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High level of HIV drug resistance and virological non-suppression among female sex workers in Ethiopia: a nation-wide cross-sectional study

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Abstract

Objective: To determine viral load non-suppression (VLN) rates, HIV drug resistance (HIVDR) prevalence and associated factors among female sex workers (FSWs) in Ethiopia.

Methods: A cross-sectional biobehavioural survey was conducted among FSWs in 11 cities in Ethiopia in 2014. Whole blood was collected and HIVDR genotyping was done. Logistic regression analysis was used to identify factors associated with VLN and HIVDR.

Results: Among 4900 participants, 1172 (23.9%) were HIV-positive, and 1154 (98.5%) had a VL result. Participants were categorized into ART (n=239) and ART-naïve (n=915) groups based on self-report. From the 521 specimens (ART, 59; ART-naïve, 462) with VL ≥1000 copies/mL, genotyping was successful for 420 (80.6%), and 92 (21.9%) had drug resistance mutations (DRMs). Pre-treatment drug resistance (PDR) was detected in (63/381) 16.5% ART-

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Authors' contributions

DA, PB, and PM were responsible for the overall study design. DA, YK, AR, JH, CZ, PM, and TB were responsible for overall project coordination. AR, JC, JH, and CZ coordinated the laboratory tests. DA and MD performed database entry and data cleaning and analysis. DA and PM performed the resistance testing and sequencing analyses. DA, PM, MD and PB interpreted the results. DA, MD, and PM wrote the manuscript. All authors revised the manuscript, provided important intellectual content and approved the manuscript.

Transparency declaration

The authors declare that they have no competing interests.

naïve participants. Nucleoside, non-nucleoside reverse transcriptase inhibitors (NRTIs, NNRTI), and dual-class DRMs were detected in 40 (10.5%), 55 (14.4%), and 35 (9.2%) of the participants, respectively. Among 239 on ART, 59 (24.7%) had VLN. Genotyping was successfully performed for 39 (66.1%). DRMs were detected in 29 (74.4%). All 29 had NNRTI, 23 (79.3%) had NRTI or dual-class DRMs. VLN was associated with age ≥35 years, CD4+ T-cell count <350 cells/mm^3 and being forced into selling sex. PDR and acquired drug resistance was associated with CD4+ T-cell count <350 cells/mm^3 (p<0.001).

Conclusions: The high VLN and HIVDR rates among FSWs underscores the need for targeted interventions to improve ART access and virological monitoring to maximize the benefit of ART and limit the spread of HIV and HIVDR.

Keywords

Female sex worker; HIV drug resistance; pre-treatment drug resistance; acquired drug resistance; virologic failure; Ethiopia

Introduction

Female sex workers (FSWs) are at high risk of HIV infection and transmission and bear a disproportionately large burden of the disease[1–4]. As in many low- and middle-income countries (LMIC), Ethiopia has a generalized HIV epidemic primarily through heterosexual transmission. Since the beginning of the epidemic, FSWs have had high risk of HIV infection and were considered key drivers of HIV transmission[5–8]. According to the 2014 at-risk population survey (MARPS), HIV prevalence among FSWs in Ethiopia was 24%, more than five times the prevalence of HIV in the general female population of reproductive age[9].

In Ethiopia, antiretroviral therapy (ART) was rolled-out free of charge in 2005 and since then, ART has been scaled up to provide access to all HIV-infected individuals[10]. In 2019, 473,261 people living with HIV were receiving ART in Ethiopia (75% coverage). Ethiopia has also implemented the test-treat recommendation since 2017. Accordingly, every person tested positive for HIV will start treatment irrespective of his/her immunological and virological status[11]. However, with rapid scale up of ART an increased trends in emergency and transmission of HIV drug resistance (HIVDR) particularly to non-nucleoside reverse transcriptase inhibitors (NNRTI) have been reported from several low-middle-income countries[12].

Despite advances in expanding access to HIV treatment and prevention, Ethiopia has limited access to regular virologic monitoring and HIVDR testing, delaying identification of patients with treatment failure and increasing the risk of drug-resistance mutations (DRMs) and onward transmission of HIVDR[12,13]. This may be more pronounced among FSWs who are highly mobile, are hard to reach, have low access to antiretroviral therapy (ART), adherence support, and viral load (VL) monitoring, and have low care retention rates[3,14]. Moreover, FSWs are frequently exposed to violence, and women who report violence have poor ART adherence and viral suppression[15,16]. Addressing these barriers has the potential to reduce HIV infection and improve HIV treatment outcome[17].

Data about ART uptake and treatment outcomes among FSWs in Ethiopia and other LMICs are limited. Given the potential risk of transmission to the general population, monitoring risk behaviour and testing for viral load non-suppression (VLN; VL≥1000 copies/mL) and HIVDR among FSWs can help inform prevention strategies to decrease HIVDR rates and onward transmission. Although FSWs are known to be at high risk of HIV infection and play an important role in HIV transmission dynamics, there is a lack of data on VLN and HIVDR among FSWs in Ethiopia. This study describes the prevalence of VLN, HIVDR mutations, and associated factors among FSWs in Ethiopia.

Methods

This study was part of a larger cross-sectional study that assessed HIV prevalence and related risk factors among FSWs in Ethiopia in 2014. Data were collected via respondent-driven sampling in 11 cities (Addis Ababa, Mekele, Bahir Dar, Adama, Dire Dawa, Gambela, Hawassa, Metema, Kombolcha, Semera, and Shashamene) (Figure 1). We defined FSWs as women who engage in sexual activity with the precondition of financial or in-kind benefits. The inclusion criteria for the study were women receiving money or other benefits for sex with four or more people within the last 30 days, aged ≥15 years, recruited by a peer, and providing consent for the interview and blood tests. The study methods have previously been described[16]. For this study only women aged ≥ 18 were included. Briefly, six seed FSWs were selected to use coupons to recruit peers in each town. Eligible FSWs who provided informed consent participated in a face-to-face interview with nurses using a structured questionnaire in a private room. After completing the interview, participants provided blood specimens for HIV, $CD4^+$ T-cell counts, VL, and HIVDR testing and were given three coupons to recruit their peers into the study.

During the survey, sociodemographic characteristics and bio-behavioural data were collected. Awareness of HIV status and prior ART exposure were used to classify study participants. Participants who reported they were currently receiving ART were in the ART group, whereas those who reported not receiving ART (either ongoing or previous treatment including antiretroviral for prevention of mother-to-child HIV transmission) were categorized as ART-naïve group. This categorization also was used to classify pre-treatment drug resistance (PDR) in ART-naïve participants and acquired HIVDR (ADR) in the ART group.

Participants were screened for HIV at the collection site via point-of-care rapid testing, which is used for HIV diagnosis in Ethiopia[10]. CD4+ T cell counts were obtained in nearby health facilities using the FACSCalibur and FACSCount systems (Becton Dickinson, San Jose, CA USA) according to the manufacturer's recommendations. Plasma was separated from whole blood and transported to the Ethiopian Public Health Institute (EPHI), where HIV-1 VL was determined using Abbott RealTime HIV-1 assay (Abbott Molecular Inc., Des Plaines, IL USA). Using 1000 copies/mL as VL suppression threshold based on WHO recommendation[18], all samples with VL≥1000 copies/mL were shipped to the International Laboratory Branch of the Division of Global HIV & Tuberculosis, Center for Global Health, CDC (Atlanta, GA) for HIVDR genotyping (for details, see the supplementary information).

HIV-1 genotyping

Genotyping was performed using the ABI HIV-1 Genotyping Kit (Thermo Fisher Scientific, Waltham, MA USA)[19]. Briefly, a 1084 base-pair fragment of HIV-1 pol (corresponding to the position 2243-3326 of HXB2; Genbank Accession Number: K03455) comprising amino acids 6–99 of the protease and 1–251 of the reverse transcriptase was generated by reverse transcriptase polymerase chain reaction (PCR) and nested PCR. The purified PCR fragments were then sequenced and analysed on the ABI Prism 3730 Genetic Analyzer (Applied Biosystems, Foster City, CA USA). Sequence assembly and editing were performed using the RECall V 2.0 HIV-1 sequencing analysis tool (University of British Columbia, Vancouver, Canada)[20]. Sequence quality control was performed using the online Quality Control program of the Los Alamos HIV sequence database (https://www.hiv.lanl.gov/).

Drug resistance mutations analysis

Surveillance drug resistance mutations (SDRMs) were examined according to the Stanford Genotypic Resistance calibrated population resistance tool, version 6.0 (https://hivdb.stanford.edu/cpr). PDR levels were classified (low, <5%; moderate, 5%–15%; or high, >15%) using the World Health Organization (WHO) threshold survey protocol[21]. ADR was analysed using the Stanford HIVdb program. Genotypic susceptibility scores ≥60 for each NNRTI and/or NRTI were considered a high level of resistance[22].

Statistical analysis

Statistical analysis was performed using SPSS, version 20 (Chicago, IL USA). We used logistic regression analysis to identify potential risk factors for VLN and for PDR and ADR mutations. We used a multivariable model to assess biologically plausible interactions. Variables considered were age, education status, income from selling sex, khat chewing, heavy episodic drinking, sex-selling venues, frequency of sexual encounters per month, violence, being forced to sell sex, $CD4^+$ T-cell counts, vaginal discharge, and genital ulcers. In the model, we included a binary response, indicating detection of any VLN, PDR, and ADR mutations from each participant as an outcome. We analysed all variables separately and entered those associated ($p<0.2$) with the outcomes into the multivariable model. Odds ratios (crude and adjusted OR) with 95% confidence intervals (CI) were obtained using logistic regression analysis. P-values ≤0.05 were considered statistically significant. Although the data were collected using RDS sampling, our study focuses on a segment of samples (i.e., participants with VL≥1000 copies/mL) to extrapolate the HIVDR (ADR and PDR) prevalence among FSWs, sample RDS weighting was not included in our analysis.

Ethical considerations

The protocol was cleared by the Scientific and Ethical Research Office of EPHI, and the Ethiopian Science and Technology Ministry Ethical Committee Institutional Review Boards (NHSBS-Round 1). This project was reviewed in accordance with CDC human research protection procedures (CDC-IRB #6343.0) and was determined to be research, but CDC investigators did not interact with human subjects or have access to identifiable data or specimens for research purposes. Individual written informed consent was obtained from each participant.

Results

Figure 2 summarizes how participants were selected for HIVDR genotyping using the HIV test, VL and the genotyping results. Of 4900 participants, 1172 (23.9%) were HIV-positive; of these, 1154 (98.5%) had VL results and were grouped based on self-report in the ART-naïve or ART groups. The threshold for VL suppression was ≥1000 copies/mL per WHO recommendations[18]. Among 915 participants in the ART-naïve group, 453 had VL <1000 copies/mL, indicating they may have been exposed to ART but did not report it. The 521 samples (ART group, 59; ART-naïve group, 462) with VL ≥1000 copies/mL were subjected for HIVDR genotyping. The genotyping success rates were 82.5% for the ART-naïve group (381/462) and 66.1% (39/59) for the ART group, respectively. Overall HIVDR prevalence rates were 16.5% (63/381) for the ART-naïve group and 74.4% (29/39) for the ART group.

We also calculated the ART uptake of participants (proportion of FSWs who tested HIV positive and were receiving ART). Self-report of ART uptake was 20.7% (239/1154). However, including participants with VL <1000 copies/mL but who self-reported being ART naïve, ART uptake was 60.0% (692/1154).

Prevalence of pretreatment drug resistance

In the ART-naïve group, 462 participants had VL ≥1000 copies/mL, and 381 had genotyping results that were included in the PDR analysis. Median age was 25 years (interquartile range [IQR], 22–29 years). Median HIV VL and $CD4^+$ T-cell count were 28,823 copies/mL (IQR, 7,809–122,812 copies/mL) and 421 cells/mm^3 (IQR, 251–606 cells/mm^3), respectively.

Sixty-three (16.5% [95% CI: 12.8%–20.3%]) of the genotyped specimens were associated with at least one major DRM. The highest prevalence of PDR was found against NNRTIs (55/381 [14.4%]), and five DRMs (K103N, Y181C, G190A/E/S, K101E/P, and V106M) accounted for most (90.0%) of the NNRTI PDR mutations (Table 1).

NRTI PDR mutations were detected in 10.5% (40/381) of the specimens, and 9.2% (35/381) had dual-class (NRTI and NNRTI) DRMs. The most prevalent NRTI DRMs were M184V and thymidine-analogue mutations (TAMs; M41L, D67G/N, K70R, L210W, T215F/Y, and K219E/Q), accounting for 58.7% (37/63) and 27.0% (17/63) of the NRTI PDR, respectively. PI PDR mutations were detected in 0.8% (3/381) of the specimens (Table 1). According to the WHO classification of HIVDR prevalence, the overall PDR level among our participants was high (≥15%) but was moderate for NNRTIs and NRTIs and was low for PIs.

Prevalence and patterns of acquired drug resistance

Among 239 participants receiving ART, 59 (24.7%) had VL≥1000 copies/mL. Median $CD4^+$ T-cell count and VL were 384 cells/mm^3 (IQR, 163–568 cells/mm^3) and 10,225 copies/mL (IQR, 2,802–95,220 copies/mL), respectively. Genotyping was successful for 39 (66.1%) of the specimens. Twenty-nine (74.4% [95% CI: 60.7%–88.1%]) of the genotyped specimens had at least one major DRM. All 29 specimens had NNRTI DRMs, 23 (79.3%) had NRTI DRMs, and none had PI DRMs (Table 2). The most prevalent NNRTI DRMs were K103N, Y181C, and G190A. The most frequent NRTI DRMs were M184V (20 [69.0%]) and TAMs (18 [62.1%]; Table 2).

Dual-class resistance was present in 79.3% (23/29) of the specimens. Overall, the mean numbers of NRTI and NNRTI DRMs detected per specimen were 3.4 and 4.7, respectively. Four of the sequences had only one mutation (all NNRTI DRMs), three sequences had two mutations, and 22 (76.0%) of the sequences had ≥3 mutations.

Genotypic susceptibility scores of individual antiretroviral drugs indicated that many of the specimens had high levels of resistance to several of the most used first-line ART drugs in Ethiopia. Most (69.0%) specimens showed high-level resistance to lamivudine and tenofovir, nevirapine (100%), efavirenz (86.2%), and rilpivirine (51.7%; Supplementary Table 1).

Factors associated with VLN and HIVDR

In both bivariate and multivariate analysis, VLN was significantly associated with being forced into selling sex ($p<0.036$), age ≥35 years ($p<0.037$), and low $CD4^+$ T-cell counts (<350 cells/mm^3 ($p<0.001$; Table 3). In bivariate analysis, PDR was significantly associated with low CD4 counts ($p<0.001$) and ever giving birth ($p<0.03$). However, in multivariate analysis, only low CD4 counts remained significantly associated with PDR ($p<0.001$). Moreover, low CD4 counts were significantly associated with ADR in both bivariate and multivariate analysis ($p<0.001$).

Discussion

To our knowledge, this is the first national study that comprehensively describes the level of VLN and HIVDR among FSWs in Ethiopia. Overall, our results showed a high prevalence of HIVDR (PDR, 16.5%; ADR, 74.4%), poor ART uptake (20.7%), and high VLN (24.7%) with multiple DRMs among participants, which indicates high risk of HIVDR transmission to the general population.

We found high prevalence of PDR, particularly toward NNRTIs. This level is higher than the PDR level reported among the general population in Ethiopia (4%–6%)[10,23–29]. Consistent with our findings, other studies have reported high PDR levels (10%–48%) among FSWs in different countries, including those in sub-Saharan Africa[28,30–34]. Moreover, previous studies also have shown a higher PDR rate among communities and groups with high-risk behaviours[29,35]. This highlights the vulnerability of FSWs to HIVDR and the risk of onward transmission to the general population.

After 10 years of ART roll-out in Ethiopia, the prevalence of NNRTI PDR in our study is above the WHO-recommended levels to replace NNRTIs with dolutegravir in first-line regimens[36]. Similar findings have been reported in other LMICs, which depend on standardized first-line ART[37,38]. The high NNRTI DRM prevalence might in part be due to the low genetic barrier of these drugs and their wide use for prevention of mother-to-child HIV transmission and as part of the standard first-line ART regimen[12,39].

In our study, K103N, Y181C, G190A/E/S, K101E/P, and V106M accounted for the vast majority of the NNRTI PDR mutations. Strains with K103N and other NNRTI mutations have a fitness similar to wild-type virus, and the mutation can persist for years in HIV-positive individuals[39–41]. It is therefore likely that the high prevalence of these mutations is

a consequence of frequent transmission from sexual partners with unsuppressed viremia to FSWs. Consistent with our study, two meta-analyses have shown that these DRMs are the dominant SRDRMs in sub-Saharan Africa[37,38].

The most common NRTI PDR mutations detected in our study were M184V, K65R, and TAMs. However, both M184V and K65R revert to wild-type relatively quickly in the absence of ART[42,43] and would be expected to be found at low frequencies among individuals with PDR. Nevertheless, M184V is one of the most detected PDR mutations in most countries, including sub-Saharan African countries[38].

We found that FSWs had poor ART uptake. Only one in five HIV-positive participants were receiving ART, which is consistent with results of other studies in sub-Saharan Africa, showing generally poor ART uptake among FSWs (range, 26%–38%)[44–47]. However, in our study, more than half of participants with self-reported ART-naïve status had VL<1000 copies/mL, indicating they may have been exposed to ART but did not disclose this history[48–51]. A recent report from Ethiopia also showed that only 26% of HIV-positive FSWs were receiving ART[52]. Consistent with our results, several studies in sub-Saharan Africa have shown high levels of VLN among FSWs[28,53–56]. This might be due to multiple barriers, such as stigma related to HIV and sex work or high mobility, that prevent FSWs from accessing the HIV care continuum (20). Moreover, FSWs are frequently exposed to violence, and women who report violence have poor ART adherence and viral suppression[15,16].

Improving access to ART for FSWs and not only will improve the survival and health of this population but also will reduce the risk of HIV transmission to their clients and could lower HIV transmission at the general population level[4,57–59]. Our findings highlight the importance of identifying potential factors that prevent FSWs from accessing HIV treatment services. Improving ART uptake could help improve outcomes for clients in national HIV control programs[57,58]. Furthermore, targeting scaleup of viral load monitoring among FSWs could help ensure timely therapy changes for those with virologic failure, according to the national treatment guidelines[60].

In our study, a high proportion of FSWs with VLN carried dual-class DRMs with high genotypic susceptibility scores to several commonly used first-line ART drugs. Consistent with our study, other studies have reported high DRM frequency with a complex pattern in patients with prolonged use of failing regimens in the absence of VL monitoring[61,62]. Besides the resultant limitations in the choice of effective treatment regimens for patients with VLN, the high prevalence of HIVDR detected among participants in our study highlights the potential risk of HIVDR transmission to the general population. Furthermore, when individuals carrying multiple DRMs are switched to second-line therapy, there is a risk of introducing a functional monotherapy, which may be associated with substantial risk of subsequent virologic failure and emergence of HIVDR.

Among FSW receiving ART with VL ≥1000 copies/mL, 26% had no HIVDR mutations, which suggests that non-adherence could be the possible cause for the detected virologic failure. This shows the importance of strengthening adherence among FSWs and of using

HIVDR testing before treatment switches to reduce the cost associated with prematurely switching to costly second-line regimens.

We found that older participants aged ≥35 years experienced higher prevalence of VLN compared to younger participants aged 18–24 years.. This finding contrasts with those of a study in Uganda, where young (18–24 years) FSWs experienced higher prevalence of virological failure than older (>35 years) FSWs[28]. This difference might in part be due to the difference in the research design of the studies. The study in Uganda was conducted among FSWs with virological failure identified during follow-up, whereas our study collected lifetime ART status, and the older participants in our study might be more likely to have treatment failure due to prolonged ART exposure compared to younger participants. The longer the duration of ART treatment, the higher the odds of developing drug resistance leading to treatment failure[65].

Moreover, participants who reported being forced into sex work had higher prevalence of VLN. Women and girls forced into sex work are especially vulnerable because they cannot control their environment[16]. This may increase the risk of substance use as a coping mechanism, which can decrease the efficacy of ART (including poor adherence), potentially leading to treatment failure[66]. Our results showed that low $CD4^+$ T-cell count (<350 cells/mm^3) was associated with VLN and DRMs among ART-experienced participants, suggesting disease progression among those with VLN and ADR and underlining the importance of DRM monitoring to improve individual outcomes.

Our study has several limitations. One limitation of our study and similar studies is that the duration of HIV infection before sampling is unknown. Because our classification of ART status among participants was based on self-report, there is a risk of misclassification if participants did not disclose previous ART exposure for fear of discrimination, which has been documented in other studies[50,51,67]. We used 1000 copies/mL as the cut-off for VLN, however, other studies have shown the development of HIVDR among patients with low-level viremia[68]. The overall genotyping success rate was 80.6%, which might have affected the overall study results. Although the data used in our analysis was collected using RDS sampling, our study only focused on a segment of the samples (i.e., participants with VL ≥1000 copies/mL) to extrapolate the HIVDR prevalence among FSW, therefore, weighting was not included in the data analysis. We also did not collect information about ART regimens, ART duration, or ART adherence, which could affect the level of ADR. Finally, some of the ART-experienced participants with VLN might have been infected with a DRM virus.

Conclusions

The suboptimal ART uptake and high VLN and HIVDR levels detected among FSWs underscore the importance of programmatic intervention to improve ART access and routine virological monitoring among this population to maximize the benefit of ART and limit the spread of HIV, HIVDR and disease progression. Our findings also demonstrate the need for implementation of HIVDR genotyping to optimize selection of regimen and transition to dolutegravir-based first-line ART in Ethiopia.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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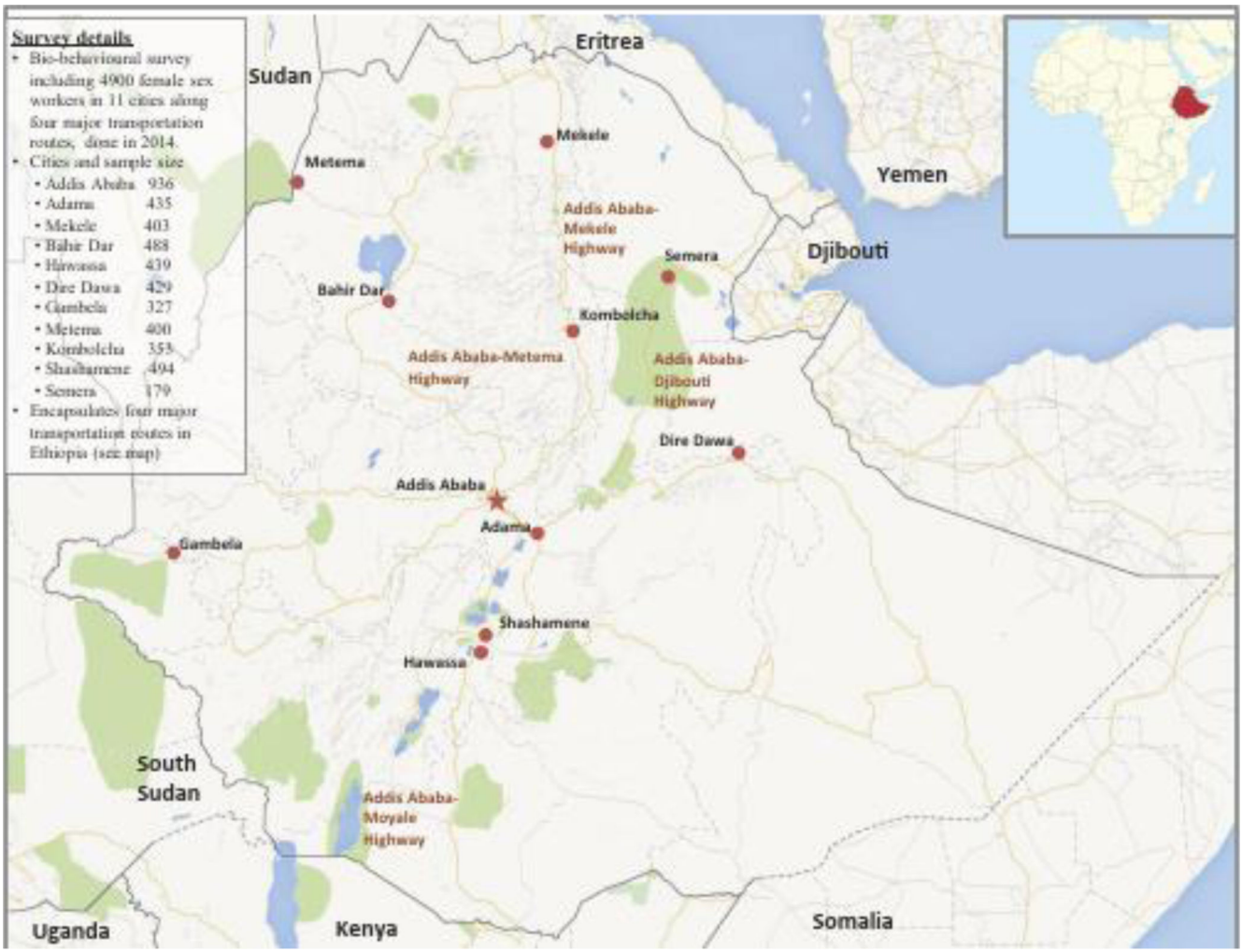

Figure 1.

Map of the cities in Ethiopia included in the 2014 study of HIV drug resistance among female sex workers. Details of the study are shown in the box. This figure was modified from Google Maps (https://www.google.com/maps/place/Ethiopia).

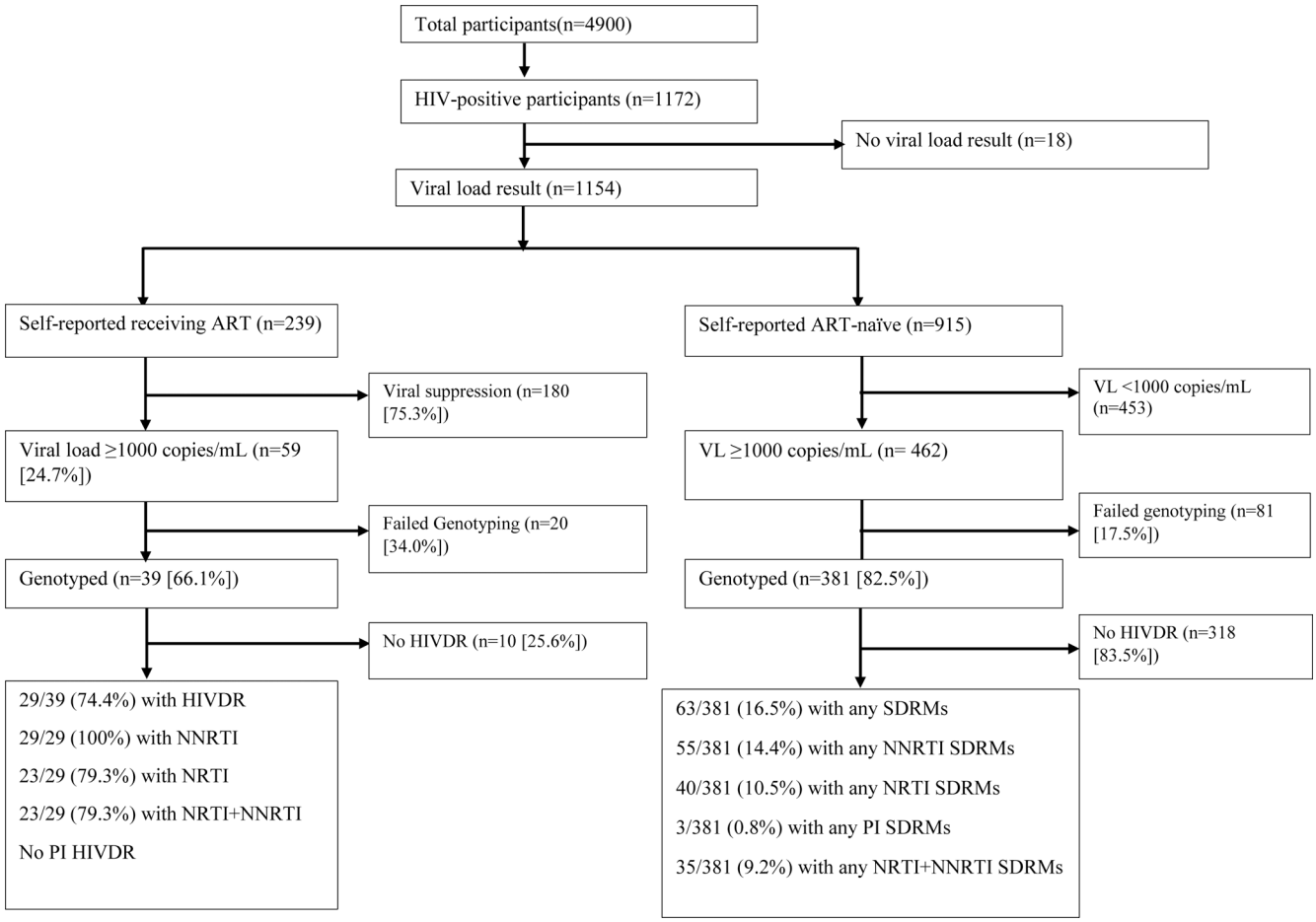

Figure 2.

Flow chart of selection of female sex workers who participated in a biobehavioural survey and genotypic analysis of drug-resistant HIV in Ethiopia (2014)

Table 1.

Frequency of pre-treatment drug-resistance mutations detected among female sex workers (n=63) in Ethiopia (2014)

NNRTI SDRMs	N (%)[1]	NRTI SDRMs	N (%)[1]	PI SDRMs	N (%)[1]
K103N/S	30 (47.6)	M184V/I	37 (58.7)	L23I	1 (1.6)
Y181C	17 (27.0)	K65R	10 (15.9)	M46I	1 (1.6)
G190A/E/S	14 (22.2)	T215F/Y	8 (12.7)	I85V	1 (1.6)
K101E/P	8 (12.7)	Y115F	3 (4.8)		
V106M	8 (12.7)	L210W	3 (4.8)		
Y188H	3 (4.8)	M41L	2 (3.2)		
M230L	3 (4.8)	K70R	2 (3.2)		
L100I	1 (1.6)	L74V/I	2 (3.2)		
V179F	1 (1.6)	D67N	1 (1.6)		
P225H	1 (1.6)	T69D	1 (1.6)		
		K219R/Q	1 (1.6)		

Abbreviations: SDRM, surveillance drug-resistance mutation included in the WHO 2009 SDRM list; NNRTI, non-nucleoside reverse transcriptase inhibitor; NRTI, nucleoside reverse transcriptase inhibitor; PI, protease inhibitors

[1]To calculate the percentages of each SDRM, we used 63 as the denominator, corresponding to the number of specimens with a PDR in the study.

Table 2.

Type and frequency of acquired drug resistance mutations detected among female sex workers with viral load non-suppression (n=29) in Ethiopia (2014)

NNRTI DRMs	N (%)	NRTI DRMs	N (%)
K103N/s	18 (62.1)	M184IV	20 (69.0)
Y181C	10 (34.5)	K65R	6 (20.7)
G190A/E/S	7 (24.1)	K70R/E	6 (20.7)
H221HY	6 (20.7)	T215F/Y	5 (17.2)
A98G	5 (17.2)	K219Q	4 (13.8)
K101E/P	5 (17.2)	A62V	3 (10.3)
V106M	4 (13.8)	Y115F	3 (10.3)
V108I	4 (13.8)	D67N	2 (6.9)
L100I	3 (10.3)	M41L	1 (3.4)
E138A	2 (6.9)	L74V/I	1 (3.4)
V179D	2 (6.9)		
P225H	2 (6.9)		
F227FL	1 (3.4)		
M230L	1 (3.4)		
K238T	1 (3.4)		

Abbreviations: NNRTI; non-nucleoside reverse transcriptase inhibitor; NRTI; nucleoside reverse transcriptase inhibitor; DRM, drug resistance mutation

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Table 3.

Bivariate and multivariate analyses for factors associated with virologic failure and HIV drug resistance among female sex workers in Ethiopia (2014)

	VLN			PDR			ADR		
	N	**OR (95% CI)**	**aOR (95% CI)**	**N**	**OR (95% CI)**	**aOR (95% CI)**	**N**	**OR (95% CI)**	**aOR (95% CI)**
Age, years									
18–24	30	Ref		163	Ref		128	ref	
25–34	139	2.36 (0.77–7.21)	3.02 (0.83–11.06)	175	1.57 (0.87–2.85) ¥	1.47 (0.74–2.92)	392	1.78 (0.51–6.18)	
≥35	70	2.25 (0.69–7.33) ¥	4.09 (1.04–16.1) *	42	1.84 (0.77–4.39) ¥	1.69 (0.65–4.41)	141	3.2 (0.86–11.83)	
Income (monthly; currency in USD)									
<$100)	169	Ref		230	Ref		432	ref	
≥$100	70	1.20 (0.64–2.27)		149	1.19 (0.69–2.06)		229	0.53 (0.19–1.46)	
Level of education									
No education	89	Ref		128	Ref		241	ref	
Primary 1st cycle (grade 1–4)	32	0.68 (0.23–2.01)		63	0.49 (0.20–1.20)		99	0.24 (0.03–1.92)	
Primary 2nd cycle (grade 5–8)	96	1.37 (0.70–2.70)		139	0.70 (0.37–1.32)		250	1.36 (0.59–3.18)	
Secondary and above	22	2.55 (0.95–6.86)		50	0.86 (0.37–1.20)		71	0.98 (0.19–4.94)	
Ever given birth									
No	52	Ref		130	Ref		194	ref	
Yes	187	1.12 (0.54–2.31)		250	2.02 (1.07–3.82) *	1.56 (0.76–3.20)	467	1.37 (0.49–3.83)	
Number sexual partners /month									
4–10	114	ref		164	Ref		267	ref	
≥11	125	1.76 (0.96–3.21) ¥	1.82 (0.89, 3.73)	216	1.02 (0.59–1.75)		394	1.99 (0.88–4.51) ¥	1.85 (0.71–4.83)
Sex selling venue									
Street	23	Ref		89	Ref		152	ref	
Local drinking houses	86	1.26 (0.38–4.16)		83	1.74 (0.80–3.79)		196	0.93 (0.23–3.73)	
Spa/massage/beauty salon/own house	31	1.39 (0.35–5.44)		23	1.23 (0.36–4.20)		56	0.79 (0.14–4.38)	
Red light houses	33	1.52 (0.40–5.81)		33	1.30 (0.45–3.76)		78	1.01 (0.20–5.08)	
Bar/hotel	49	1.90 (0.55–6.59)		136	1.01 (0.47–2.15)		140	1.09 (0.24–4.84)	
Other	17	4.22 (1.00–17.80)		16	0.39 (0.05–3.21)		39	2.11 (0.35–12.59)	

	VLN			PDR			ADR		
	N	OR (95% CI)	aOR (95% CI)	N	OR (95% CI)	aOR (95% CI)	N	OR (95% CI)	aOR (95% CI)
Heavy episodic drinking in the past month									
No	72	Ref		172	Ref		260	ref	
Yes	32	1.62 (0.62–4.26)		103	0.60 (0.29–1.23)		158	0.32 (0.04–2.66)	
Frequency of khat chewing per week									
Never	168	Ref		168	Ref		347	ref	
Less than once	23	1.17 (0.43–3.17)		51	0.40 (0.15–1.08)		77	1.08 (0.29–4.02)	
1–2 days	9	0.95 (0.19–4.74)		40	0.30 (0.09–1.02)		49	1.76 (0.34–9.03)	
3–4 days	3	1.65 (0.15–8.73)		24	0.52 (0.15–1.86)		30	0	
5–7 days	36	1.46 (0.66–3.22)		97	0.72 (0.38–1.39)		158	0.74 (0.20–2.66)	
Physically beaten in the past 12 months									
No	209	Ref		313	Ref		599	ref	
Yes	30	1.13 (0.47–2.69)		67	0.74 (0.35–1.59)		61	0.52 (0.19–2.39)	
Forced into selling sex									
No	213	Ref		326	Ref		581	ref	
Yes	26	3.03 (1.31–6.99) *	2.79 (1.07–7.27) *	54	0.59 (0.24–1.44)		80	3.77 (1.37–10.36) *	3.21 (0.99–10.38)
Unusual vaginal discharge in the past 12 months									
No	194	Ref		311	Ref		583	ref	
Yes	45	1.14 (0.54–2.38)		69	1.36 (0.70–2.64)		78	0.71 (0.23–2.19)	
Genital ulcer in the past 12 months									
No	215	Ref		335	Ref		260	ref	
Yes	24	1.02 (0.38–2.70)		45	1.30 (0.59–2.86)		158	0.32 (0.04–2.51)	
CD4 count (cell/mm^3)									
Lower (<350)	48	4.19 (2.11–8.32) *	4.67 (2.23–9.77) *	129	3.44 (1.90–6.23) *	3.24 (1.78–5.89) *	124	6.51(2.77–15.32) *	7.25 (2.95–17.83) *
Higher (≥350)	172	Ref		215	Ref		491	ref	

Abbreviations: PDR, pre-treatment drug resistance; ADR, acquired drug resistance; OR, odds ratio; aOR, adjusted odds ratio; CI, confidence intervals.

* P ≤ 0.05;

¥ P < 0.2;

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§Facilities other than those mentioned in the list.