recent meta-analytic evidence indicates that HIV incidence among women engaged in sex work across sub-Saharan Africa is nearly eight times higher than among women in the general female population, underscoring entrenched inequities that continue to shape HIV transmission dynamics despite overall regional progress. Similarly, pooled estimates from Eastern and Southern Africa demonstrate HIV prevalence as high as 36% among FSWs, reflecting persistent epidemiological vulnerability in settings where broader population-level incidence is declining [5, 6, 14]

The declining HIV prevalence observed among Ghanaian FSWs aligns with these regional trends, but our findings suggest that a substantial portion of this reduction may be attributable to population turnover rather than uniform declines in HIV risk across all subgroups. The proportion of new entrants (< 5 years in sex work) more than doubled between 2011 and 2020. Existing evidence indicates that newer entrants typically reflect the HIV prevalence of the general female population which is considerably lower than that of long-term sex workers thereby diluting overall prevalence estimates [5, 15, 16]. This phenomenon has been documented across multiple sub-Saharan African settings and is consistent with our cohort analysis, which revealed clear gradients of increasing HIV prevalence with longer duration in sex work.

The strong association between duration in sex work and HIV infection observed in our study is consistent with epidemiological theory and large-scale reviews showing that HIV risk accumulates with prolonged exposure to high-risk networks and structural vulnerabilities. Our finding that individuals with ≥ 15 years of sex work experience had more than twice the odds of HIV infection compared with new entrants resonates with evidence from across the region demonstrating that cumulative exposure remains a dominant driver of risk even amid declining overall incidence [5, 16].

Education was also a significant and consistent predictor of HIV infection. Participants with higher educational attainment particularly secondary and tertiary education had substantially lower odds of HIV infection compared with those with no education. Similar associations have been reported in other African contexts, where education enhances health literacy, increases negotiating power for condom use, and improves access to health-seeking opportunities. In studies from Eastern and Southern Africa, limited education has been repeatedly identified as a structural determinant that intensifies vulnerability to HIV among FSWs. Educational disparities therefore remain central to explaining heterogeneity in HIV outcomes and should be prioritized within prevention strategies [5, 17].

The association between marital dissolution including divorce, separation, and widowhood and elevated HIV prevalence is also consistent with broader evidence. Across multiple sub-Saharan African settings, widowed and divorced women have shown disproportionately high HIV prevalence, reflecting both biological and social vulnerabilities [18]. Many women enter sex work following marital breakdown or economic hardship, and some may have acquired HIV from former partners prior to entering sex work. Research indicates that structural vulnerabilities including gendered economic inequities, low social

protection, and lack of access to support services significantly heighten HIV risk among formerly married women. Our findings reinforce the need for differentiated interventions tailored to this subgroup [7].

The consistently higher HIV prevalence observed among seaters compared to roamers raises important programmatic considerations. While seater-based sex work locations may theoretically facilitate outreach due to their fixed locations, our results suggest this group may be under-served or that existing interventions are not effectively reaching them. This finding is consistent with prior research [9, 19], although conflicting evidence exists, suggesting variability in intervention success across settings

More broadly, the persistence of elevated HIV burden among FSWs worldwide who remain more likely to acquire HIV than the general population reflects systemic barriers including limited access to comprehensive sexual and reproductive health services, stigma, punitive laws and discriminatory health systems. These barriers are particularly relevant in Ghana, where stigmatization of sex work remains high and can reduce service uptake despite available interventions [7].

Together, the findings from this study highlight the need to interpret declining HIV prevalence within a broader structural and demographic context. While programmatic efforts in Ghana appear to be having some effect, the increasing proportion of new entrants into sex work suggests that population-level declines may obscure persistent vulnerabilities among long-term FSWs, seaters, less educated women, and formerly married individuals. These groups require intensified, differentiated, and long-term interventions.

Future programming should therefore prioritize structural and rights-based approaches, including expanded community-led service delivery, stigma reduction, and enhanced economic and educational empowerment may help reduce both entry into sex work and HIV risk among women. Strengthening prevention packages such as PrEP access, regular testing, condom distribution, and tailored outreach will be essential to reducing cumulative exposure risks. Evidence from sub-Saharan Africa underscores that unless structural and social determinants are addressed, epidemiological gains will remain uneven and fragile [7].

Conclusion

This analysis of three rounds of Ghana's national BBS (2011–2020) demonstrates a substantial decline in HIV prevalence among female sex workers (FSWs) over the last decade. However, our period-cohort findings indicate that the observed decline is not uniform across the FSW population. Rather, it is partly explained by population turnover notably, a rising proportion of new entrants (< 5 years in sex work), who carry lower cumulative exposure and, consequently, lower HIV prevalence. In contrast, longer duration in sex work remains strongly and consistently associated with higher odds of HIV infection, underscoring the cumulative nature of risk within this population.

Across survey years, educational attainment, marital/relationship status, and type of sex work emerged as stable predictors of HIV infection. Lower education, marital dissolution (divorce, separation, widowhood), and seater-based work were each associated with significantly higher odds of HIV. These patterns point to enduring structural and social determinants that shape vulnerability, even as overall prevalence declines.

Overall, the findings suggest that continued progress will require more than broad coverage of standard prevention packages. Programmes should differentiate and intensify efforts for long-term FSWs, seaters, women with limited education, and those experiencing or emerging from marital dissolution. Key elements include: (i) scaling up tailored, community-led prevention and testing, including PrEP, condoms/lubricants, and frequent HIV screening; (ii) expanding stigma reduction, and rights-based service delivery to address structural barriers in venues where seater work predominates; and (iii) integrating education and economic empowerment initiatives that enhance agency and sustained engagement in care. At the same time, the influx of new entrants calls for early-entry prevention rapid linkage to testing, PrEP, and peer outreach to prevent the accrual of risk over time.

Finally, the interpretation of these results should be tempered by study limitations: reliance on cross-sectional, unweighted data in two survey rounds, and self-reported behavioural measures. Nonetheless, the consistency of predictors across rounds and the cohort gradient by duration provide robust signals for intervention. Future research should prioritize weighted analyses where possible, longitudinal designs to track individual trajectories, mixed-methods inquiry to understand structural drivers within seater settings, and implementation studies that test differentiated, rights-based models at scale.

Abbreviations

ART	antiretroviral Therapy
BBSS	Biological and Behavioural Surveillance Surveys
FSW	Female Sex Workers
HIV	Human immunodeficiency Virus
PrEP	Pre-Exposure Therapy
STI	Sexually Transmitted

Declarations

Ethics approval and consent materials

The original BBS protocols received ethical approvals from the Ghana Health Service Ethics Review Committee (GHS-ERC: 007/01/22) and the Noguchi Memorial Institute for Medical Research Institutional Review Board (028/21–22). Written informed consent was obtained from all participants prior to data collection. The present analysis used de-identified secondary data.

Competing interest:

The authors do not have any competing interests.

Finding:

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Consent to Publish declaration:

Not applicable. All of the material is owned by the authors and/or no permissions are required.

Data Availability declaration

The data is available upon request.

Author Contribution:

Conceptualization: SD, CG, KT

Data curation: EAT, SD, CG

Formal analysis: EAT, SD, CG, KOA, KT

Investigation: EAT, SD, KOA, CG, KT

Methodology: EAT, SD, CG, KT

Supervision: SD, CG,

Writing – original draft: EAT, KOA, SD, CG.

Review of manuscript – SD, CG, KT

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Tables

Tables are available in the Supplementary Files section.

Figures

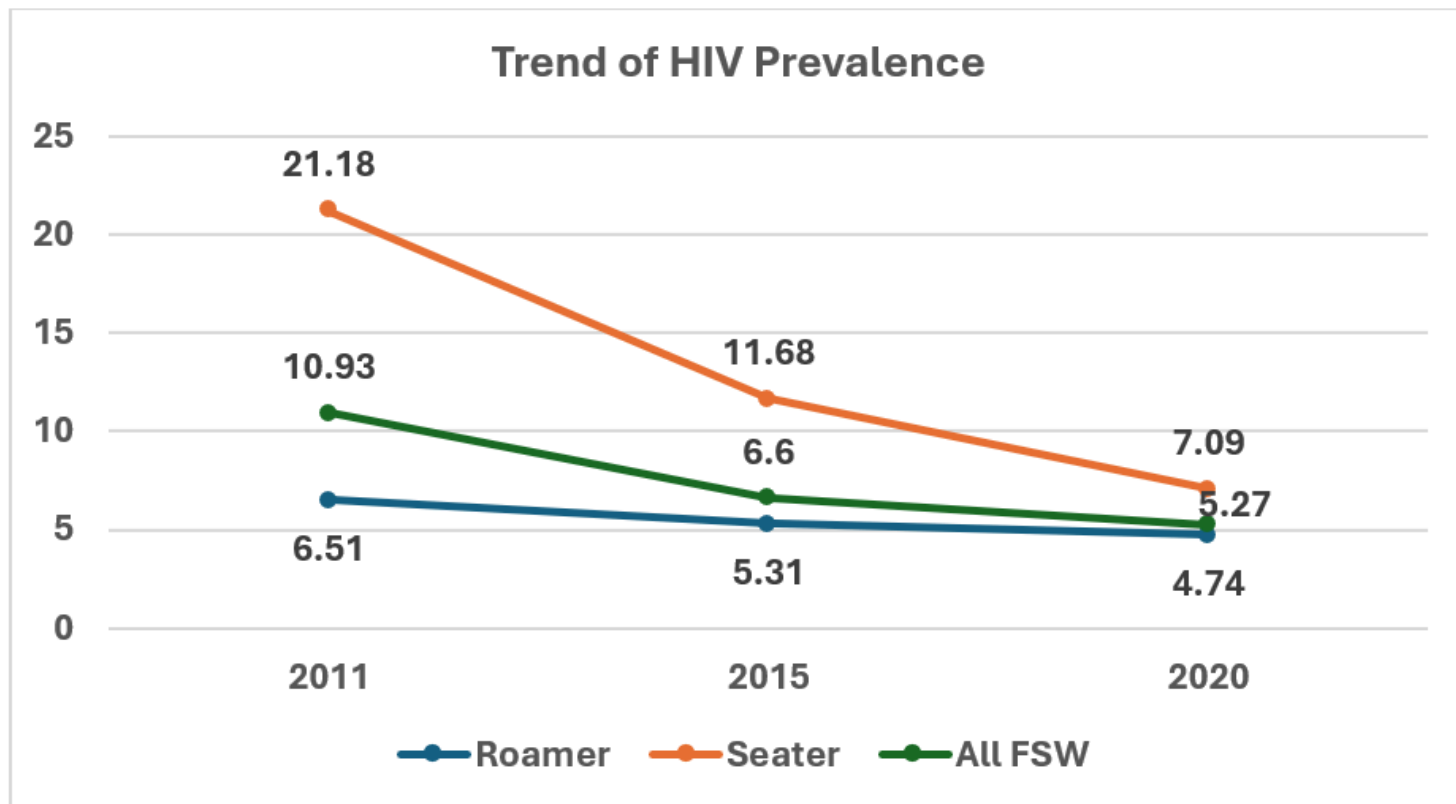


Figure 1

HIV prevalence trend

Supplementary Files

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