

# HIV prevalence and associated factors among female sex workers in Ethiopia, east Africa: A cross-sectional study using a respondent-driven sampling technique

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## Summary

**Background** HIV acquisition among Female Sex Workers (FSWs) is 30 times higher than the acquisition rate among females in the respective general population. A higher HIV burden in FSWs challenges the prevention and control of the virus in other population groups. However, there is inadequate evidence on the burden of HIV among FSWs in Ethiopia. This study was conducted to assess the extent of HIV and associated factors among FSWs in the country.

**Methods** This was a cross-sectional study that involved a total of 6,085 FSWs. The participants were selected using a respondent-driven sampling technique (RDS). FSWs who lived at the study sites for at least a month before the study time were considered eligible for recruitment. The study was conducted from January 01 to June 30, 2020 in 16 cities across Ethiopia. A mixed-effect logistic regression model was applied to determine factors associated with HIV positivity.

**Findings** The pooled HIV prevalence among FSWs in this study was 18.7% (95% CI: 17.8, 19.7) with considerable variation across cities. The highest HIV prevalence was observed in Bahir Dar city, 28.2% (95% CI: 23.9, 33.0) and the lowest was seen in Shashemene city, 14.0% (95% CI: 10.2, 18.9). The odds of HIV positivity in FSWs was associated with being older than 35 years of age (AOR = 8.1; 95% CI: 6.1, 10.3), reactive for *Treponema Pallidum* (AOR = 2.6; 95% CI: 1.0, 3.4), being widowed (OR = 2.2; 95% CI: 1.6, 2.9), not able to read and write (OR = 2.0; 95% CI: 1.5, 2.4), incidence of condom breakage (OR = 1.5; 95% CI: 1.2, 1.7) and having a history of STIs (OR = 1.3; 95% CI: 1.1, 1.6).

**Interpretation** One in five FSWs was HIV positive. HIV prevalence was higher in the older age groups and in those who were positive for *Treponema Pallidum* (Syphilis). The findings indicated the importance of strengthening HIV prevention and control in FSWs to achieve the national goal to eliminate HIV by 2030.

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**Keywords:** HIV prevalence; Associated factors; FSW

## Introduction

In 2020, key populations (sex workers, people who inject drugs, men who have sex with men, and transgender people) and their sexual partners had contributed to 65% of HIV infections in the world.<sup>1</sup> The relative acquisition of HIV in Female Sex Workers

(FSWs) is 30 times higher than the acquisition rate in the respective general female population.<sup>2</sup> FSWs engage in the sex work to earn their livings; they are widely available at or around different social establishments like bars, liquor shops, and guesthouses. These places facilitate unlimited interaction between FSWs and members of the general population. Thus, they play a key role in spreading HIV to the general population.<sup>3</sup> Moreover, because FSWs commonly have low economic

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### Research in context

#### *Evidence before this study*

Female Sex Workers (FSWs) are a high-risk population for HIV acquisition, hence assessing HIV burden in such population is key for planning and monitoring the disease prevention and control programs. We searched PubMed for population level studies assessing HIV prevalence and associated factors among FSWs published between Sep 18, 2014 and Sep 30, 2019, using the search term ((HIV) AND (Prevalence) AND (associated) AND (Factor\*) AND (Female Sex Workers\*)). We identified no original, recent, large-scale and methodologically robust study that documented the HIV prevalence and associated factors in FSWs in low-income countries.

#### *Added value of this study*

This is a multisite study that enrolled 6,085 FSWs using a respondent driven sampling technique (RDS), one of the best available method to study a hidden population. The outputs of this study can be inferred to other countries with similar context. The findings add to the evidence that the burden of HIV is many folds higher in FSWs than other females in the general populations.

#### *Implications of all the available evidence*

This study has estimated the HIV prevalence and associated factors with the higher rates of the infection. The study has showed that HIV prevention interventions that are effective in reducing HIV prevalence in the general population might not be effective to reduce the prevalence in FSWs. This strengthen the need for targeted interventions to control the spread of HIV in FSWs.

and educational status, their ability to choose safer clients is often compromised to reduce their exposure to HIV infection and prevent onward transmission.<sup>4</sup>

HIV/AIDS situation in Ethiopia is characterized as a low-intensity and mixed epidemic with significant heterogeneity across geographic areas. HIV prevalence in the key population is consistently higher than the prevalence in the general population.<sup>5</sup> The 2016 Ethiopian demographic and health survey estimated the adult HIV prevalence in the country to be 0.9% with significant variation by region; the highest was 4.8% in Gambella, and the lowest was 0.4% in the Southern Nations Nationalities and Peoples' Region (SNNRP). The urban HIV prevalence (2.9%) was seven-fold higher than the rural HIV prevalence (0.4%). The burden was also higher in women (3.6%) than in men (2.0%) in urban areas while in rural areas, the prevalence was 0.6% and 0.2% among women and men respectively.<sup>6</sup> On another hand, a multi-site survey

conducted among the Most at Risk Populations (MARPS) using a respondent-driven sampling technique (RDS) in 2013 documented that the prevalence of HIV infection among FSWs in the country was about 23 percent. It varied across towns, ranging from 14 percent in Hawassa town to 32 percent in Mekele town.<sup>7</sup> As the interaction between the general population and FSWs is natural, the HIV epidemic in the country is likely to be fueled by higher-risk behavior groups, including female sex workers.

Predictors of the higher HIV infection among FSWs may vary across countries and contexts. Early sexual debut, younger age, school dropout, being separated from family, illegal drug use, and short duration of sex work were strong predictors of unprotected sex and exposure to STIs infection in China.<sup>8</sup> Less condom access was associated with unprotected sex in venue-based FSWs while more money offer was associated with unprotected sex in street-based FSWs in Mexico.<sup>9</sup> Not using a condom, sexual violence, illicit drug use, and presence of STIs were strong predictors of HIV positivity in FSWs in Brazil.<sup>10</sup>

In LMICs, Sex workers are often marginalized, criminalized, and stigmatized by the societies in which they live, which increases their vulnerability to HIV infection.<sup>11</sup> Consequently, they tend to hide in the population; And obtaining behavioral and biological information about FSWs for programmatic purposes remains challenging.<sup>12</sup> Therefore, their access to and utilization of HIV prevention, care and treatment services is very low.<sup>13–15</sup> In Ethiopia, information on the burden of HIV in FSWs is inadequate and not up-to-date. This study was thus conducted to assess the extent of HIV prevalence and associated factors among FSWs in the country's large cities, where the FSWs concentration is known to be high.

## Methods

### Formative assessment

The formative assessment was conducted to collect important information about the FSWs to design and implement the actual survey. The minimum number of clients an FSW meets in a month was four. FSWs acknowledge a woman as FSW if she is in a sex work business for a living and meets at least one client per week. To simplify the recruitment process, we enrolled FSWs who were acknowledged by their peers. Cities with a high cluster of FSWs were also identified and FSWs were mapped in each city.

### Study design and period

A cross-sectional study design was applied to assess the HIV prevalence and associated factors among FSWs in Ethiopia. Data were collected from January to June 2020.

### Study area/setting

Based on the population size of the cities, we stratified them into three categories, large (> 1 million population), medium (100,000 - 1,000,000 population) and small (< 100,000 population) cities. There was only one city in the large category (the capital city, Addis Ababa), which was included directly in the study with no further procedure. Seven of the nine moderate cities (Dire Dawa, Adama, Bahir Dar, Gondor, Desse, Hawassa, Jimma) and eight among the 95 small cities (Harar, Nekemt, Gambella, Shashemene, Mizan, Dilla, Arba Minch and Semera/Logia) were selected in a simple random sampling technique using lottery method. In each city, the study team rented a house that served as a temporary data and sample collection site. We posted direction indicators at different junctions on the roads to guide participants to the houses. However, we have made the posted study name vague to protect the safety of the participants. Interviews and blood draws were also conducted in a private room to ensure the participants' comfort and privacy.

### Sample size determination

The sample size for each city was calculated using a single population proportion formula. The formula to calculate the sample size was:

$$n = D(Z_{1-\alpha}^2 P(1 - P))/d^2.$$

Where,  $n$  = sample size required;  $D$  = design effect,  $Z = 1.96$  at 95% confidence,  $P$  = HIV prevalence among FSWs at each city and  $d$  = precision (set at 5%)

Because we conducted the study in 16 cities from three categories, which was relatively large in number, we used a design effect of 1.5. The sum of the calculated sample size for each city was 5385. This sample size is also sufficient to assess factors associated with HIV infection.

### Study population and sampling procedures

Women aged 15 years and above who received money or other benefits for sex with four or more people within the last 30 days were considered eligible. She should also be resided or worked in the survey city for at least one month in the period preceding the survey, be willing to refer her peers to participate in the study, and possesses a valid coupon (if not a seed).

We have used a network-based sampling approach because it is difficult to obtain a sampling frame to study a socially hidden population like FSWs. We initiated the RDS technique by purposively selecting members of the target population from each known category of FSWs, which are referred to as seeds. The type of sex workers (based on where and how they meet their clients - bar and/or hotel-based, red-light houses, local drinking houses, street-based and cell phone-based);

age categories ( $\leq 20$ ,  $21-30$ ,  $\geq 31$ ), place of work/geographic locations of the sites (sub-cities) were considered in selecting the seeds. The number of seeds recruited for cities depended on the estimated total number of FSWs living in the cities. Unproductive seeds, not recruiting additional FSW, were replaced. Each seed was given three coupons to recruit three peer FSWs. Participants recruited by seeds form the first wave of the recruitment chain; they were each given three coupons to invite their peers for the second wave; it continued to produce many waves one after another till the expected city sample size was fulfilled.

Participants were expected to select, educate and refer their peers to the study sites within two weeks. This period was assumed to be fairly adequate for participants to visit the study sites. It was also a maximum period that could be spared to recruit one wave of the study without significant budget shortage. We used anonymous biometric fingerprint scanners to ensure that there was no double enrollment of participants.

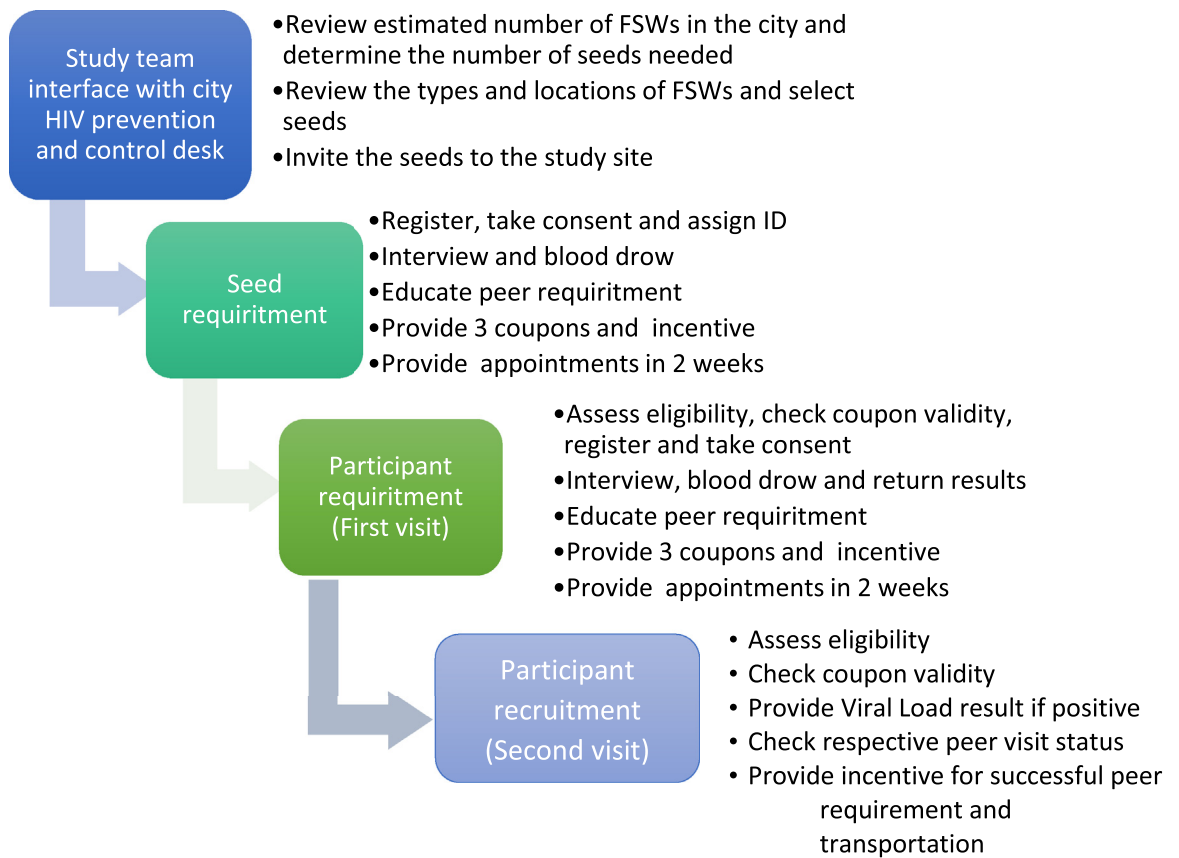
Damaged, not readable and photocopied coupons were invalid. Each participant who visits the study site should bring the coupon that identifies (by number) who referred them. The recruitment process had continued until the desired sample size was achieved and the RDS equilibrium condition was attained. Equilibrium is reached when the proportion of important variables of the sample like gender, age, HIV status, etc. remain constant over the following waves of participant recruitment.

Participants were given 5 USD (United States Dollar) as an incentive for each successful peer recruitment and an additional amount to compensate for their transportation expenses. This double incentive mechanism was used to encourage the more hidden FSWs to participate in the study. On another hand, participants were given only three coupons to invite peers which balances a tendency of over-sampling of volunteers due to the incentive. Such restriction aids in driving the recruitment chains further into the target population with diverse subpopulations than it would be with a conventional chain-referral or snowball sampling techniques.<sup>16</sup> The study procedure in the diagram is shown below (Figure 1).

### Dependent and independent variables

HIV status of the FSWs was considered as a dependent variable. The status was determined by testing blood specimens for HIV using the National HIV testing algorithm (HIV1/2 stat-pak - assay one, Abone - assay two and SD bioline - assay three).<sup>17</sup> HIV test was offered to all FSWs whether they were aware of their HIV status before the survey time or not. Only HIV status determined during the survey time was used as a dependent variable.

Independent variables included participant's age, age at first sex, marital status, educational status,



**Figure 1.** Study procedure to recruit Female Sex Workers at city level from January to June 2020 in Ethiopia. ID – Identifier, FSW – Female sex worker.

average monthly income, the incidence of condom breakage, use of lubricants during sex, history of STI, and current *Treponema Pallidum* test result. Except for the *Treponema Pallidum* test used to assess Syphilis, which was conducted at the site level, all independent variables were obtained from interviewing study participants. History of STIs was recorded, when FSWs reported experience of any signs or symptoms of STIs including excess and smelly vaginal discharge, lower abdominal pain, and ulcers around/on the vagina.

**Data collection**

A structured interview questionnaire was designed and uploaded to an open data kit (ODK). The kit was programmed to prevent missing data. A question can not be opened unless the preceding one is answered. A real-time data entry was made by trained data collectors using a KOBO tool kit (an open-source tool for mobile data collection). Cleaned participants’ data from all sites were been deposited to the Ethiopian Public Health Institute (EPHI) server daily.

**Sample collection and test procedures**

A temporary laboratory bench was organized at each site. After completing the study interview, consented participants were asked to take laboratory tests. A whole blood sample from a finger prick was used to test for HIV and *Treponema Pallidum*. In ten percent of HIV-negative and all HIV-positive individuals, venous blood was collected, plasma extract prepared, and shipped to the EPHI HIV Molecular Reference Laboratory for retest to check the quality of tests done at sites. HIV test results were determined using the national HIV testing algorithm and Syphilis was diagnosed using Syphicheck, a rapid test kit to detect *Treponema Pallidum*.

Both HIV and Syphilis test results were returned to all participants. Those participants who were HIV positive were offered an additional test to quantify their viral load. FSWs with HIV-positive result were escorted to the nearby health facilities for care and treatment. Those who tested HIV-negative were counseled on HIV risk reduction plans including pre-exposure prophylaxis and consistent condom use.

### Quality control and assurance

Data collectors, testers and supervisors were trained on the study protocol including data collection tools, survey procedures and laboratory processes. Each study team had a supervisor stationed at the survey site and was responsible for the daily monitoring of data collection activities and laboratory test performance. Each activity related to the data and sample management had its standard operating procedure (SOP) to be followed. The survey procedure was pretested with volunteer FSWs in a town not included in the study. During reporting of the findings, we have adhered to a STROBE (Strengthening The Reporting of Observational Studies in Epidemiology) checklist.

The test kits, sample transportation and storage conditions were monitored daily. The sample testers' proficiency was also regularly assessed using well-characterized/known samples to ensure their capability to conduct the test properly. Furthermore, specimens collected for the quality assurance purpose were retested by senior laboratory scientists who were blinded to the site-level test results. The results indicated a 100% concordance to the site test results.

### Data analysis

The Respondent-Driven Sampling Analysis Software (RDSAT) version 64 was used to prepare the data to test assumptions and estimate the prevalence of HIV in FSWs. Stata 14.1 was used to run regression analysis.

### Diagnostic plots and figures

Diagnoses for the RDS assumptions were conducted using R version 3.6.2. The majority of the study participants were recruited from seeds that generated two to six waves. A maximum of 16 waves were attained. HIV prevalence and consistent condom use status were used to assess the convergence of sample results on the population estimates. Convergence plots illustrate a population's parameter proportion on the y-axis by the number of recruits on the x-axis.<sup>18</sup> The convergence plots of HIV status and consistent condom use in each city showed that both variables converged on the population estimates indicating sample stability. The bottleneck (in-group affiliation) graphs of the two variables also illustrated low homophily. In addition, we had estimated the level of homophily using the HIV status (0.3) and consistent condom use (0.2). The observed low homophily, convergence to population estimates and non-existence of bottlenecks shows the independence of the study samples from the conveniently selected seed samples.<sup>19</sup>

### Weighting

The data were weighted against the social network of FSWs using the RDS analysis tool (RDSAT). Among

the available approaches in the RDSAT, we used RDS II to estimate the prevalence of HIV among FSWs because we do not have an exhaustive and well-estimated size of FSWs in the cities as well as in the country. However, unweighted data were used in a regression model to compute factors that were associated with HIV because using weighted data decreases the accuracy of the outputs and the regression model works well with unweighted data.<sup>20,21</sup>

### Regression analysis

Binary logistic regression was used to determine factors associated with HIV positivity in FSWs with a 95% confidence interval. Variables that fulfill a statistical criteria, a p-value of less than 0.25, were included in a mixed-effect logistic regression model to compute the adjusted odds ratio (AOR). The model accommodated the intercept-level random effects for cities and seeds. A collinearity test was conducted and variables with r-values greater than 0.5 were removed from the logistic regression model. We used the Pearson's R test for collinearity to ensure that each variable in the analysis represents a unique concept. Only non-overlapping variables that could associate with HIV infection were included in the logistic regression model. A P-value of less than 0.05 was considered to report significant associations between dependent and independent variables.

### Ethical considerations

Participation in the study was voluntary, participants provided consent to be interviewed and to give a blood sample. Participants who were adults and mature minors (15-18 years) had provided written informed consent before being enrolled in the survey. Participants were assigned identification numbers upon arrival and were identified by their ID, no personal identifying information was collected. All documents in a hard copy were locked in filing cabinets and access to the cabinets was limited to the study team only. Password-protected computers were used to collect and store data. The study protocol was reviewed and approved by the Ethiopian Public Health Institute's Institutional Review Board (Ref. EPHI 6.13/517).

### Role of the funding source

The funder of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report. All co-authors have full access to the dataset and decided to submit the manuscript for publication.

### Results

Depending on the number of FSWs living in the cities, a minimum of five and a maximum of 12 seeds from each

Variables	Categories	Number	Percent
Age (n=6085)	Less than 25	3190	52.4
	25-34	2413	39.7
	35 and above	482	7.9
Educational Status	Can not read and write	1054	17.3
	Primary school (grade 1-8)	3560	58.5
	High school and above (grade>9)	1471	24.2
Marital Status	Never married	2944	48.4
	Currently married	231	3.8
	Separated	372	6.1
	Divorced	2262	37.2
	Widowed	276	4.5
Monthly income in Birr	<= 3000	2601	42.7
	>3000	3484	57.3

**Table 1: Socio-demographic characteristics of FSWs in Ethiopia from January to June 2020 (N=6085).**  
FSWs – Female sex workers.

city; and a total of 98 seeds were selected at the beginning of the study. Thirty-seven of the seeds were in the age category of less than 25 years, 41 were between the age of 26 and 30 years, and 20 were above the age of 30 years. The majority of the seeds were venue-based FSWs; 70 of them meet their clients in hotels/restaurants/local drink houses, 22 meet their clients on street, 28 meet their clients through short messages on their cell phones and 11 were home-based FSWs. Some of them meet their clients using two or more options listed above. To recruit 6085 (99.74% of those who passed eligibility screening) participants successfully, 15,890 coupons were distributed. The average coupon return rate was 38.4% with considerable variations across cities. The highest coupon return rate was in Dire Dawa city (54.3%) and the lowest was in Bahir Dar city, 33.2%.

Of all FSWs in this study, 3190 (52.4%) were in the age group of less than 25 years; 3560 (58.5%) had primary level education; 2944 (48.4%) were never married and 2262 (37.2%) were divorced. The average monthly income of 2601 (42.8%) FSWs was reported to be less than 3,000 Ethiopian Birr (ETB) (Table 1).

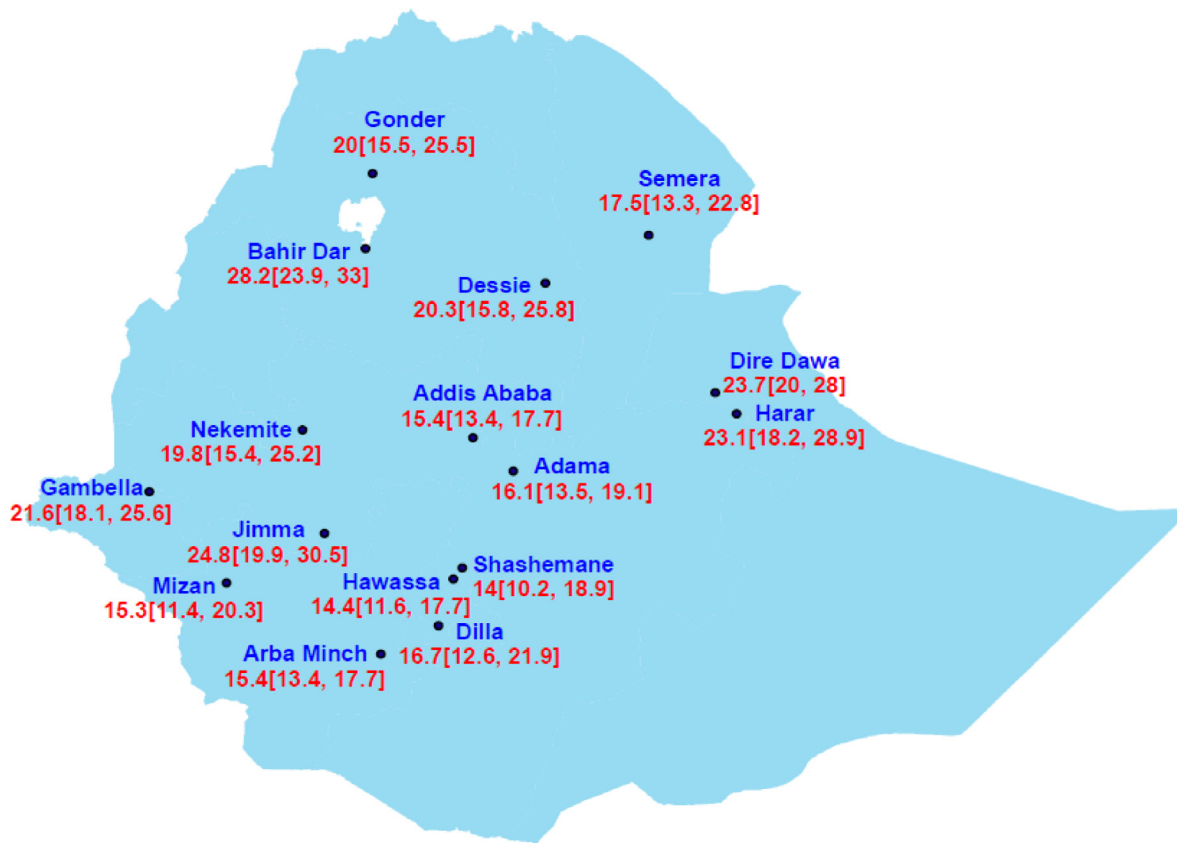
The pooled HIV prevalence among FSWs in this study was 18.7% (95% CI: 17.8, 19.7) with considerable variation across cities. The highest HIV prevalence was observed in Bahir Dar city, 28.2% (95% CI: 23.9, 33.0) and the lowest was seen in Shashemene city, 14.0% (95% CI: 10.2, 18.9). The HIV prevalence was 15.4% (95% CI: 13.4, 17.7) in the capital city Addis Ababa, 20.4% (95% CI: 19.0, 21.9) in medium cities and 18.1% (95% CI: 16.4, 19.8) in small cities. (Figure 2)

A large majority, 89.6% (95% CI: 88.6, 90.5) of the 6,085 FSWs who participated in this study had ever tested for HIV before the study time. In 86.6% (95% CI: 83.7, 89.0) of HIV-positive FSWs, the viral load level in their body was less than 1000 copies per milliliter (ml).

Based on the logistic regression analysis conducted, we identified a total of eleven social, behavioral and biomedical factors (current age, age at first sex, marital status, educational status, monthly income, condom breakage, use of lubricant, history of STIs, current infection with Syphilis, alcohol use and physical violence due to sex work in the last 12 months) that were independently associated with HIV prevalence in FSWs. Being older age (> 35 years of age), earlier initiation of sex (<18 years of age), being currently married, divorced, or widowed, lower grade school attendance, less average monthly income, incidence of condom breakage in the last 30 days, use of lubricants, having a history of STI and a currently positive test result for *Treponema Pallidum* were associated with HIV positivity of FSWs. However, alcohol use and history of physical violence did not maintain the association with HIV positivity in a mixed effect logistic regression model (Table 2).

The odds of getting HIV infection increases as the age of FSWs increases. The odds of being HIV positive among FSWs aged 35 and above, and 25–35 years were 8.1 and 3.6 times higher than the odds of being positive in those under the age of 25 years respectively. The odds of HIV infection among FSWs who initiated the first sex before the age of 18 was 1.4 times higher than the odds of infection in those who delayed the first sex beyond the age of 18 years. The odds of HIV positivity among currently married was 1.5, among divorced 1.5 and among widowed 2.2 times higher than the odds of positivity in those who never married.

The odds of HIV infection among FSWs who cannot read and write was 2 times and the odds among those who attended primary school was 1.3 times higher than the odds of infection among those who attended high school and above. The odds of HIV positivity in FSWs who earn an average monthly income of less than 3,000



**Figure 2.** HIV prevalence with upper and lower limits in 95% confidence interval across cities in Ethiopia from January to June 2022.

ETB was 1.3 times higher than the odds of HIV positivity among those who make more than 3,000 ETB per month.

The odds of HIV infection among FSWs who experienced an incidence of condom breakage was 1.5 times higher than the odds of infection among those FSWs with no incidence of condom breakage in the last 30 days. The odds of HIV infection among those who used lubricant during sex in the last six months was 1.2 times higher than the odds among those who did not use lubricant in the same period. The odds of being HIV positive among FSWs who had a history of STI was 1.3 times higher than the odds of being positive in those who had no history of STI. The odds of HIV infection among FSWs who were reactive for *Treponema Pallidum* was 2.6 times higher than the odds of HIV infection in those with non-reactive test result for *Treponema Pallidum*.

## Discussion

The pooled HIV prevalence among FSWs was 18.7% (95% CI: 17.8, 19.7) with considerable variations across the cities included in the study. The odds of being HIV positive was significantly higher in FSWs who were

older, currently married, divorced, widowed, had lower educational status, reported condom breakage in the last 30 days, reported a history of STIs and were currently positive for *Treponema Pallidum*. Fairly, a good proportion of FSWs had access to HIV test while many of HIV positive FSWs had a high viral load (>1000 copies/ml).

Our study showed that HIV prevalence among FSWs remained similar to the prevalence reported among FSWs eight years back in the country, 23.00% (95% CI: 19, 28).<sup>7</sup> This may show that the national HIV prevention and control efforts that had resulted in the drop of the prevalence in the general population might have limitations in targeting to lower the prevalence in FSWs. For instance, though pre-exposure prophylaxis (PrEP) is the most effective strategy in reducing HIV prevalence in those with increased exposure to HIV, the strategy was being implemented in Ethiopia recently.<sup>22</sup> This could be one of the reasons for the sustained high HIV prevalence among FSWs in the country.

The burden of HIV in FSWs is four to five folds higher than the prevalence among females living in urban parts/cities of the country, 4.1%.<sup>23</sup> The fact that FSWs are engaged in selling sex to different clients may put them at a higher risk of exposure to acquiring HIV,

Variables	Categories	No of participants	% HIV +ve	P-Value Chi <sup>2</sup>	AOR	95% CI
Age in year	<25	3190	7.8	<0.0001	1	
	25–34	2413	27.1		3.6	3.0, 4.3
	35 and above	482	49.6		8.1	6.1, 10.3
Age at first sex in year	18 and above	978	17.4	<0.0001	1	,
	< 18	5107	19.0		1.4	1.2, 1.6
Marital status	Not Married	2944	10.8	<0.0001	1	,
	Currently married	231	19.1		1.5	1, 2.1
	Separated	372	22.3		1.2	0.9, 1.6
	Divorced	2262	25.2		1.5	1.3, 1.8
	Widowed	276	45.3		2.2	1.6, 2.9
Highest grade attended	Secondary school and above (> grade 9)	1471	12.7	<0.0001	1	,
	Not able to read and write	1054	31.0		2	1.5, 2.4
	Primary school (< grade 9)	3560	17.6		1.3	1.1, 1.6
Average monthly income (ETB)	More than 3000	3484	16.0	<0.0001	1	,
	Less than 3000	2601	22.4		1.3	1.1, 1.5
Condom breakage in the last 30 days	No	4260	16.7	<0.0001	1	,
	Yes	1825	23.4		1.5	1.2, 1.7
Lubricant use in the last 6 months	No	5300	18.4	0.079	1	,
	Yes	785	21.0		1.2	1, 1.5
History of STI	No	5083	17.7	<0.0001	1	,
	Yes	1002	23.9		1.3	1.1, 1.6
Treponema Pallidum test	Non-reactive	5746	17.0	<0.0001	1	,
	Reactive	339	47.5		2.6	1, 3.4
Alcohol consumption	At least once per week	915	23.0	<0.0001	0.9	0.7, 1.1
	Never drink	5170	18.0		1	
History of physical violence in the past 12 months	Yes	1356	19.5	0.43	1.0	0.8, 1.1
	No	4729	18.5		1	
Variance due to study sites		0.01				0.0, 0.6
Variance due to seed		0.18				0.0, 0.3

**Table 2: HIV prevalence and associated factors in FSWs in Ethiopia from January to June 2020 (N=6085).**  
FSWs – Female sex workers; STI – Sexually transmitted infection; ETB – Ethiopian birr.

and hence they may act as a core group for the HIV transmission and spread in the general population.<sup>24</sup> Therefore, though the HIV prevalence among FSWs in Ethiopia is lower than the prevalence reported by some African countries (Rwanda, 42.9%<sup>25</sup> and Kampala 33.0%<sup>26</sup>), we assume the prevalence in our study, nearly one HIV positive in every five FSWs, is a very high HIV prevalence. Tailored and intensified HIV prevention programs toward controlling HIV in FSWs are required to sustain the reduced HIV prevalence in the general population.

There was no statistically significant difference in the pooled HIV prevalence in the capital, medium and small cities. However, a slightly higher HIV prevalence in the medium cities was observed, which could be due to an accumulated number of HIV-positive FSWs in the medium cities (may be more on ART) or due to ongoing high-level transmission in the medium cities. Several studies documented that differences in the HIV

prevalence among FSWs were secondary to the differences in structural, biomedical and behavioral factors related to the HIV transmission, not merely related to the type and category of the cities themselves.<sup>27–29</sup> In addition, clients of FSWs are not only those who live in the city where FSWs reside. They may come from other cities in different categories, even from rural parts of the country,<sup>30</sup> and this client and FSW interaction network across cities may contribute to getting similar HIV prevalence in different categories of cities.

Even though a high proportion of FSWs had access to HIV testing, there was a significant number of HIV positive FSWs with HIV viral load of more than 1000 copies/ml. This finding is similar to many studies conducted in Africa<sup>31–33</sup> indicating the need to invest to achieve a population-level viral suppression.

In this study, the odds of being HIV positive was higher in the older age FSWs. This finding is similar to multiple previous studies.<sup>34–36</sup> Some of the possible



reasons for the higher HIV prevalence in the older age FSWs include: longer exposure time to the risk of infection with multiple partners, FSWs who were infected at an early age and on ART tend to live longer,<sup>37</sup> and vaginal dryness in older women due to hormonal changes.<sup>38</sup> The wall of an altered genital tract might be easily damaged or lacerated during sexual intercourse to facilitate the entry of HIV into the body.<sup>39</sup> It may also contribute to condom breakage which again increases their exposure to HIV infection.

This study has shown that the risk of HIV infection increased as the educational level of FSWs decreased. Unlike illiterates, educated individuals could have increased access to the knowledge of HIV prevention methods, the ability to comprehend and analyse information in favor of behavioral changes to prevent themselves from HIV infection.<sup>40</sup> A different viewpoint could be: FSWs with lower schooling might have a lower socioeconomic status that may force them to meet with many risky clients in a day to earn their living, hence they might be at a higher risk of HIV infection. Similar to our finding, a longitudinal population-based study conducted in rural South Africa showed that the risk of HIV acquisition and school dropout has a significant association. According to the longitudinal study, one additional year of education reduced the hazard of acquiring HIV by seven percent.<sup>41</sup> In addition to other benefits of educating women, keeping them in secondary school was a more cost-effective HIV prevention method than other standard prevention methods.<sup>42</sup>

Another interesting finding of this study was that delayed first sex beyond the age of 18 years had a protective effect from getting HIV in FSWs. Age at first sex was associated with early marriage and early school dropout.<sup>43</sup> The relationship between age at first sex, lack of education, and increased HIV risk could be indicative of a social milieu in which young women are made vulnerable to HIV infection through interacting factors like poverty.

This study had also indicated a higher HIV prevalence among FSWs who were divorced and widowed compared to FSWs who were never married. The finding is similar to the result of a study conducted in rural Malawi that showed a higher HIV-positive proportion among divorced and widowed women. The study also indicated that the women's HIV-positive status had played a major role in the marriage dissolution through a divorce.<sup>44</sup> In addition, a multi-country study was done in Sub-Saharan Africa to show that the HIV prevalence in formerly married women was higher than in those not married.<sup>45</sup> HIV prevalence among currently married FSWs in this study was also higher than the prevalence among unmarried FSWs. This could be explained by the lower rate of consistent condom use among married FSWs with their husbands as well as their paying partners<sup>46,47</sup> which may put them at a higher risk of acquiring HIV.

In agreement with previous studies, the odds of being HIV positive was higher in FSWs with low average monthly income.<sup>44,48</sup> This could be due to the relative economic instability of FSWs with lower income which may compromise their ability to decline risky sexual practices. As sex work is their main source of income to feed their dependents and/or themselves, they may not afford to lose their clients. Insisting on condom use may result in loss of clients, decrease in earnings and physical abuse. FSWs with lower socioeconomic status are more likely to meet partners with lower socioeconomic status which was reported to be a strong predictor of HIV seropositivity.<sup>49</sup>

Condom breakage in this study was associated with a higher odds of HIV positivity. Inappropriate use was also documented to be associated with a higher HIV positivity in previous studies.<sup>25,50,51</sup> Condom breakage could occur as a result of low quality<sup>52</sup> or/and the condom missuses including proper lubricant choice; For example, non-water-based lubricants can degrade latex condoms in as little as 60 seconds of contact to result in breakage.<sup>53</sup> The predominantly used condoms in Ethiopia were evaluated against the international quality standards, ISO 407. The condoms had fulfilled the standard requirements and were reported to be safe and effective for use.<sup>54</sup> In our study, we have shown that both condom breakage and lubricant use were associated with higher HIV infection among FSWs. In addition, a study conducted in the eastern part of Ethiopia showed lower awareness about the appropriate use of condoms and lubricants.<sup>55</sup> Hence, the condom breakage might be due to the type of lubricants FSWs use. Therefore, besides improving condom availability, it is also critical to enhance the proper use of condoms.

Our study also demonstrated that the presence of STIs had a significant association with the higher odds of being HIV positive, which is similar with many previous studies.<sup>56–58</sup> The association between STIs and HIV infection could be explained by the biological and behavioral factors that exist in those exposed to STIs and HIV. The presence of STIs increases HIV transmission and susceptibility by disrupting the mucosal lining and immune changes in the genital tract.<sup>59,57</sup> The presence of advanced AIDS conditions in return increases the severity of some STIs like Herpes Simplex Virus type 2 (HSV-2)<sup>59</sup> which affects the genital tract microenvironment to increase susceptibility to other STIs and HIV infectiousness through facilitating increased viral load and higher viral shedding.<sup>60</sup> According to a multi-site prospective cohort study conducted in Zimbabwe and Uganda, HSV-2 contributes most to the acquisition of new HIV infections.<sup>61</sup> Therefore, HIV prevention and control strategy should consider STIs prevention and management as a major component.

RDS was used to overcome issues related to the conventional referral chain sampling techniques. We had recruited participants in lengthy waves far beyond the

equilibrium points to secure a deeper penetration into the social network structure to obtain representative samples. Double incentives and limited coupons were used to manage biases related to voluntarism, masking and in-group affiliation. We have used efficient ways of determining sample stability including convergence and bottleneck analysis.<sup>62</sup> Cities involved in the study were also selected systematically and randomly. We believe, our HIV estimates in the FSWs are robust and fairly generalizable to FSWs in the country, at the city and cluster of cities (small, medium, large) level.

The consistent and high HIV prevalence among FSWs in this study may reflect the gap in targeting to reduce HIV prevalence in FSWs. Because FSWs and their clients are parts of the general population, they play a key role in the HIV transmission dynamics.<sup>63</sup> As long as there is a high HIV prevalence among FSWs in cities in Ethiopia, maintaining the low HIV prevalence (0.9%) in the general population in the country could be difficult. Therefore, targeted and evidence-based strategies should be designed to fight against HIV in FSWs.<sup>64,65</sup> This should include: expanding HIV test services and early initiation of ART for all FSWs with special consideration to the older age FSWs, providing alternative income sources for young girls in school and FSWs with economic instability,<sup>66–68</sup> educating FSWs about proper condom use, and strengthening STIs management.<sup>69,70</sup>

Because the study participants are hidden, we could not get a sampling frame, thus the estimates from a non-probability sampling technique may produce a biased HIV prevalence. The direction of the bias is difficult sometimes to predict as it depends on a particular chain with an unknown risk level. In addition, an estimated number of FSWs in each city was used to determine the number of seeds required to start the survey. As the estimated number was derived from the program data, not mapping, the estimated number could be under the actual number of FSWs. Overall, we believe the biases even out and the estimate in this study are reasonable. Some variables in the study could be sensitive to answers or FSWs may tend to report it in a different way (social desirability bias). For instance, FSWs may tend to say 'yes' to the consistent condom use question. Though this variable is important in HIV transmission, we have dropped it off from the model during analysis. Also, participants might have difficulty recalling when answering some questions related to their far past experiences. However, we believe these limitations do not change the main findings of our study. Another limitation of this study is that though we used biometric devices to ensure the single participation of FSWs in the study, we didn't assess the impact of the device on the FSWs' study participation rate. Last, though equilibrium for most variables was reached rapidly, few variables had not attained equilibrium.

Overall, about one in every five FSWs was HIV positive in Ethiopia. The odds of being HIV positive in

FSWs was significantly higher in the older age FSWs, in those with lower education, who were currently married and ever partnered, reported or having STIs, with low average monthly income, who initiated first sex at an early age, had an incidence of condom breakage and used lubricant during sex. It is important to further understand why HIV prevalence has not declined in FSWs, particularly in these specific groups. The currently used interventions must be examined, and appropriate strategies that target reducing HIV burden in FSWs should be designed and implemented.

### Contributors

SA conceived and designed the study. MD, AW, MD and YB revised the study protocol and supported data analysis. SA drafted the first version of the manuscript while MD, AW, MD and YB extensively edited it to this level. All authors read and approved the final manuscript. AW had direct access and verified the underlying data reported in the manuscript.

### Data sharing statement

Anonymized raw data will be available upon a written request directed to the corresponding author. The data will be shared with requesters after approval and a signed data-sharing agreement between the requester and the Ethiopian Public Health Institute.

### Declaration of interests

All authors declare no competing interests

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### Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.eclinm.2022.101540](https://doi.org/10.1016/j.eclinm.2022.101540).

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