Behavioral and Biological Factors Related to HIV Transmission among Female Sex Workers in Ethiopia

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2021

Document Version:
Publisher's PDF, also known as Version of record

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LUND
UNIVERSITY

DOCTORAL DISSERTATION

By due permission of the Faculty medicine, Lund University, Sweden.
Dissertation to be defended at Clinical Research Centre, Malmö,

December 20 2021 at 13:00.

Faculty opponent
Associate Professor Lynn Atuyame

School of Public Health, Makerere University, Uganda

Organization	Document name
LUND UNIVERSITY Faculty of Medicine, Department of Clinical Sciences, Malmö, Division of Social Medicine and Global Health.	**Doctoral Dissertation** **Date of issue** **December 20, 2021**
Author(s): Minilik Demissie Amogne	Sponsoring organization

Title: Behavioral and Biological Factors Related to HIV Transmission among Female Sex Workers in Ethiopia

Abstract

Due to legal, cultural, and social factors, female sex workers (FSWs) experience an elevated level of violence, heavy alcohol consumption, and sexual abuse. These individual and societal factors create a web of vulnerabilities that facilitate the spread of HIV within this population group. Moreover, stigma and discrimination are common among HIV-positive FSWs, contributing to poor HIV treatment adherence, drug resistance, and treatment failure. Effective HIV prevention programs among FSWs are therefore crucial to halt the spread of HIV not only among sex workers but also among the general population. Nevertheless, FSW-targeted programs and research activities are limited in quality, quantity, and coverage in Ethiopia. Thus, the general aim of this thesis was to explore the experiences of FSWs in Ethiopia to gain a better understanding of factors that contribute to the increased risk of HIV infection among FSWs.

Papers I, II, and III are based on a cross-sectional bio-behavioral study conducted among 4900 FSWs in eleven major towns in Ethiopia. The data collection was conducted using a respondent-driven sampling technique (RDS). A blood sample was collected for HIV, CD4, viral load and drug resistance testing. For paper IV, a qualitative study was conducted among 17 FSWs using a snowball sampling. Logistic regression was used as the main tool for analysis in the cross-sectional studies, and content analysis was used for qualitative data.

The results of Paper I showed that 17.5% of FSWs had been physically beaten within the last 12 months and 15.2% had been raped since they started selling sex. Bing young, sex-selling venues (street based), high consumption of alcohol, and khat chewing were significant predictors of physical violence (beating). The significant predictors of sexual violence (rape) were low income, high consumption of alcohol and khat chewing. Paper II revealed that 29.1% of the study participants experienced HED in the past month. Significant determinants of HED were being younger, being forced into selling sex, working in a bar/hotel, having a higher income, and chewing khat frequently. In turn, HED was significantly associated with physical beating and condom breakage. Paper III showed that the prevalence of pre-treatment drug resistance (PDR) among ART naïve FSWs was 16.5%, which is classified as high according to WHO criteria. Viral load non-suppression was significantly associated with being forced into selling sex, age ≥35 years, and low CD4+ T-cell counts (<350 cells/mm3). Only low CD4 counts were significantly associated with acquired drug resistance (ADR) and PDR respectively. Finally, Paper IV showed that FSWs who were taking PrEP faced stigma, due to the similarity of the PrEP pill to the ART pill, and experienced adherence-maintaining challenges. Reasons for not starting to take PrEP included fear of side effects, poor confidence, and/or misconceptions.

The findings indicated that different individual and structural factors among FSWs played a role in increased exposure to violence and HED, which in turn may increase vulnerability to HIV acquisition and transmission. The findings also suggest the need for targeted interventions to improve ART access and routine virological monitoring to control the transmission of both HIV and HIVDR. In addition, the challenges and barriers to PrEP uptake among FSWs need to be addressed to better facilitate the uptake of PrEP.

Keywords: Female sex workers, HIV, Violence, HED, condom failure, treatment failure, drug resistance, experience, PrEP challenge, Ethiopia

Classification system and/or index terms (if any)

Supplementary bibliographical information		**Language:** English
ISSN and key title 1652-8220 Doctoral Dissertation Series 2021:150		**ISBN** 978-91-8021-157-4
Recipient's notes	**Number of pages 94**	Price
	Security classification	

Signature  Date December 20, 2021

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Coverphoto by Minilik Demissie Amogne

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Lund University, Faculty of Medicine Doctoral Dissertation Series 2021:150
ISSN 1652-8220
ISBN 978-91-8021-157-4

Printed in Sweden by Media-Tryck, Lund University
Lund 2021

To family and friends

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List of original papers

The thesis is based on the following original papers:

1. Amogne MD, Balcha TT, Agardh A. (2019) Prevalence and correlates of physical violence and rape among female sex workers in Ethiopia: a cross-sectional study with respondent-driven sampling from 11 major towns. BMJ Open, 9(7)
2. Amogne MD, Agardh A, Abate E, Ahmed J, Asamoah BO. (2021) Determinants and consequences of heavy episodic drinking among female sex workers in Ethiopia: A respondent-driven sampling study. PLoS ONE 16(5)
3. Arimide DA, Amogne MD., et al. (2021) High level of HIV drug resistance and virological non-suppression among female sex workers in Ethiopia: a nation-wide cross-sectional study. Manuscript (*submitted to JAIDS*)
4. Amogne MD, Eduard J. Sanders, Belihu WB, Jesper Sundewall, Agardh A. (2021) Experiences of female sex workers concerning condom failure and the role of pre-exposure prophylaxis (PrEP) in Ethiopia: a qualitative study. (*submitted to BMC public health*)

The papers have been reprinted with permission from each journal

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Abbreviation

ADR: Acquired Drug Resistance

AIDS: Acquired Immunodeficiency Syndrome

AOR: Adjusted Odd Ratio

ART: Anti-Retroviral Treatment

ARV: Antiretroviral (drug)

CCR4: C-C Chemokine Receptor Type 4

CCR5: C-C Chemokine Receptor Type 5

CDC: Centers for Disease Control

DBS: Dried Blood Spot

DHS: Demographic and Health Survey

DIC: Drop-in Center

EPHI: Ethiopian Public Health Institute

FSW: Female Sex Workers

FTC: Emtricitabine

Gp120: Envelope Glycoprotein

HED: Heavy Episodic Drinking

HIV: Human Immunodeficiency Virus

HIVDR: HIV Drug Resistance

MSM: Men Who Have Sex with Men

NGO: Non-governmental organization

PDR: Pre-Treatment Drug Resistance

PLHIV: People Living With HIV

PMTCT: Prevention of Mother to Child Transmission

PrEP: Pre-Exposure Prophylaxis

PSI: Population Service International

RDS: Respondent Driven Sampling

STI: Sexually Transmitted Infection

TB: Tuberculosis

TDF: Tenofovir Disoproxil Fumarate

TDR: Transmitted Drug Resistance

VLN: Viral Load Non-Suppression

WHO: World Health Organization

Introduction

Sex work is the provision of sexual services in exchange for money or goods, and female sex workers (FSWs) are women who receive money or goods to provide sexual services either regularly or occasionally (1, 2). Although there are different reasons mentioned for being a sex worker, most FSWs are motivated by the need to earn money for a living. For the majority of FSWs, sex work is the option they have for securing an income. Others believe that sex work is better paid and offers more flexible working conditions and time than other jobs (3). Moreover, some women choose sex work because it provides them with more freedom and autonomy over their bodies (4). In Ethiopia, it is illegal to operate a brothel or procure sex workers as a commercial activity, but the sale of sex by women is neither prohibited nor legally recognized (5). Thus, being FSW is common, and mainly operates in bars, hotels, on the street, red-light houses, local drinking houses, and other venues.

Women are more likely to become infected and adversely affected by the HIV/AIDS epidemic than men due to biological, social, cultural and economic reasons (6). The greater the gender discrimination in societies, the more negatively they are affected by HIV (6, 7). In Ethiopia, the HIV/AIDS epidemic has remained a major public health problem, mainly affecting women and subgroups of the population such as FSWs. According to the DHS 2016, the HIV prevalence in the general population was estimated at 0.9% (1.2% women, and 0.6% men) (8). Nevertheless, according to a study conducted among FSWs, the HIV prevalence was 23%, signifying a disproportionate burden among FSWs (9). This provides evidence for the notion that FSWs play a significant role in expanding and sustaining the HIV epidemics in the country (10).

In addition, in most pparts of the world, FSWs experience a higher level of violence and sexual abuse than women in the general population do (11). Legal, cultural, and social factors, including working conditions, increase the exposure to violence for FSWs (11). Violence against sex workers is neither reported nor monitored properly due to the uncertain legal status of FSWs, which further increases risk of violence (12). Moreover, studies from various countries indicate that violence undermines condom use (13), reduces the ability of FSWs to negotiate proper condom use, and increases their exposure to unwanted pregnancy and HIV/STI (14–16).

Furthermore, alcohol use is considered as one of the important components of commercial sex work (17). Most of the venues where FSWs meet their clients serve

alcohol, and FSWs are expected to facilitate the trade (18). As studies from a variety of settings have indicated, harmful alcohol drinking exposes FSWs to risky situations, including unprotected sex, condom failure, and exposure to sexual violence (19–21). Understanding drinking contexts is thus a first step toward developing intervention and prevention programs to reduce alcohol's harmful effects on FSWs (18).

In Ethiopia, to battle HIV among FSWs, a range of prevention strategies including behavioral change communication, condom promotion and distribution, HIV testing and counselling, HIV treatment services, and STI screening and treatment have been implemented (22). Currently, to further strengthen the HIV prevention activity, the pre-exposure prophylaxis (PrEP) program has been launched for FSWs and discordant couples (22). Nevertheless, these prevention activities have not been as successful as expected due to multiple individual and structural factors at different levels. Stigma and discrimination, violence, substance use, and poor linkage of the interventions to structural factors are some of the challenges. Further, HIV-positive FSWs suffer more from treatment failure and drug resistance than the general population due to low access to health care services, poor adherence, and high attrition (23, 24). Challenges related to PrEP uptake, including side effects, stigma, and poor adherence, are also common among FSWs (25).

In general, in Ethiopia, knowledge and experience about how to work with sex workers on health and related issues remains limited. Therefore, the aim of this thesis is to bring together different epidemiological, behavioural, and biological data to develop evidence that may inform the HIV prevention programs among FSWs.

Overview of female sex workers

Selling sex has been practiced throughout the world since ancient times. Although specific details are lacking, 2400BC was the earliest recorded mention of prostitution as an occupation (26). Prostitution has been a key institution in varying societies for hundreds of years (27). It was widespread in ancient Greece, where it was practiced at various socioeconomic levels (28). Although prostitution has been highly popular, prostitutes have been considered to belong to the lowest level of society (27). The belief that prostitution is harmful shapes how individuals and communities approach the issue of prostitution (29). Different scholars debate the legality of prostitution. Some argue that prostitution should be completely abolished due to its nature of objectification and exploitation of women, while others view prostitution as a means by which women are actually empowered (27). But both parties agree that prostitution is a social issues such as gender equality and women’s rights to their own bodies (27). Starting from the 1980s, the term "sex work" became popular among activists advocating for the rights of sex workers (1). They consider

“prostitution” to be a deviance that dehumanizes individuals, so they prefer it to be recognized as a work (27).

Female sex work can be formal, such as commercial sex workers operating in different venues (brothels, hotels, on the street, or in red-light houses) or informal, which includes individuals who may not self-identify as sex workers and those who sell sex irregularly (30). In most parts of the world, attitudes towards FSWs are predominantly negative and/or conservative. Sex work is categorized as an offense against ethics and a threat to the morality of society (31). Thus, countries have different approaches towards sex work; some consider it legal, and some criminalize it or have an unknown status. In Nairobi, Kenya, it is illegal to make a living by selling sex (32). In the Netherlands and Australia, aspects of sex work are decriminalized, while in countries like Sweden, men who are involved in buying sex are criminalized, to create a public stigma to change their sexual behaviour (33). The criminalization of sex work creates an environment that makes FSWs vulnerable to violence and other unwanted outcomes (12).

The beginnings of commercial sex work in Ethiopia were associated with the movement of kings, landlords, warlords, and then expanded during the establishment of cities (34, 35). There were indications of the institution related to prostitution at royal camps in the Middle Ages, in the seventeenth-century city of Gondar, as well as later at commercial centers on the periphery of the empire (36). Later, the subsequent development of Addis Ababa and other towns witnessed the emergence of a modern type of sex work (36). The majority of sex workers are women who have moved to the cities from rural areas due to traditional and cultural practices, unwanted marriages; or to search for jobs (35, 37). Initially, the migrant women live and work as housemaids in individual households or as waitresses in drinking and eating establishments (bars, hotels, cafeterias, local drink selling houses, etc.) eventually, some of them join sex work due to different individual and structural factors (35, 37).

According to a 2014 estimate, the size of the sex worker population in Ethiopia was 120, 000 to 160,000 (9, 38). Currently, sex work in Ethiopia is undergoing demographic change as the number of FSWs is growing, and much younger girls are joining the sex trade (39). There are concerns that younger women engaging in sex work may be less likely to negotiate safer sex such as condom use with their partners (40).

HIV/AIDS

The human immunodeficiency virus (HIV) that causes acquired immunodeficiency syndrome (AIDS) has been one of the world's health and development issues since the first cases were reported in 1981 (41,42). Despite major advances in treatment over recent decades, it continues to be a significant and complex global health concern. Approximately 76 million people have become infected with HIV since the start of the epidemic, and 36.3 million [27.2–47.8] people have died from AIDS-related illnesses (42). In 2019, an estimated 38 million people were living with HIV, with approximately 1.7 million new infections and 690,000 deaths (42). Women represent over half (55%) of the adults (15-49 years) living with HIV (PLHIV) worldwide (42). Sub-Saharan Africa, with more than two-thirds of all PLHIV globally, is the hardest-hit region in the world, followed by Asia and the Pacific (12, 41–43) .

The most common route of HIV transmission worldwide is heterosexual contact. Sex workers, men who have sex with men, people who inject drugs, transgender people, and prisoners are groups of the population disproportionally affected by HIV (41). Although HIV continues to be a global public health issue, increasing access to effective prevention, diagnosis, treatment, and care is making it a manageable health condition (41, 43) .

There are two types of HIV (HIV type 1 and HIV type 2); worldwide, the dominant type is HIV-1, and HIV-2 is most concentrated in the West African regions (44, 45). HIV disease progresses from an asymptomatic period, through mild symptoms, to severe disease characteristic (46). Several factors determine the individual progression of HIV, such as the age of diagnosis, baseline CD4+ T-cell counts, genetics, and comorbidities (45, 46) . The symptoms vary depending on the stage of infection; in the first few weeks, some people may experience no symptoms or an influenza-like illness including fever, headache, rash, or sore throat. As the infection progresses, it weakens the immune system, causing swollen lymph nodes, weight loss, fever, diarrhea, and cough-like symptoms (45, 46). Without treatment, infected persons could also develop severe illnesses such as tuberculosis (TB), cryptococcal meningitis, severe bacterial infections, and cancers such as lymphomas and Kaposi's sarcoma (46).

CD4+ T cells are the primary target of HIV, which also express chemokine receptors (CCR5, CCR4) that are exploited by HIV to enter the cells (47). The fusion begins after the attachment of the CD4 binding domains of gp120; then the envelope complex undergoes a structural change, exposing the chemokine binding domains of gp120 and allowing them to interact with the target chemokine receptor (47). After HIV has bound to the target cell, the HIV RNA and various enzymes (including integrase, reverse transcriptase, protease, and ribonuclease) are injected into the cell for replication. Understanding the mechanisms of HIV attachment and replication has implications for potential treatment production (48, 49).

HIV/AIDS in Ethiopia

The first cases of HIV infection and AIDS cases in Ethiopia were reported in 1984 and 1986, respectively (50). In the 1980s and early 1990s, Addis Ababa was the center of the epidemic, after which in the early 1990s the epidemic spread to other areas (50). In Ethiopia, the major transmission route is heterosexual contact and to a lesser extent through mother-to-child transmission, traditional surgical practices, and probably injecting drug users (51). Up till now, the HIV/AIDS epidemic has remained a major public health problem, becoming more concentrated in urban areas and sub-population groups (37). Higher prevalence in larger towns may be associated with labor migration due to large-scale construction projects and growing service industries (38).

In 2019, the prevalence of HIV in the general population was 0.9% (4) and the estimated number of PLHIV in Ethiopia was 669,236. Of these, 11,613 people were newly infected and 11,546 people died of AIDS (52). In the same year, 61.8% of the HIV-positive population were women (52). The HIV epidemic in Ethiopia is heterogeneous by gender, region, and sub-population groups. For example, the HIV prevalence in urban areas was seven times higher than in rural areas (2.9% versus 0.4%) and among regions, it varied from 0.16% in the Somali region to 4.45 in the Gambella region (8). **(Figure 1)**

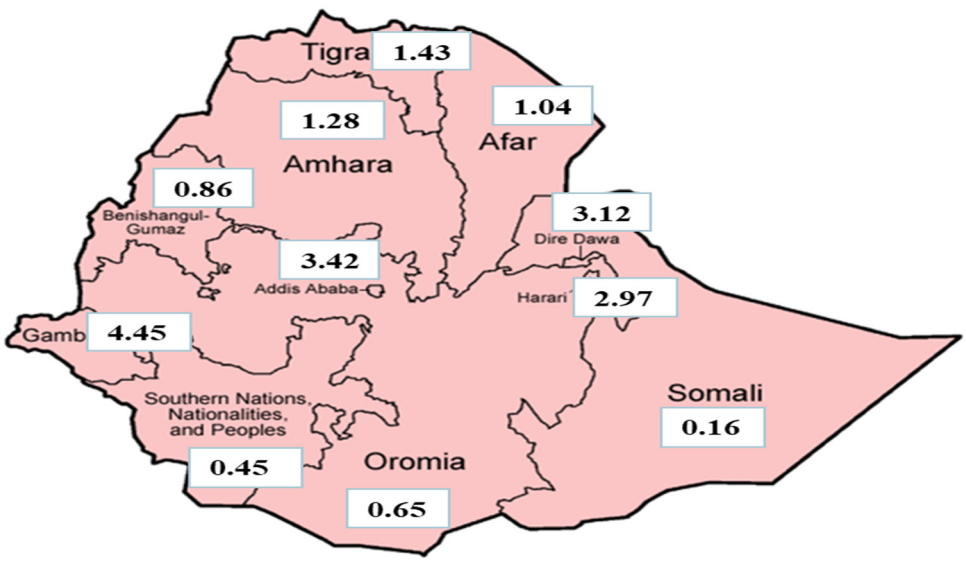

Figure 1: HIV prevalence by region, Ethiopia

The government of Ethiopia has demonstrated a high level of commitment to combat the epidemic since the late 1980s (50). A National Task Force on HIV was established in 1985, and a strategic framework and a national HIV/AIDS program were launched in 1987 with technical and financial support from the World Health Organization (WHO) (50). The first core government intervention has been community conversation (CC), in each Kebele (lower level administrative unit) and then among in-school youth at primary and secondary levels (38). Since then, the country has made remarkable efforts to control the HIV/AIDS epidemic. However, the prevalence remains relatively high in cities, with a 3% prevalence rate compared to less than 1% nationally (53). Although reductions in the incidence rates are remarkable successes, tracking new infections has become a challenge, resulting in poor progress to achieve the first 90, awaring all PLHIV to know their HIV status (54). The gaps identified to achieve epidemic control include preventing the spread among key populations, including FSWs, ensuring retention in care, new case identification, and improving treatment coverage for pediatrics (54). This requires extra efforts to identify new HIV infections, groups that carry the highest-burden, and infected individuals who have been missed with the existing system. Thus, the country has implemented HIV/AIDS as a notifiable disease and established a case-based surveillance system integrating it with index case testing (53).

Furthermore, the country has identified key and priority population groups, considering local epidemiology. The identified key populations are FSWs and prisoners, and the priority populations are widowed, separated or divorced women, distance drivers, PLHIV and their partners, and mobile workers in hotspot areas (22).

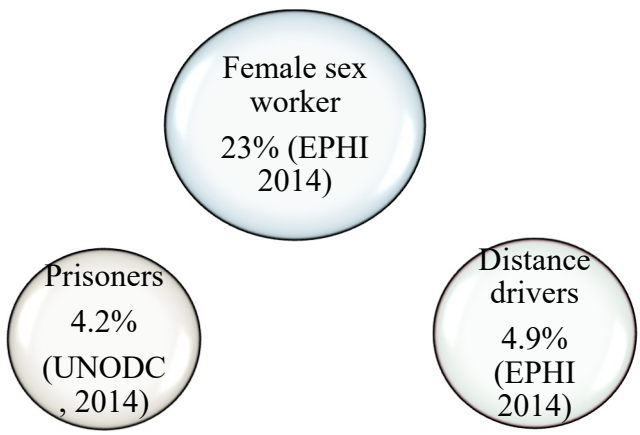

Figure 2: HIV prevalence of key and priority populations in Ethiopia

Female sex workers & HIV/AIDS

FSWs have high rates of client turnover and unprotected sex, both of which are associated with high rates of HIV and other STI infections (43). Due to that, they have often been described as a group in which the infection is endemic and from whom it spreads to the population at large (37). The stigma, marginalization, and discrimination of the society in various ways contribute to their vulnerability to HIV. In addition, sometimes sex workers are powerless to negotiate safer sex; clients may use intimidation or violence to force unprotected sex (55).

The HIV prevalence among the FSW population in the world is estimated to be 10 to 20-fold higher than in the general population (43). In 1985, less than one percent of sex workers tested positive for HIV in Ethiopia, but that rose to 36 to 55% in five urban areas by 1990 (50). According to a 2014 study, the overall weighted HIV prevalence among FSWs was estimated to be 23%, ranging from 14% in Hawassa town to 32% in Mekele and Bahirdar town (9). If one compares the HIV prevalence among FSWs with the HIV prevalence in the general population (0.9%), the difference is notable. The HIV prevalence among FSWs in Rwanda was estimated to be 50% (56) and 29.5% in Nairobi, Kenya, indicating that HIV has a disproportionate effect on FSWs everywhere (57).

Together with HIV testing, promoting consistent condom use has been one of the most commonly advocated preventive interventions for FSWs in Ethiopia (39). Condom use at last sex with a paying partner has been reported to be high, at 98.4% but lower with a non-paying regular partner at 61.4% (9). The most cited reason mentioned for not using condoms with a regular partner in a behavioral study among FSWs in five Ethiopian cities was trust (9). This may be one of the gaps in addressing HIV transmission where regular relationships are common. In addition, condom use is compromised by violence, clients' demand to have sex without a condom, the alcohol or drug consumption level of the client and/or FSWs themselves, and other contextual factors (58, 59).

Despite the adoption of strategies to reduce vulnerability among FSWs in Ethiopia, the actual implementation has been poor. In the 1980s, the Ethiopian government started a rehabilitation program for sex workers that included vocational skills training and provision of work in various factories (39). However, the initiative lacked motivation and eventually failed, partially because the sex workers were not considered in the planning of the project (39). Few services are currently available for sex workers in major Ethiopian towns. Some non-governmental organizations (NGOs) have implemented drop-in centers where a range of services are provided, including education, recreation, washing facilities, rights advocacy, and preventive and curative health services, including ART and PrEP provision (60). However, these programs are limited in quality and coverage and are compounded with multiple challenges, including the lack of updated data (size estimation, and behavioral and biological data). In addition, there is limited access to FSW-friendly

services in health facilities and poor mechanisms to protect FSWs from violence (22). Moreover, some organizations are reducing their sites due to budget-related issues. A study conducted in 12 towns showed that only 42% of sex workers were reached by service providers and HIV prevention outreach workers (38).

Although they work in a difficult environment, FSWs try to use different approaches to reduce exposure to HIV/STI and unintended pregnancy. Studies conducted in Mexico and Côte d'Ivoire reported that FSWs recommend using female-controlled methods such as female condoms and avoiding drug and alcohol use during sex work as a mechanism to reduce the exposure (61, 62). Studies conducted in Ethiopia also reported similar mechanisms to reduce the incidence of unwanted outcomes (15, 63). Besides their actions, FSWs suggest that good access to health care and psychological support will improve their efforts to reduce exposure and its effects (62, 64). In addition, in a study conducted in the Philippines, FSWs suggested peer-based approaches to promote prevention activities such as condom use could be a good preventive mechanism (64).

In general, in order to address the high burden of HIV among FSWs, UNAIDS recommends (12):

1. Addressing the violence against sex workers
2. Decriminalizing sex work
3. Strengthening sex work communities.
4. Scaling-up and funding health and social services for sex workers

Protection of human rights, particularly protection against discrimination, is the core principle in the prevention of HIV (7). Stigma, denial, and fear of disclosure due to discrimination among FSWs living with HIV continue to fuel the epidemic and remain a serious impediment to any control efforts in Ethiopia (51).

Violence

According to the United Nations, “gender-based abuse” is “any act of violence that results in, or is likely to result in, physical, sexual, or psychological harm or suffering to women, including threats of such acts, coercion, or arbitrary deprivation of liberty, whether occurring in public or in private life” (65, 66). It is one of the major contributors to death and illness, social isolation, poor economic productivity, and loss of personal freedom among women and girls (67). In sub-population-groups such as FSWs, the burden is multiplied.

The majority of sex workers have experienced violence in their lives; some even accept it as a normal part of the job, although it is not inherently violent (68). The

violence is mainly driven by stigmatized beliefs towards FSWs, social marginalization, and criminalization of the work (68). Violence towards sex workers comes from a broad spectrum of perpetrators, including the police, clients, intimate partners, gangs, bar managers, and/or members of the surrounding community (16, 69).

Addressing violence among FSWs has the potential to reduce HIV transmission. A modelling estimate conducted in Kenya and Ukraine shows that the reduction of violence among FSWs led to an approximately 25% reduction in incidents of HIV infections (70). Individual and structural measures should be considered to reduce violence better and protect this population group. Considering the strong negative relationship between violence and HIV-related care, such interventions could improve HIV-related health outcomes (68, 71)

Besides violence, stigma and discrimination towards FSWs are common in most parts of the world (12). According to a definition provided by Link and Phelan, (72) which is the most widely used, stigma is the co-occurrence of labelling, stereotyping, separation, status loss, and discrimination in a context in which power is exercised. Stigma is manifested as widespread violations of human rights, repressive laws, violence, and lack of access to appropriate health and social care, and social marginalization (73). For sex workers living with HIV, the stigma is multiplied, due to the sex work plus being HIV positive (39).

Stigma and discrimination have also been pointed out as fundamental causes of population health inequalities (73). Stigma in health care services may increase negative health-seeking attitudes and practices (74). Social and cultural isolation combined with stigma and discrimination further reduce FSWs' access to social and health services, preventing FSWs from seeking HIV-related services (12). A study in Russia reported that stigma from healthcare providers towards sex workers living with HIV had a greater impact than stigma due to sex work alone (75). In addition, the police and other law enforcement officials often violate the rights of FSWs rather than providing support and protection. Abuses committed by police include verbal and physical abuse, arrest, and refusal to provide protection (76). For the HIV prevention program to be effective, HIV responses should be grounded in the respect of human rights, including non-discrimination on the basis of sex work and/or HIV status (77).

Alcohol and drug use

Alcohol use has been identified as an important component of commercial sex work (17). According to studies in Kenya, India, and Malawi, most FSWs perceive alcohol as a facilitator for sex work, which helps to attract clients, enabling them to earn extra money, but also as a contributor to violence and/or unprotected sex (19,

20, 78). A study conducted in Kenya reported that the incidence of HIV and violence among hazardous drinkers was 9.6 and 3.1 times higher than their counterparts, respectively (19). In another study conducted in China, FSWs who drank alcohol reported inconsistent condom use and higher rates of STI history (79). In addition, harmful drinking reduces adherence to ART, which accelerates the disease progression of HIV, leading to treatment failure and drug resistance (19). According to a cohort study in Switzerland, high-alcohol consumers were twice as likely to interrupt their therapy than their counterparts, and treatment interruption is one of the main causes of treatment failure (80, 81).

On the other hand, due to behavioral and structural factors, FSWs are at high risk of unintended pregnancies and abortions (82, 83). Although not conducted among FSWs, a study conducted in Ghana reported that women who consumed alcohol were at a higher risk of dying from abortion than those who did not drink (84). Given the high consumption of alcohol and unintended pregnancy among FSWs, the risk of dying among FSWs during abortion would be much higher.

Besides alcohol, other drugs also contribute to the vulnerability of FSWs. In Eastern and Central Europe and Central Asia, injecting drug use is one of the routes of HIV and other infection transmissions among FSWs (20, 85). In Ethiopia, FSWs often chew Khat (Catha edulis) in the daytime to increase energy during the night for sex work and to socialize with other FSWs (86). Khat is a plant grown commonly in the horn of Africa; the leaves are chewed to attain a state of euphoria and stimulation (87). In the body, khat can increase blood pressure and heart rate, like other stimulants. According to studies conducted among the general population in Ethiopia, chewing khat was associated with having risky sexual behaviors and high alcohol consumption (88, 89). Nevertheless, the positive and negative contribution of khat chewing to sex work is not well documented. Studies are needed to clarify how chewing khat negatively affects FSWs' behavior and khat's link with unwanted health outcomes.

HIV/AIDS treatment and treatment failure

The introduction of antiretroviral therapy has been one of the success stories for HIV prevention. It was introduced in 1996 and led to dramatic reductions in morbidity and mortality due to HIV/AIDS. As of 2019, 25.4 million (67%) of PLHIV in the world are on treatment (41). The treatment includes the use of combination antiretroviral therapy (ART) to attack the virus and medications to prevent and treat opportunistic infections (41,90). Engagement in HIV treatment not only improves individual health outcomes but also significantly reduces the risk of transmission (treatment as prevention). Individuals with viral load suppression have effectively no risk of transmitting HIV sexually to their partners (91). Therefore,

attaining success in distributing ARV, maintaining adherence, and sustaining viral load suppression are means to control onward HIV transmission.

In Ethiopia, ART provision began in 2003 and free ART was launched in 2005 (92). In 2019, 473261 (75%) of PLHIV in Ethiopia were on ART. However, data on HIV-positive FSWs who are on ART is limited, and it is difficult to determine the success and failure of the treatment. Yet, according to the PSI Ethiopia estimation report, only 26% of HIV-positive FSWs are on treatment, magnifying the risk of HIV onward transmission. According to a recent meta-analysis among FSWs living with HIV, ART initiation ranges from 19% in Kenya to 48% in Rwanda, and current ART use ranges from 23% in Kenya to 70% in Burkina Faso (93). Stigma and discrimination, poor nutrition, and substance use were commonly reported and associated with poor linkage to care, ART initiation, and retention in care among FSWs (94, 95) .

Early enrollment in ART and achieving viral load suppression reduces mortality and improves the quality of life (96). Viral load monitoring ensures a reduction in misdiagnosis of treatment failure, leading to effective utilization of limited resources. However, virological failure remains a common problem for HIV patients. Virological non-suppression (VLN) is when the viral load is ≥1000 copies/ml of blood (97). The causes of ARV treatment failure and VLN include poor adherence, poor absorption of medications, inadequate dosing, drug-drug interactions, and drug resistance (94, 98) .

Like any other drug, HIV medicines are subject to the emergence of drug-resistant strains. HIV drug resistance is caused by changes in the genetic structure of HIV that affect the ability of drugs to block the replication of the virus (81). If not prevented, HIV drug resistance can affect the efficacy of antiretroviral drugs, resulting in increased numbers of HIV infections and HIV-associated morbidity and mortality (99, 100).

The WHO has identified three types of HIV drug resistance that threaten the HIV response (101).

1. Transmitted HIVDR (TDR) occurs when an uninfected, treatment-naive person is infected with a drug-resistant strain of HIV from someone with HIVDR mutations.
2. Acquired HIVDR (ADR) occurs when a treatment-experienced person living with HIV develops drug mutations. It could be due to poor treatment adherence, treatment interruptions, inadequate drug concentrations in the body, etc.
3. Pre-treatment HIVDR (PDR) is detected at the time of first-line ART initiation or re-initiation, which could be due to transmitted drug resistance, or HIVDR acquired as a result of previous ARV exposure, such as mothers

and children in prevention of mother-to-child transmission programs (PMTCT).

HIV-positive FSWs are a marginalized group that is often stigmatized and also highly mobile, which leads to poor adherence, further leading to drug resistance and treatment failure (102). In a study conducted in Guinea-Bissau, ART experienced and treatment naive FSWs had 50.0% and 9.4% HIVDR, respectively (95). HIVDR among FSWs in Tanzania was also reported in 54 (39.1%) of 138 samples (103). When compared with the general population, the levels among FSWs were very high, signifying their disproportionate effect. Understanding the HIV care and treatment experiences of FSW is therefore important for intervention activities to enhance ART treatment outcomes and control the onward transmission (104).

Pre exposure prophylaxis (PrEP)

PrEP is one of the biomedical prevention methods that came into practice for public use to further decrease the transmission of HIV among population groups at higher risk of HIV (90, 105). PrEP is a combination of the antiretroviral (ARV) Tenofovir disoproxil fumarate (TDF) and Emtricitabine (FTC) and has been shown to be effective in reducing the risk of HIV acquisition (106). In 2015, the WHO recommended PrEP as a form of prevention for high-risk individuals in combination with other prevention methods. Following that, the Ethiopian health minister adopted and started PrEP provision for FSWs and negative partners of discordant couples in health facilities and in DIC centers (105).

PrEP provides additional protection for FSWs, reducing their vulnerability from partners and clients who prefer or insist on sex without condoms (107). Having additional protection when other prevention methods are unavailable, or when condoms break, for example, is perceived by FSWs as a benefit of PrEP (108, 109). Nevertheless, different misconceptions and barriers compound PrEP uptake. According to a systematic review conducted worldwide, the most mentioned barriers to PrEP use were concerns about safety, side effects, cost, and effectiveness (106). The review identified that participants had safety concerns about whether it could affect their health since PrEP involves taking a pill while healthy. Among most at-risk population groups, including FSWs, barriers mentioned include stigma surrounding similarity with ARV drugs and concerns related to taking the pill daily (106, 109). Lack of social support also hinders PrEP uptake and adherence among FSWs (107). In Ethiopia, there have been no studies exploring the challenges and benefits of PrEP use. Understanding the barriers and motivators to PrEP uptake and adherence among FSWs is critical for the development of effective methods to attain better PrEP use.

Theoretical framework

Bronfenbrenner Ecological Theory

In this thesis, Bronfenbrenner's ecological theory model (110–112) was used to explain the interaction among contributing factors for increased HIV exposure among FSWs. Ecological systems theory can be used to conceptualize health (e.g. in terms of HIV-infection) as a product of interaction between, on the one hand individuals, focusing on intra-personal factors and on the other hand environmental factors, interpreted in terms of microsystems, mesosystems, exosystems, and macrosystems (110, 111).

Individual factors that make female sex workers more vulnerable to HIV include personal characteristics (age, educational status, etc.) and cognitive factors (knowledge, attitude, perception, and misconceptions) and how the individual interacts with different aspects of the environment through behaviors (condom use, alcohol, and drug use), (85, 113–115) . We have included these personal factors and behaviors in the study design and data analyses to gain a deeper understanding of the risks that increase HIV infection.

Microsystem: The microsystem is the innermost layer of Bronfenbrenner's model. It assesses interpersonal relationships and direct interactions with one's immediate surroundings (111). FSWs have different social networks and relationships with clients and peers, which could play a role in changing their attitudes and practices concerning protection. These interactions affect proper condom use, alcohol use, and health-seeking behavior either positively or negatively (116). We examined the role of the client’s behavior and demand from FSWs experience which could increase the risk of HIV among FSWs.

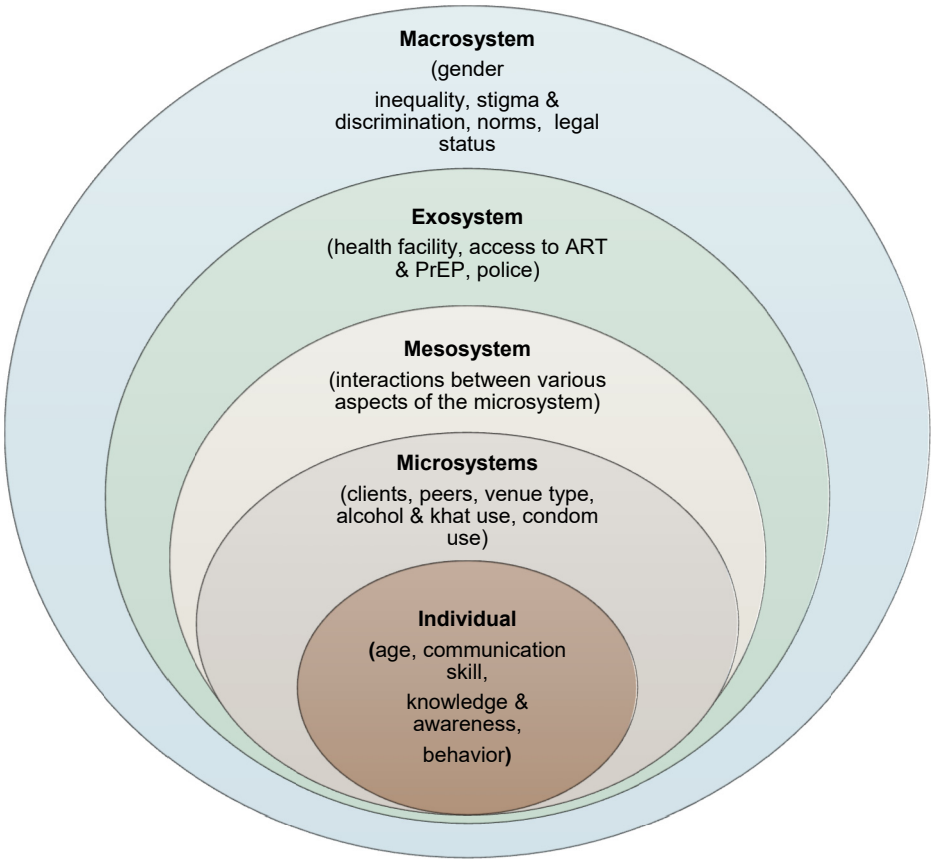

Figure 3. Bronfenbrenner's ecological theory as a framework for increased HIV risk exposure among female sex workers in Ethiopia

The mesosystem: includes interactions between various aspects of the microsystem (112). In the case of FSWs, their interaction and relation with the working organization (venues) may have contributed to behavior change and HIV infection. FSWs who work in bars may have greater access to alcohol, while street-based FSWs may not have, so understanding these structural differences can help formulate appropriate prevention strategies (117). We conducted analyses to understand the association between venues, physical violence, HED occurrence, and the role of FSWs.

Ecosystem: includes institutions that influence an individual's daily settings but are not part of that individual's immediate environment (112). Typical examples of this for FSWs are the health care system and the police. The actions of health care

facilities have the potential to determine the health-seeking behavior of FSWs who use HIV-related services. The positive attitudes of health service providers have the potential to increase the retention and adherence of HIV positive FSWs, contributing to minimizing the emergency of drug resistance and treatment failure. In addition, the interaction between the police and FSW contributes to either violence reduction or aggravation. A study conducted by the Johns Hopkins Bloomberg School of Public Health suggests that more abusive interactions with police increased the risk of violence at the hands of clients (118).

The macrosystem is the outermost layer of Bronfenbrenner's model. This system includes social or cultural ideologies and beliefs that affect an individual's environment (112). FSWs are the most stigmatized and discriminated group in the population due to cultural values and norms, laws, and gender inequality. As different studies have shown, both FSWs and PLHIV experience a high level of stigma and discrimination (119). HIV-positive FSWs who face stigma are exposed to isolation, poor social support, and poor health service utilization, causing treatment failure (72, 73, 95). In the qualitative analysis, we analyzed to see the role of stigma in PrEP uptake behavior among FSWs.

Rationale

As indicated by different studies (8, 120), the HIV epidemic in Ethiopia is heterogeneous by region and different sub-groups. Among those expected sub-groups, FSWs play a major role. FSWs are exposed to numerous adverse conditions such as poor living and housing, social marginalization and stigma, violence and STIs, including HIV (35). Thus, effective HIV prevention programs for FSWs are very crucial for halting the spread of HIV in Ethiopia. However, there is limited national level data related to the magnitude and the risk factors associated with HIV infection among the FSWs in Ethiopia. The available informations on the prevalence and exposing factors of HIV, violence, and HED is limited, and focuses only on a specific site or venues (15, 63, 121).

In addition, there is a critical information gap regarding factors contributing to the HIVDR emergence and viral load non-suppression among FSWs. While FSWs are the core group for spreading and sustaining the HIV epidemic (10), not having data relating to factors contributing to treatment failure will contribute to sustaining the HIV epidemic. Moreover, there is no data regarding the challenges and opportunities of PrEP uptake among FSWs in Ethiopia. Thus, generating such types of evidence based on data at a national level will help to promote prevention, treatment and intervention activities.

Therefore, this thesis aims to contribute to knowledge on FSWs' vulnerability and exposure to HIV through understanding violence, HED, HIVDR, and PrEP uptake. It also explores aspects that contribute to the increased risk of HIV infection from individual, interpersonal, and structural perspectives. The knowledge generated will be used to develop better strategies and targeted interventions to reduce the spread of HIV and ease the burden among FSWs.

Aims

General aims

The overall aim of this doctoral thesis is to obtain evidence regarding behavioral and biological factors that contribute to the increased exposure to HIV among FSWs and to gain a deeper understanding of experiences that might contribute to such exposure.

Specific aims

Aim I: To assess the prevalence and correlates of physical violence and rape among female sex workers.

Aim II: To assess the determinants and consequences of heavy episodic drinking (HED) among female sex workers.

Aim III: To assess factors that contribute to an elevated level of drug resistance and treatment failure among female sex workers.

Aim IV: To explore the experiences of FSWs concerning condom failure and the role of pre-exposure prophylaxis.

Methods

This thesis is based on a mixed-methods study design, aimed to provide a deeper understanding of the factors that increase risky behavior and exposure to HIV and other outcomes among FSWs. A mixed-methods design is a procedure for collecting and analyzing data that incorporates both quantitative and qualitative methods in order to better understand a particular phenomenon (122). In Ethiopia, FSWs are common and mainly operate in bars, hotels, on the street, red-light houses, local drinking houses, and other venues, especially concentrated in larger towns. Different data sources and data collection methods were used to assess and explore factors related to violence, HED, condom failure, PrEP uptake, viral load non-suppression, and drug resistance occurrence. **Table 1** below provides an overview of the aims, study design, data source, and analytical approaches of the studies. Both quantitative (Paper I, II, III) and qualitative (IV) research designs were applied.

Table 1: Summary of the papers study design, sample size, data collection and analysis.

Papers	Aims	Study design	Sample	Data collection	Analysis
Paper I	To assess the prevalence and correlates of physical violence and rape among female sex workers.	Quantitative Cross sectional	Random sample of 4900 FSWs residing in 11 towns in Ethiopia	A structured face to face interview	Descriptive and multivariate regression analysis
Paper II	To assess the determinants and consequences of heavy episodic drinking (HED) among female sex workers	Quantitative Cross sectional	Random sample of 4900 FSWs residing in 11 towns in Ethiopia	A structured face to face interview	Descriptive and Multivariate regression analysis.
Paper III	To assess factors that contribute to an elevated level of drug resistance and treatment failure among female sex workers	Quantitative Cross sectional	Random sample of 4900 FSWs residing in 11 towns in Ethiopia	A structured face to face interview	Descriptive and Multivariate regression analysis, and HIV drug resistance analysis
Paper IV	To explore the experiences of FSWs concerning condom failure and the role of Pre-exposure prophylaxis	Qualitative	17 FSWs residing in Addis Ababa	In-depth interviews	Content analysis

Papers I-III

Study design, population and samples

Papers I, II, and III are based on a cross-sectional bio-behavioral study conducted in 2014 in Ethiopia. The study was conducted in seven major regional capitals (Addis Ababa, Adama, Bahir Dar, Dire Dawa, Gambella, Hawassa, and Mekele) and four transport corridor towns (Kombolcha, Logia, Metema, and Shashemene). RDS was employed to recruit a sample size of 400 in each town, and a total of 4900 FSWs participated in the study. The RDS recruitment strategy is a popular way to recruit marginalized populations such as FSWs to obtain population-level estimates (123). The number of FSWs available in each town and equilibrium attainment affected the sample size. Equilibrium theory is when peer recruitment reaches a sufficiently large number of waves, and the sample stabilize, becoming independent of the seeds from which recruitment began and thereby overcoming bias the non-randomly selected seeds may have introduced (124).

Data collection procedure

For papers I, II, and III

Seeds (initial participants) were used in each town to initiate the study according to the RDS principle. Seeds were selected based on the type of sex worker, age category, and geographic location. All FSWs who come the study site were assessed for eligibility, after that they were offered consent for interview and HIV testing. A face-to-face interview with a structured questionnaire was conducted (Appendix I). The questioners was piloted before the actual implementation to assess the questions and make the study team familiar with the content. The pilot was conducted in a city that was not part of the study site. After completing the interview, in line with the concept of RDS, the participants were given three coupons to recruit potential participants. To avoid double participation, and ensure only one-time participation, an anonymous fingerprint code was generated using a scanning device.

Whole blood was collected from each participant for HIV, CD4, viral load, and drug resistance testing. All the study participants were tested and counselled using the national HIV testing algorithm, and HIV positives were linked to health care services. This algorithm uses HIV (1 + 2) Antibody Colloidal Gold (KHB) as a screening test, followed by HIV 1/2 STAT-PAK if positive. In cases with negative STAT-PAK results, a third test, Unigold HIV, was used as a confirmatory test.

Reimbursement was given to compensate the time and costs for transport and other related costs by the participants. This was determined using results from a formative assessment conducted in three cities (Addis Ababa, Dire Dawa, and Hawassa).

About 100 ETB ($5.0) was given for successful participation (self-participation) and an additional 50 ETB ($2.5) for each successful participant she recruited.

Coupon Management: An electronic database for tracking coupons and recruitment was established with participant ID, fingerprint code, and a pre-printed label that was scanned. The software keeps track of recruitment data, including who recruited whom and when they were interviewed.

Blood Specimen Collection and Processing

Plasma samples and dried blood spot (DBS) samples were prepared using a standard operating procedure. After collecting a blood sample (6-10ml) using an EDTA tube, HIV testing was performed. Then, when the test result became positive, 1.8 ml of whole blood was aliquoted for CD4 testing using a nunc tube. In addition, a five-spot dried blood spot (DBS) sample was prepared before plasma separation. A pre-printed label was pasted on the DBS filter papers for further analysis along with behavioral data. After centrifuging, the plasma was aliquoted into three pre-printed labelled nunc tubes for ELISA, viral load, drug resistance and QC testing. The plasma was stored under -20 degrees in a nearby health institute and the DBS was stored at room temperature until transported to EPHI on a weekly basis. All the necessary precautions were taken during transportation of the samples to EPHI. Plasma specimens were transported using iceboxes (with ice packs, $<0C^{o}$) and the DBS specimens were separately wrapped in glycine paper to prevent cross-contamination and transported at room temperature using envelopes. Until testing, the plasma specimens were stored at $-80C^{o}$, and the DBS specimens at $-20C^{o}$ freezers at the EPHI national HIV laboratory. After testing, the remaining samples were stored for future testing. HIV testing was done using Enzyme Linked Immunosorbent Assays (ELISA) according to WHO standards. ELISA tests that were previously evaluated at EPHI, Vironostika Uniform II Ag/Ab (Combo) for screening and Murex Ag/Ab tests (Combo) as a confirmatory test were used.

The process of sample collection, storage and testing was monitored by introducing a pre-tested control material (known positive sample) according to EPHI standard operating procedures. For DBS specimens, a humidity indicator was included (one humidity indicator card and a moisture absorbent with a different level of humidity in a plastic bag).

Internal quality control samples (plasma) from EPHI were included to control the process of HIV testing. For external quality control, 5% of the positives and 5% of the negative specimens were sent to the HHS/CDC-Atlanta laboratory.

A CD4 cell count was performed for all HIV positive study participants in all towns. The laboratory test was done within 48 hours of sample collection using the FACS caliber or FACS count system at regional laboratories. Internal quality control material was included in the reagents for the CD4 machine (like FACS caliber or FACS count system) according to the manufacturer's procedure. Plasma viral load

count was conducted at the EPHI National HIV Laboratory using the Abbott Real-time HIV-1 assay, and the drug resistance testing was conducted at the Atlanta Centers for Disease Control (CDC) laboratory.

Measures

Dependent variable

The dependent variables for Paper I were physical beatings in the previous 12 months and rape since they began selling sex. For physical beating, the participant was asked 'When exchanging sex for money during the last one year, have you ever been physically beaten by a sexual partner or client?' and for rape, 'Have you ever been raped or forced to have sex against your will since you started selling sex?'. The responses to each question were dichotomized into a 'yes' and 'no' answer. For both questions, all who had reported beating and rape at least once were considered as having experienced violence (yes). The different time durations used to assess experiences of physical beatings and rape were based on the presumed frequency of the two different types of violence. Physical beatings might occur more frequently, while rapes occur less frequently. Therefore, to measure the general burden of the two experiences, and minimize recall bias, we specifically selected the time duration that might be appropriate for the recall of the particular experience.

For Paper II, five dependent variables were used to assess the determinants and consequences of heavy episodic drinking. HED was measured according to the WHO definition of "at least 60 grams or more of pure alcohol on at least one occasion in the past 30 days" (125).

Consumption of 60 grams of pure alcohol corresponds approximately to six standard alcoholic drinks. The participants were asked: "How often do you have 6 or more drinks on one occasion?" A drink was defined as a drink of beer, liquor, or other local drinks such as Tella, Tej, or Areke. The response alternatives were 0, Never; 1, Less than once a month; 2, Monthly; 3, Weekly; and 4, Daily or almost daily. For the purpose of the analysis, respondents who selected 2 through 4 were categorized as engaging in monthly HED. Those who never drank were grouped with those who did not have HED.

To examine the potential consequences of HED, four dependent variables were used, including HIV status, violence, condom breakage/slippage, and inconsistent condom use. Condom breakage/slippage and inconsistent condom use were assessed in terms of the last 30 days before the study. Inconsistent condom use was measured with the question, "With how many different paying partners did you have sex without condoms in the last 30 days?" Not using condoms at least once was considered inconsistent condom use.

To assess factors contributing to drug resistance and virological failure (Paper III), three dependent variables were used, including viral load non-suppression (VLN), pre-treatment drug resistance (PDR), and acquired HIVDR (ADR). VLN is when the viral load level ≥1000 copies/mL based on WHO criteria (100). PDR is a resistance that is detected among people newly initiating ART or ART naive individuals, while ADR is when ART-experienced individuals develop a drug-resistant strain (100).

Independent variable (Paper I-III)

For Paper I, the independent measures included current age, monthly income from selling sex, marital status, educational status, sex-selling venue, frequency of khat chewing, alcohol drinking, HIV status, and condom breakage.

For Paper II, the independent variables were the current age, the age at which the participants began to sell sex, being forced into selling sex, whether participants supported others (financial or in-kind), monthly income from selling sex, educational status, sex-selling venue, frequency of chewing of khat, and whether they ever used any other drugs.

For Paper III, the independent variables were current age, monthly income, educational status, sex-selling venue, alcohol consumption, frequency of khat chewing, number of sex transactions/month, being forced into selling sex, violence (physical beating), HED, self report of having vaginal discharge and ulcer, and CD4 count.

Current age was a continuous variable and, for the purpose of analysis, categorized into ten-year intervals: younger (15-24), middle age (25-34), and older (35+), with the younger age group used as the reference category.

Monthly income from selling sex was an open-ended question and for the analysis was categorized into 1000 birr ($50) intervals considering the cost of living in the country at the time. (Papers I & II).

Monthly income from selling sex (Paper III) was an open-ended question and for the analysis was dichotomized into two (less and over $100), due to the small sample size. The analysis focused only on HIV positives participants with viral load non-suppression.

Educational status was categorized as no formal education, primary first cycle (grade 1-4), primary second cycle (grade 5-8), and secondary and above, in accordance with the country's education system.

In addition, sex workers were categorized based on their *sex-selling venue*,

Alcohol consumption was measured by different indicators, including frequency of alcohol consumption, number of drinks per specific day and frequency of heavy episodic drinking (6 or more standard drinks per day).

Frequency of khat chewing was assessed according to the number of days they used khat in a week.

Ever using any other drug was measured and was categorized as "yes" or "no." Using any other drug at least once was categorized as "yes."

Data analysis

For Papers I and II, the analysis considered all records of the source study and included 4900 eligible FSWs from eleven towns.

In Paper I, 4900 FSWs were included in the analysis, and the data was managed directly by SPSS without applying weights, whereas in Paper II, RDS-based weights were applied for each record in the data set. RDS weights were generated using RDS-Analyst software. On top of this weight, information on the estimated number of FSWs in each town, as well as the number of completed interviews in each town was applied to obtain a final weight.

In Papers I, II, III, a descriptive analysis was applied to describe the demographic and socioeconomic characteristics of the study participants. In addition, binary and multivariate logistic regression was applied to determine independent factors associated with violence, HED, VLN, ADR and PDR among FSWs. In addition, correlation analysis was performed to examine potential multicollinearity. Cases with missing data were excluded from the analyses and significance was accepted at p-value <0.05. In Paper III, all variables which became significant at bivariate $P<0.2$ were entered into a multivariable model.

In addition, in Paper II, attributable risk fractions (AF) for paricipants who reported HED, and population attributable risk fractions (PAF) for the entire FSW population were analysed to assess the specific contribution of HED experiance for the occurrence of physical beating, condom breakage/slippage, and inconsistent condom use. The proportions were calculated to measure the effects that could be avoided if HED was prevented under an assumption of a causal link between HED and the listed variables (126).

For Paper III, the analysis focused on a segment of the samples, i.e., HIV positive participants, to determine the VLN and HIVDR (ADR and PDR) level among FSWs. Therefore, in the ART-naïve group, 462 participants had a viral load (VL) $\geq$ 1000 copies/ml and 381 successful genotyping results were included in the PDR analysis. For ADR, among 239 self-reported ART-experienced FSWs, 59 (24.7%) had a VL $\geq$ 1000 copies/ml and among those, 39 (66.1%) were successfully genotyped. Factor analysis for ADR considered all virally suppressed participants (692), considering that viral load suppression is impossible without ART unless the individual is an elite controller. In addition, VLN analysis was conducted among

239 self-reported ART experienced FSWs based on a 1000 copies/ml viral load threshold according to WHO criteria (100).

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 WHO threshold survey protocol (127). ADR was analyzed using the Stanford HIVdb program. Genotypic susceptibility scores of ≥ 60 for each NNRTI and/or NRTI were considered a high level of resistance (128).

Paper IV

Study design, population and samples

A qualitative study with a snowball sampling technique was conducted among FSWs from January 2021 to February 2021, in Addis Ababa, Ethiopia. Addis Ababa is the capital city of Ethiopia and more than 10,000 FSWs are estimated to operate in different venues (9). Seventeen FSWs participated in the study and the sample size was decided based on the saturation of the information.

Data collection procedure

A semi-structured interview guide (Appendix II) was developed and four pilot interviews were conducted to evaluate the flow of the interview and identify sensitive areas. The first participant was approached in the drop-in center (DIC), and then the chain of sampling continued using snowball sampling until saturation. All interviews were conducted privately to maintain confidentiality. The interview was audio-recorded after obtaining permission from the participants.

Data analysis

For the current study, we used manifest and latent qualitative content analysis as described by Graneheim and Lundman (129). First, the recording was transcribed in Amharic, and then translated into English for the further steps in the analysis. Then, to gain an overall picture of the interview transcriptions, the two interviewers read the transcriptions independently. The next step was identifying the relevant meaning units, which then was condensed. After that, the meaning units were coded. Then the codes were grouped into categories, making sure that codes were not grouped more than once or missed. The two interviewers discussed the resulting

categories until they reached a consensus. Then the categories were shared with the rest of the research team for further discussion. Finally, after a thorough discussion with all the study members, emerging themes were identified.

Ethical considerations

For all of the studies included in the thesis, the Ethiopian Public Health Institute's ethical review board (EPHI-IRB) provided ethical clearance for the study protocol. In research involving human subjects, the principles of ethics need to be strictly followed for the sake study participants. Especially for vulnerable population groups such as FSWs, ethical procedures should be adhered strictly. FSWs are considered vulnerable due to their possible low-income status and low literacy level, which exposes them to easy exploitation by third parties. Therefore, the ethical process among FSWs should be strict.

The four ethical principles, i.e. respect for autonomy, beneficence, non-maleficence, and justice, were strictly followed in the studies included in this thesis (130). Adequate oral and written information was provided to the study participants, explaining the purpose of the study and the data collection procedure. Confidentiality was assured and possible benefits and disadvantages of the study were described to the participants. They were told that they have the right to withdraw from the study at any time and was informed that the withdrawal has no any consequences. Individual informed consent was sought from each participant before the interview. In addition, the study members were trained to make every effort to protect the privacy and confidentiality of the data. The names and all personal identifiers were removed from the written transcript and replaced with code numbers. Thus, the name or identity will never be associated with the contents of any future analysis or written document.

Results

A total of 4900 FSWs participated in the study. The majority of the participants were between the ages of 15 - 24 years old, with a mean age of 24 years, and 44% of them were divorced, separated or widowed. A quarter of them reported no formal education and 40% of them earned a monthly average income of less than $50. The majority started selling sex between the ages of 18-24 years, although nearly 25% started before the age of 18. Thirty-three percent met their clients in bars/hotels, followed by 26.5% on the street **(Table 2)**. **Figure 3** below shows the recruitment tree in one of the study sites (Shashemene Town). The different colors indicate different seeds.

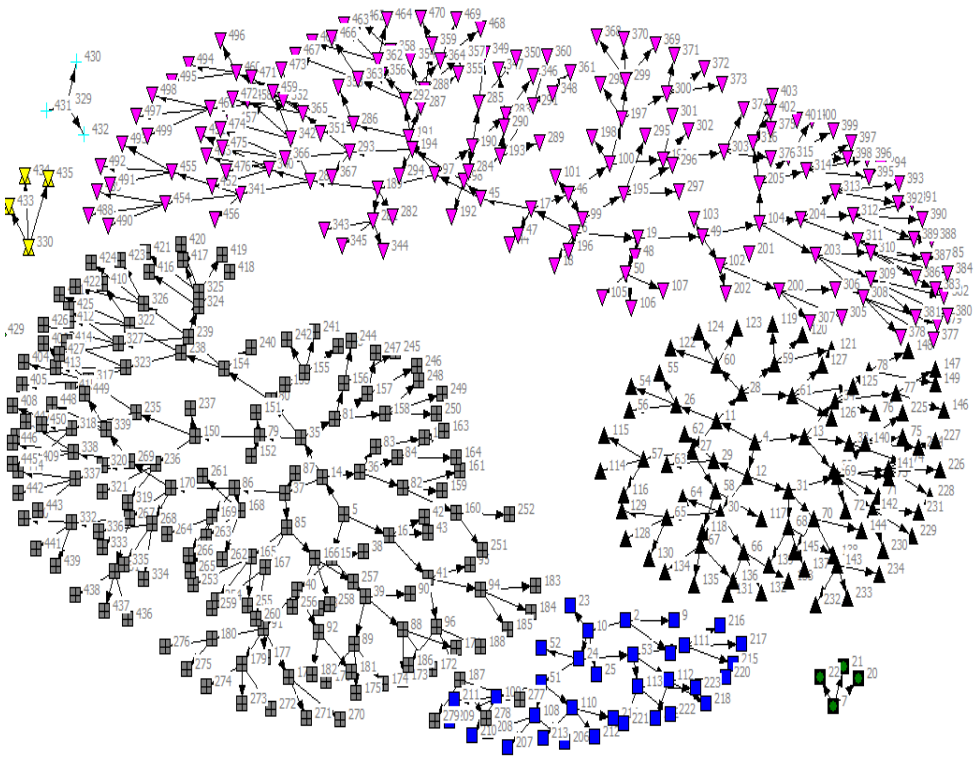

Figure 3: Recruitment chain of one of the study sites (Shashemene town), generated by RDS 7.46 software.

The majority (70%) of the respondents consumed alcohol, and about half of the respondents chewed khat. Regarding condom use, 25.5% of them reported condom breakage within the past 30 days prior to the study. Regarding physical and sexual violence experiences, 17.5% and 15.2% of them reported physical beatings within the past 12 months and rape since they started selling sex, respectively. The HIV/AIDS status of the respondents was also assessed, and a quarter of them (24%) were HIV positive. In addition, 54.9% of HIV positive participants had a viral load suppression level of <1000 copies/ml. This indicates that most of the study participants who were on ART did not report or hid their actual status for unknown reasons. According to studies, without being on ART, achieving viral load suppression is impossible unless the individual is an elite controller. Elite controllers are HIV-positive people who maintain low viral load levels without needing to take ART for many years and make up less than 0.5% of the HIV-positive population (131). **Table 2** shows the distribution of the sample characteristics

Table 2. Distribution of socio-demographic, behavioural and other factors among 4900 female sex workers across eleven towns, Ethiopia

Variable	Frequency	Percentage
Age		
15 - 24	2831	57.8
25 - 34	1700	34.7
35+	369	7.5
Total	4900	100.0
Missing	0	
Mean age of respondents = 24.16 SD= 5.7		
Educational status		
No Education	1224	25.0
Primary 1st cycle (1 - 4)	764	16.0
Primary 2nd cycle (5 - 8)	2062	42.0
Secondary & above	831	17.0
Total	4881	100.0
Missing	19	
Sex selling venues		
Bar/Hotel	1613	33.0
Local drinking houses	983	20.1
Spa/Massage/Beauty salon/Own house	261	5.3
Red-light houses	429	8.8
Street	1295	26.5
Other	304	6.2
Total	4885	100.0
Missing	15	
Current marital status		
Never Married	2698	55.2
Married/Cohabited	37	0.8
Separated/Divorced	1976	40.5

Widowed	173	3.5
Total	4884	100.0
Missing	16	
Sex selling starting age		
Less than 15	120	2.5
15 - 17	1088	22.3
18 - 24	2864	58.7
25 - 29	583	12.0
30 & above	220	4.5
Total	4875	100.0
Missing	25	
Monthly income from selling sex		
Less than 1000 (<$50)	1932	39.6
1001 - 2000 ($50 - $100)	1554	31.8
2001 - 3000 ($100 - $150)	812	16.6
3001 - 4000 ($150 - $200)	318	6.5
4001 - 5000 ($200 - $250)	150	3.1
Above 5000 (>$250)	117	2.4
Total	4883	100.0
Missing	17	
Frequency of alcohol consumption		
Never	1493	30.6
Once a month or less	222	4.5
2 - 4 days a month	492	10.1
2 - 3 days a week	1394	28.5
4 or more days a week	1283	26.3
Total	4884	100.0
Missing	16	
Alcohol containing drinks on a typical day		
1 or 2	806	23.8
3 or 4	1383	40.8
5 or 6	742	21.9
7 to 9	296	8.7
10 or more	164	4.8
Total	3391	100.0
Missing	0	
Frequency of heavy episodic drinking		
Never	1863	54.9
Less than monthly	236	7.0
Monthly	299	8.8
Weekly	630	18.6
Daily or almost daily	363	10.7
Total	3391	100.0
Missing	0	
Drunk so much and can't remember what happened the next day		
Yes, in last 30 days	534	15.8
Yes, not in last 30 days	233	6.9
No	2609	77.2

Don't remember	4	0.1
Total	3380	100.0
Missing	11	
Frequency of khat chewing		
Never	2431	49.8
Less than once a week	577	11.8
1 - 2 days per week	429	8.8
3 - 4 days per week	284	5.8
5 - 7 days per week	1162	23.8
Total	4883	100.0
Missing	17	
Condom breakage in the past 30 days		
Yes	1243	25.5
No	3635	74.5
Total	4878	
Missing	22	
Ever been raped or forced to have sex since start selling sex		
No	4142	84.8
Yes	742	15.2
Total	4884	100.0
Missing	16	
Physically beaten in the last 12 months		
No	4026	82.5
Yes	855	17.5
Total	4881	100.0
Missing	19	
HIV status		
Negative	3708	76.0
Positive	1172	24.0
Total	4880	100.0
Missing	19	
Self-reported ARV status		
On ARV	239	20.7
Not on ARV	915	79.3
Total	1154	100.0
Viral load level (both ART experianced and ART naive)		
VL <1000 copies/mL	633	54.9
VL ≥1000 copies/mL	521	45.1
Total	1154	

Paper I

Female sex workers and violence

Tables 3 and **4** show the findings of the bivariate and multivariate logistic regression analysis to determine factors associated with physical beating and rape. Being older (35+) was significantly associated with low physical beating (aOR 0.59, 95% CI 0.38, 0.92). In addition, FSWs who attended primary 1st cycle faced fewer physical beatings than those who reported no education (aOR 0.71, 95% CI 0.52, 0.97). The sex-selling venue where FSWs meet their clients was associated with physical beatings. When compared with FSWs who worked in bars/hotels, those who worked on the street (aOR 1.92, 95% CI 1.53, 2.39), in red-light houses (aOR 1.63, 95% CI 1.12 to 2.38) and in local drinking houses (aOR 1.35, 95% CI 1.02 to 1.78) had an increased odd of physical beating. Furthermore, substance abuse contributed to physical violence; FSWs who drank alcohol four or more days per week (aOR 1.92, 95% CI 1.21, 3.04), those who had heavy alcohol consumption in the past 30 days (aOR 1.98, 95% CI 1.58, 2.49), and before past 30 days (aOR 1.85, 95% CI 1.35, 2.53) had more likelihood of experiencing physical violence. In addition, FSWs who chewed khat 3-4 days per week (aOR 1.58, 95% CI 1.13, 2.21) and 5-7 days per week (aOR 1.43, 95% CI 1.13, 1.80) had experienced more beatings. Physical beating was also associated non-optimal condom-use. FSWs who had been physically abused had significantly more condom breakage (aOR 1.51, 95% CI 1.25, 1.84). **(Table 3)**

Table 3. Bivariate and multivariate logistic regression analysis of factors associated with physical violence (physically beaten) in the past twelve months among female sex workers across eleven towns in Ethiopia,

Variables	Crude OR (95%)	aOR (95%CI)
Age		
15 - 24*		
25 - 34	1.02 (0.87, 1.19)	1.04 (0.82, 1.22)
35+	0.52 (0.37, 0.74)	0.59 (0.38, 0.92)
Educational level		
No Education*		
Primary 1st cycle (1 - 4)	1.01 (0.79, 1.31)	0.71 (0.52, 0.97)
Primary 2nd cycle (5 - 8)	1.35 (1.11, 1.63)	0.98 (0.77, 1.26)
Secondary & above	1.49 (1.18, 1.87)	1.14 (0.85, 1.53)
Monthly income from selling sex		
Less than 1000 birr (<$50) *		
1001 - 2000 birr ($50-$100)	1.44 (1.20, 1.73)	1.13 (0.90, 1.41)
2001 - 3000 birr ($100-$150)	1.67 (1.35, 2.07)	1.14 (0.87, 1.48)

3001 - 4000 birr ($150-$200)	1.61 (1.19, 2.17)	1.12 (0.77, 1.61)
4001 - 5000 birr ($200-$250)	2.12 (1.44, 3.14)	1.44 (0.93, 2.24)
Above 5000 birr (>$250)	1.62 (1.01, 2.58)	1.12 (0.63, 1.99)
Current marital status		
Never Married*		
Married/Cohabited	1.05 (0.46, 2.41)	0.68 (0.24, 1.89)
Separated/Divorced	0.93 (0.80, 1.09)	1.08 (0.88, 1.29)
Widowed	0.59 (0.37, 0.95)	0.87 (0.48, 1.59)
Sex selling venues		
Bar/Hotel*		
Local drinking houses	0.87 (0.69, 1.09)	1.35 (1.02, 1.78)
Spa/massage/beauty salon/own house	0.45 (0.28, 0.71)	1.04 (0.58, 1.84)
Red-light houses	0.95 (0.71, 1.27)	1.63 (1.12, 2.38)
Street	1.51 (1.26, 1.82)	1.92 (1.53, 2.39)
Other	1.37 (1.01, 1.86)	1.39 (0.98, 1.99)
Frequency of alcohol consumption		
Never*		
2 - 4 days a month	1.82 (1.35, 2.44)	1.25 (0.77, 2.04)
2 - 3 days a week	2.07 (1.66, 2.57)	1.32 (0.84, 2.06)
4 or more days a week	3.54 (2.87, 4.37)	1.92 (1.21, 3.04)
Alcohol containing drinks on a typical day		
1 or 2*		
3 or 4	1.39 (1.09, 1.76)	1.08 (0.84, 1.39)
5 or 6	2.03 (1.58, 2.62)	1.15 (0.85, 1.57)
7 to 9	2.19 (1.59, 3.03)	1.09 (0.74, 1.64)
10 or more	2.76 (1.88, 4.03)	1.14 (0.72, 1.81)
Frequency of heavy episodic drinking		
Never*		
Less than monthly	1.43 (1.03, 1.98)	1.07 (0.75, 1.52)
Monthly	1.23 (0.90, 1.66)	0.84 (0.59, 1.18)
Weekly	1.73 (1.39, 2.14)	1.07 (0.82, 1.39)
Daily or almost daily	1.97 (1.53, 2.55)	0.99 (0.71, 1.38)
Drunk so much and can't remember what happened the next day		
No*		
Yes, in the last 30 days	2.90 (2.37, 3.56)	1.98 (1.58, 2.49)

Yes, before last 30 days	2.22 (1.65, 2.99)	1.85 (1.35, 2.53)
Frequency of khat chewing in a week		
Never*		
Less than once a week	1.24 (0.96, 1.60)	1.04 (0.77, 1.42)
1 - 2 days per week	1.67 (1.28, 2.18)	1.30 (0.96, 1.77)
3 - 4 days per week	2.49 (1.87, 3.34)	1.58 (1.13, 2.21)
5 - 7 days per week	2.48 (2.08, 2.96)	1.43 (1.13, 1.80)
Condom breakage		
No*		
Yes	1.99 (1.69,2.33)	1.51 (1.25, 1.84)
HIV test result		
Negative*		
Positive	1.04 (0.88, 1.24)	--

Abbreviations: OR, Odd ratio; aOR, adjusted odds ratios; CI, confidence interval; * Reference

Due to the nature of the work and clients' behavior, FSWs experience more forced sex. FSWs who earned a relatively lower income experienced more forced sex or rape. In addition, drinking alcohol four or more days per week (aOR 2.33, 95% CI 1.47, 3.7), experience of heavy episodic drinking (aOR 1.71, 95% CI 1.24, 2.38), and chewing khat 3-4 days per week (AOR 2.15, 95% CI 1.55, 2.98) were positively associated with rape. Moreover, condom breakage (AOR 1.26, 95% CI 1.03, 1.55) was significantly more frequent among FSWs who reported rape. **(Table 4)**

Table 4. Bivariate and multivariate logistic regression analysis of factors associated with sexual violence (rape) since sex selling start among female sex workers across eleven towns in Ethiopia,

Variables	Crude OR (95%)	aOR (95%CI)
Monthly income from selling sex		
Less than 1000 birr (<$50) *		
1001 - 2000 birr ($50-$100)	0.69 (0.58, 0.85)	0.62 (0.49, 0.77)
2001 - 3000 birr ($100-$150)	0.51 (0.39, 0.66)	0.42 (0.32, 0.57)
3001 - 4000 birr ($150-$200)	0.65 (0.46, 0.92)	0.45 (0.29, 0.69)
4001 - 5000 birr ($200-$250)	1.01 (0.66, 1.55)	0.84 (0.53, 1.33)
Above 5000 birr (>$250)	0.75 (0.44, 1.27)	0.62 (0.34, 1.15)
Educational level		
No Education*		
Primary 1st cycle (1 - 4)	1.45 (1.14,1.85)	1.06 (0.79, 1.43)
Primary 2nd cycle (5 - 8)	1.08 (0.88,1.32)	0.83 (0.65, 1.07)
Secondary & above	1.09 (0.85,1.41)	0.92 (0.68, 1.25)

Frequency of alcohol consumption		
Never*		
2 - 4 days a month	1.74 (1.27, 2.38)	1.15 (0.69, 1.89)
2 - 3 days a week	1.87 (1.48, 2.36)	1.24 (0.78, 1.96)
4 or more days a week	3.43 (2.75, 4.28)	2.33 (1.47, 3.73)
Drunk so much and can't remember what happened the next day		
No*		
Yes, in the last 30 days	1.66 (1.33, 2.07)	1.34 (1.05, 1.72)
Yes, before last 30 days	1.27 (0.91, 1.78)	1.07 (0.75, 1.52)
Frequency of heavy episodic drinking		
Never*		
Less than monthly	1.39 (0.99, 1.95)	1.61 (1.12, 2.32)
Monthly	1.59 (1.18, 2.13)	1.71 (1.24, 2.38)
Weekly	1.03 (0.80, 1.31)	1.04 (0.78, 1.38)
Daily or almost daily	1.69 (1.29, 2.21)	1.49 (1.06, 2.11)
Frequency of khat chewing in a week		
Never*		
less than once a week	0.89 (0.67, 1.19)	0.83 (0.59, 1.16)
1 - 2 days per week	2.89 (2.26, 3.69)	2.13 (1.61, 2.83)
3 - 4 days per week	2.92 (2.19, 3.89)	2.15 (1.55, 2.98)
5 - 7 days per week	1.47 (1.21, 1.79)	1.06 (0.83, 1.36)
Condom breakage		
No*		
Yes	1.62 (1.37, 1.92)	1.26 (1.03, 1.55)
HIV test result		
Negative*		
Positive	0.88 (0.73, 1.07)	--

Abbreviations: aOR, adjusted odds ratios; CI, confidence interval. * Reference

Paper II

Determinants of heavy episodic drinking (HED)

Our analysis showed that 29.1% of FSWs experienced HED at least once in the past month prior to the study. The current analysis showed that FSWs with high income experienced more HED than their counterparts; as income increased, the odds of HED also increased. In addition, when compared to FSWs on the street, those who operated in bars/hotels (aOR 2.19, 95% CI 1.81, 2.66) and in local drinking houses (aOR 1.29, 95% CI 1.002, 1.67) had higher odds of HED. Furthermore, those who began selling sex before the age of 18 (aOR 1.48, 95% CI 1.13, 1.95) and those who were forced into the sex trade (aOR 2.91, 95% CI 2.45, 3.46) experienced higher odds of HED. In addition, FSWs who frequently chewed khat had higher odds of HED than the non-users. **(Table 5)**

Table 5 Bivariate and multivariate logistic regression analysis of monthly heavy episodic drinking (HED) in relation to predictor variables among female sex workers in 11 towns in Ethiopia (2014)

Variables	N	Crude OR (95%)	aOR (95%CI)
Educational level			
No education *	1230	1.0	1.0
Primary 1st cycle (1-4)	780	1.23 (0.98, 1.53)	1.12 (0.86, 1.46)
Primary 2nd cycle (5-8)	1941	1.97 (1.66, 2.34)	1.46 (1.18, 1.80)
Secondary and above	922	3.05 (2.51, 3.70)	2.20 (1.72, 2.81)
Average monthly income from selling sex			
≤1000 ETB (≤US$50)*	1608	1.0	1.0
1001–2000 ETB (US$51–$100)	1575	1.90 (1.60, 2.25)	0.99 (0.81, 1.23)
2001–3000 ETB (US$101–$150)	927	3.66 (3.04, 4.40)	1.49 (1.18, 1.88)
3001–4000 ETB (US$151–$200)	489	3.14 (2.51, 3.93)	1.36 (1.02, 1.80)
4001–5000 ETB (US$201–$250)	166	6.00 (4.30, 8.36)	3.94 (2.64, 5.89)
>5000 ETB (>US$251)	122	4.07 (2.79, 5.95)	1.46 (0.92, 2.32)
Sex-selling venues			
Street*	1866	1.0	1.0
Local drinking houses	872	0.45 (0.36, 0.55)	1.29 (1.002, 1.67)
Spa/Massage/Beauty salon/Own house	159	0.26 (0.15, 0.45)	0.46 (0.25, 0.83)
Red light houses	477	0.55 (0.42, 0.70)	0.81 (0.60, 1.10)
Bar/Hotel	1145	1.70 (1.45, 1.98)	2.19 (1.81, 2.66)
Other	367	1.80 (1.43, 2.26)	1.62 (1.22, 2.15)
Age when started to sell sex, years			
<18	1216	1.69 (1.37, 2.10)	1.48 (1.13, 1.95)

18–24	2889	1.87 (1.54, 2.26)	1.59 (1.25, 2.03)
≥25 *	781	1.0	1.0
Someone forced you into selling sex			
No*	3404	1.0	1.0
Yes	1482	5.04 (4.41, 5.76)	2.91(2.45, 3.46)
Provide any regular financial or other support to family member and/or to others			
No	2494	2.05 (1.81, 2.33)	1.17 (0.99, 1.38)
Yes*	2392	1.0	1.0
Frequency of khat chewing per week			
Never*	2304	1.0	1.0
Less than once	546	2.03 (1.58, 2.61)	1.99 (1.52, 2.59)
1–2 days	390	3.67 (2.84, 4.73)	3.31 (2.51, 4.36)
3–4 days	282	4.59 (3.47, 6.06)	4.62 (3.42, 6.24)
5–7 days	1364	14.84(12.48, 17.65)	11.15 (9.20, 13.50)

Abbreviations: OR, odd ratio; aOR, adjusted odds ratios; CI, confidence interval; * Reference

The Effects of Heavy episodic drinking

Heavy alcohol consumption exposed FSWs to different risky situations. According to our study, FSWs with HED had 1.27 and 1.44 times higher odds of physical beating and condom breakage/slippage than those without HED, respectively (Table 6). In addition, assuming a cause effect association, we examined the specific contribution of HED to the occurrence of physical beating and condom breakage/slippage. The results showed that 6.2% of physical beating and 8.9% of condom breakage/slippage reported could be attributed to HED. **(Table 7)**

Table 6. Bivariate and multivariate logistic regression analysis showing the effect of monthly heavy episodic drinking (HED) on outcome variables among female sex workers (FSW) in 11 towns in Ethiopia (2014)

Predictor variable	Dependent variables Crude OR (95% CI)			
	Physical beating	Condom breakage/slippage	Inconsistent condom use	HIV status
HED				
No*	1.0	1.0	1.0	1.0
Yes	1.29 (1.11, 1.50)	2.31(2.02, 2.64)	1.68 (1.35, 2.09)	1.04 (0.90, 1.22)
P-value	0.001	< 0.001	< 0.001	0.578
	Adjusted OR (95% CI)			
	Physical beating	Condom breakage/slippage	Inconsistent condom use	
HED				
No*	1.0	1.0	1.0	
Yes	1.27 (1.05, 1.53)	1.44 (1.21, 1.70)	1.30 (0.99, 1.72)	
P-Value	0.014	< 0.001	0.059	

Abbreviations: OR, odds ratios; CI, confidence interval, *Reference
HED was adjusted for sex selling starting age, average income, sex selling venue, Khat chewing, start selling sex by force, and educational level variables.

Table 7. Heavy episodic drinking (HED) attributable risk fraction for the occurrence of physical beating, rape, condom breakage/slippage, and inconsistent condom use among female sex workers in 11 towns in Ethiopia (2014)

Predictor variable	Outcome variable	Attributable risk fraction (AF) (%)	Population attributable risk fraction (PAF) (%)
HED	Physical beating	21.3	6.2
	Condom breakage/slippage	30.6	8.9

Paper III

Factors associated with VLN and HIVDR

Among 915 HIV positive participants with self-reported ART-naive status, 453 had VL<1000 copies/ml, indicating they may have been exposed to ART but hid their actual status. There were 521 samples with VL≥1000 copies/ml (59 on-ART and 462 ART-naïve) which proceeded to HIVDR genotyping. The overall prevalence of PDR among ART naïve FSWs was 16.5% (63/381) and 74.4% among self-report ART experienced FSWs (ADR). The overall PDR level among our participants was classified as high (>15%) by the WHO classification of HIVDR prevalence. In both bivariate and multivariate analysis, VLN was significantly associated with being forced into selling sex (aOR 2.79, 95% CI 1.07, 7.27), age ≥35 years (aOR 4.09,

95% CI 1.04, 16.1), and low CD4+ T-cell counts <350 cells/mm3 (aOR 4.67, 95% CI 2.23, 9.77). In the case of ADR and PDR, only low CD4 counts were significantly associated in multivariate analysis with PDR (aOR 3.24, 95% CI 1.78, 5.89) and ADR (aOR 7.25, 95% CI 2.95, 17.83). **(Table 8)**

Table 8. Bivariate and multivariate analyses for factors associated with virologic failure and HIV drug resistance female sex workers in Ethiopia

Variables	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									
15–24	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 of sex transactions/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)	
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		
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/mm3)									
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-value ≤0.05; ¥P-value <0.2.

Paper IV

Experience of condom breakage/slippage and PrEP uptake

A total of 17 FSWs participated in the study; their ages ranged from 21 to 35 years. Most of them met their clients on the street, and 10 of them had started taking PrEP. Condom use among FSWs was compounded by multiple vulnerabilities. Despite their struggles to ensure proper condom use, the results showed that condom failure remains a challenge. FSWs tried to minimize the incidence and harmful consequences of condom failure with different mechanisms, including PrEP use.

Overall, the current analysis identified three themes: 1) Struggling with the continuous risk of condom failure, which includes factors that make FSWs more vulnerable, such as deliberate condom breakage/slippage/tearing, struggling, being drunk, and FSWs' active engagement in sexual intercourse. 2) Doubting the feasibility of PrEP as a protection strategy, which included FSW misconceptions about PrEP, and FSWs' lack of confidence and competence; 3) Being challenged by the negative aspects associated with PrEP use, which included PrEP side effects and adherence challenges such as pain, stigma, and substance use status. (Paper IV).

Discussion

General discussion

This thesis explores the risks and challenges associated with being a FSW, including violence, HED, condom failure, treatment failure, and challenges related to PrEP uptake. As mentioned in the theoretical model, multiple systemic levels, including intrapersonal, interpersonal, institutional, and community level factors, contribute to a high level of vulnerability. Age, sex-selling venues and high consumption of alcohol and khat were significant predictors of physical violence (beating). On the other hand, the significant predictors of sexual violence (rape) were low income and high consumption of alcohol and khat. In addition, 29.1% of the study participants experienced HED in the past month and being younger, being forced into selling sex, working in a bar/hotel, having a higher income, and chewing khat frequently were significant determinants of HED. In turn, HED was significantly associated with physical beating and condom breakage. In addition, we also explored factors that affect PrEP uptake and reasons for rejecting PrEP. FSWs who were taking PrEP reported stigma due to the similarity of PrEP with the anti-retroviral pill and reported the challenge of maintaining adherence. Among FSWs who did not start taking PrEP, the reasons for rejecting PrEP included fear of side effects, poor confidence, and/or misconceptions.

FSWs are vulnerable to different forms of violence due to the specificities of their work environment, community perception, legal status, alcohol/drug use, and the personal characteristics of FSWs (11, 132). Violence exposes them to several negative health outcomes, including physical injury, Psychological trauma, and increased risk for HIV/STI directly and/or indirectly (133). A systematic review examining the role of the sex work environment in promoting or reducing the risk of violence found that in India, FSWs who worked in their own homes were less prone to sexual violence, and in Great Britain, FSWs who worked outdoors had six times higher odds of suffering from violence (134). The current study also found that FSWs who work on the street were more exposed to physical beatings than bar/restaurant-based FSWs. This is highly related to the level of protection FSWs obtain from the surrounding environment. Streets are usually exposed to gangsters and even the police chase FSWs since it is illegal to met clients on the street. This suggests that the legality of venues could contribute to violence reduction.

Being young and being a sex worker at the same time is a dangerous combination that increases exposure to violence and HED (135). The current study found out that younger FSWs were more prone to physical beatings and drank more alcohol. Although it is primarily poverty that pushes young women into the sex trade, government agencies and programs should give special attention to young women since they are highly susceptible to abuses (136). Young FSWs often have less knowledge of HIV risks and less ability to mitigate those risks than their older counterparts (137). In order to achieve success, an intervention strategy must take into consideration the contextual factors driving girls and young women into the sex trade. Programs should design innovative approaches to inform about the links between being young, high alcohol consumption (HED), violence (abuses), and exposure to increased sexual risks.

In addition, both alcohol and Khat consumption were identified as contributors to increased physical beating and rape. Alcohol and other substance use is considered an integral part of the sex trade, in that it plays a facilitative role. Not all FSWs use alcohol, but in most types of venues, FSWs are expected to drink alcohol to facilitate the trade. Substance use exposes FSWs to various situations, including exposure to beatings and rape, which in turn increases the risk of HIV and other STIs (132). Recently, the number of khat users has been increasing in Ethiopia, especially among the younger generation and vulnerable population groups, including FSWs. Although khat is a legal substance in the country, it can be an entry point to the use of other illicit drugs and risky sexual practices (88). Most FSWs engage in khat chewing as a way to spend the day, a way of recreation, socializing, and to help them be active during work at night. Nevertheless, as a stimulant leaf when mixed with alcohol, it masks the consumption level, exposing FSWs to HED (138), which further increases the probability of violence and unprotected sex. Therefore, FSWs should be aware of the risks associated with khat chewing. Programs working with FSWs should clarify the possible link between khat chewing, alcohol consumption, and the possibility of violence and HIV/STI infection risks. This is a typical example of mesosystem level interactions that increase the vulnerability of FSWs.

The other factor identified during this study that increased FSWs' exposure to HED was being forced to do sex work. A study conducted in Europe among trafficked women also noted that trafficked women are highly exposed to drug dependence, alcohol, or cigarettes to cope with the abuse, stress, and anxiety (139). In addition, a study conducted in India reported that trafficked sex workers faced high levels of sexual violence, alcohol use, and exposure to HIV infection (140). Sex traffickers and brothel owners use violence and alcohol to break women physically and mentally, making them controllable and submissive (141). Moreover, FSWs also use alcohol and drugs to cope with the stress and abuse related to sex work (18, 142). Therefore, identifying whether a particular FSW was forced into sex work or not is one of the first steps to reduce the harm associated with HED and violence.

Furthermore, HED and unsafe sex are highly inter-related and are responsible for a large proportion of the overall burden of diseases (143). Sex under the influence of alcohol is a high-risk encounter because the effect of the alcohol can compromise sex workers' judgment, self-control and the ability to practice safe sex (143). The current study found that FSWs who reported having HED had significantly more condom breakage and physical violence. The link between violence and HIV among FSWs commonly operates through the relationship between violence, HED, and condom use (144).

The demand for sex without condoms from clients sometimes escalates to threatening, which pressures FSWs to compromise condom use and/or reduces their ability to negotiate safe sex (144). According to our qualitative findings, a demand to have sex without a condom from clients even extends to deliberate condom breakage/slippage during sexual intercourse. A similar study conducted in Kenya also reported that clients could attempt to compromise condoms to increase sexual pleasure (145). On the other hand, some sex workers are willing to take the risk because clients are willing to pay more to avoid using condoms (146). This shows that HIV prevention efforts should involve clients to discourage them from offering more money to have respect for FSWs (147, 148). It is not enough to inform FSWs about sexual health; clients and others must also be convinced of the value of safe practices (10). For this to happen, officials (including the police) should protect to empower FSWs during sex work activity, which could further create a sense of respect from clients. In general, addressing clients' responsibility requires a change of policy and a macrosystem level understanding of the challenges experience by FSWs.

Nevertheless, it is not always the action and demand of clients that causes the condom to break/slip; it can also happen due to the poor quality of the condom, and sometimes FSWs contribute to the failure. Our study participants reported that negligent FSWs with heavy alcohol consumption during sex work faced more condom breakage/slippage. In addition, those FSWs who were actively engaged or absorbed in the sexual act could lose their awareness of the situation, increasing the chance of condom breakage/slippage. In the case of commercial sex, women are supposed to be more responsible and be alert since it is their health at stake. Programs should consider these factors and work with FSWs to alert them about how their actions could contribute to condom failure and HIV/STI infections. Therefore, effective methods such as PrEP, which have a vital role as an additional HIV prevention tool, should be promoted together with condom use.

PrEP is a medicine taken to prevent HIV acquisition; it is highly effective for preventing HIV when taken as prescribed (149). It is especially recommended for people at higher risk of HIV, including FSWs. FSWs require additional protection from HIV since they have multiple sexual partners and a high frequency of condom failure challenges (109). PrEP is a user-controlled (self-controlled) method, and this is one of the main advantages, especially among FSWs. The willingness of the third

party is not needed, which eliminates the risks associated with demanding clients and/or forced sex (150). Nevertheless, different misconceptions and barriers which arise from multiple social and biological factors compromise FSWs' ability to take PrEP (151). A study in the USA reported that some individuals doubted PrEP's potential to effectively protect against HIV and wanted to see the evidence before starting to take it (152). Our findings also showed that some participants assumed PrEP were a replacement for condoms, and comparing taking PrEP to condoms, FSWs preferred to use condoms, as found previously. In addition, similar to a study in South Africa (109), our study identified that side effects were a reason for lack of initiation of PrEP and also played a role in PrEP discontinuation. Most of these misconceptions are the result of the gap created by faculty information communication. A study among FSWs and MSMs in South Africa reported that information, education and communication (IEC) materials played an important role in helping study participants to start taking PrEP (109). Therefore, the IEC materials should consider individual and structural factors that affect FSWs, such as insufficient education and training, and social discrimination (153).

A study conducted in the USA among young adults using oral PrEP found concerns over ARV-related stigma and the burden of daily pill-taking (152). In this study also, participants cited similar concerns as a challenge to PrEP uptake. A study in Nigeria found that poor public awareness of the fact that ARV is being used as the prevention of HIV and the similarity with PrEP creates barriers (154). Emphasis should be given to preventing stigma associated with PrEP-taking FSWs, since it limits uptake and adherence as well.

FSWs bear a disproportionate share of the burden of HIV infections, treatment failures, and HIVDR, and they are a potential source of the virus's emergence and spread. HIV drug resistance can limit the ability to achieve viral suppression among HIV-positive people on ART (155). In the current study, the prevalence of PDR (16.5%) was much higher than the general population of Ethiopia (4-6%) (156). Similarly, studies conducted in Uganda and Benin also reported high levels of PDR among FSWs (12, 157). This highlights the burden of FSWs with regard to the acquisition of drug-resistant viruses and the risk of onward transmissions to the general population. FSWs are highly prone to treatment failure due to their working conditions and high loss to follow-up. Studies in the Ivory Coast and Benin reported that loss to follow-up is very common among FSWs (24, 30, 103). The working environment, substance/alcohol use, mobility, and violence are among the most mentioned reasons for attrition. In general, the ability to negotiate safer sex, insist on condom use, have control over their work lives, and to have good adherence to PrEP and/or ART is achievable when FSWs have a safer environment and less stigma and discrimination (158).

Methodological considerations

The current thesis has a number of strengths. First, it involves multiple sites (11 large towns) and a large sample size (4900) across the country. The second strength is the sampling technique, i.e., RDS, which is a strategy recommended for hard-to-reach populations. When conducted properly, it can provide a representative sample of the target population. The third strength is the assessment of FSWs' HIV status on site using the national testing algorithm. The fourth strength is the combination of biological and behavioral data to provide evidence regarding FSWs' increased risk exposure. In addition, the pilot studies conducted prior to the actual implementation added strength to the main study protocol.

However, the studies contained in the thesis also have a number of limitations. The first is the cross-sectional study design; the temporal link between the outcome and the exposure cannot be determined since both are examined at the same time. Second, sexual behavior and violence are sensitive topics that are subject to underreporting because of social desirability bias. Third, recall bias could have occurred because some of the questions concerned incidents that occurred several years before the data collection time. Below we describe the methodological considerations of the quantitative and qualitative studies in detail.

Quantitative data collection

RDS and external validity

Probability sampling designs cannot be applied to hard-to-reach populations, including FSWs, and the homeless, due to the absence of sampling frames, the small size of the group, and frequent changes of address (159). RDS is a network-based sampling that starts with a convenience sample and incentivizes respondents not only to participate in the survey but also to get their peers from the target population to participate (159). It combines "snowball sampling" (getting individuals to refer those they know, these individuals in turn refer those they know and so on) with a mathematical model that weights the sample to compensate for the fact that the sample was collected in a non-random way (123). It is highly recommended for hard-to-reach groups, and when applied properly, it gives a representative sample of the study population. We applied this technique to get a representative sample of FSWs in the selected cities. In each city, seeds were selected from every sub-group of FSWs population (bar based, street, red-light, etc.) and geographic area to get a representation of each network. The data gathered from this study is therefore generalizable and can be used for designing nationwide programmatic interventions and policy statements.

In Paper 2, we applied a weight generated from RDS Sat 7.1 software for each participant. This approach converts the RDS data into clustered data to account for the pre-existing relationship between recruits and the recruiters.

Measurements

Papers I–III were cross-sectional studies using the RDS data collection technique. The data was collected with a face-to-face interview with the study participants. Therefore, assessing sexual risk behavior could introduce social desirability bias. Some of our findings might have been underestimated or overestimated due to the issue of social desirability. Although the survey conducted was anonymous, the sensitive nature of the questions relating to sexual behavior may have affected the responses that were received. For example, they might report a high level of condom use and a lower level of alcohol consumption. In addition, the study is also exposed to recall bias since some of the questions targeted events in the past and create difficulty remembering the actual incident. To minimize recall bias, we assessed physical violence in the past year and rape since they started selling sex.

Confounding is a systematic error that occurs in epidemiological studies connected with the study. It affects variables in a way that produces false associations between two variables (160). Confounding can be addressed during study design by use of randomization, restriction, or matching and can also be controlled by adjusting during multivariate analysis (161). To minimize confounding, we used the RDS sampling technique to obtain a random sample. In addition, during multivariate analysis, the variables were adjusted for potential confounders based on evidence from the literature review.

Further, in Paper 2, HED was measured according to the WHO definition of at least 60 grams or more of pure alcohol on at least one occasion in the past 30 days. A consumption of 60 grams of pure alcohol corresponds approximately to 6 standard alcoholic drinks (125). We defined HED as 6 drinks per occasion, which might not be the definition used by other studies. This difference in definitions may have slight implications with regard to the risk factors that we identified.

Qualitative data collection

One of the major advantages of qualitative study design is that it gives a detailed description of participants' feelings, opinions, and experiences (162). According to Maxwell, qualitative design has a flexible structure as the design can be constructed and reconstructed (163), and therefore the participants have sufficient freedom. However, qualitative research needs to be evaluated according to trustworthiness through the research process according to the four suggested criteria: credibility, confirmability, dependability, and transferability (164).

Credibility evaluates the extent of true value created from the participant's reality and not from the researcher's subjective view. The true value of the study depends on the data collection, analysis, and interpretation (164) and the extent of the respondents' ability to give a rich description of their experience (165). In our qualitative study, the analytical process was conducted through discussion with all

authors, which helped to achieve consensus and to ensure the credibility of the results. In addition, two researchers who have experience with the subject matter (one male and one female, respectively) conducted the in-depth interviews, which may help to reduce the bias of one interviewer.

Dependability is the extent that the study could be repeated by others including the research steps from the start of a research project to the development and reporting of the findings (166). To make sure it is dependable, the study process from the pilot, the transcription and coding, and analysis processes are explained in detail in the paper.

Confirmability refers to the extent to which the findings can be verified by others and correspond to the collected data (164). To strengthen the confirmability, the stages in the analysis process were clearly described and quotations were used to ensure that the findings are from the collected data.

Transferability refers to the degree to which the results of qualitative research can be generalized or transferred to other contexts or settings (166). In the current study, to make the finding transferrable, we made sure that the data collection attained information saturation and involved different FSW groups. The lives of most FSWs working in different settings have similarities in terms of challenges and opportunities, which makes the current study transferable.

Implications for future research

The current study findings have added to knowledge and understanding of multiple factors associated with HIV infection amongst FSWs in Ethiopia. However, the findings also suggest that more research is needed. Regarding violence, we have only measured the burden from a female sex worker's perspective. It would be informative if future research included other stakeholders such as the police to explore their awareness of the issue. Thus, a qualitative study design involving the police and venue owners is recommended to explore their role and perspectives on the occurrence of violence.

In addition, the study tried to assess factors contributing to treatment failure, but the small number of HIV positives with drug resistance posed limitations for the identification of the contributing factors. In order to understand factors affecting the uptake of ART, a follow-up study with support measures for FSWs should be conducted. The support could depend on the factors identified during the study process. Thus, conducting a cohort study among HIV positive FSWs could help to assess how individual and structural factors (including sex selling venue, health facility system, etc.) contribute to viral load non-suppression and HIVDR. The study should include service provision such as viral load and drug resistance testing.

In terms of PrEP use, our findings identified the barriers and opportunities for increasing the uptake from FSWs perspective. However, research concerning the perspective of the health service providers is also needed. Morevoer, PrEP uptake at the public health facility level is not well documented. Public health facilities are more stable than DICs; thus ensuring good access and adherence among FSWs at these centers is recommended. Thus, conducting a study at a public health facility to document the barriers and challenges from the health service provider's perspective is recommended. In addition, exploring the service provision at the public health facility from the FSWs' perspective will benefit the programs designed to increase the uptake of PrEP.

Conclusions

The information provided from this thesis will help to inform strategies at the national level to develop and implement prevention, control, and intervention activities. Our findings indicate that the vulnerability of FSWs to HIV is strongly driven by a combination of structural, biological, and behavioral factors. Different factors among FSWs play a role in increasing exposure to violence and HED, which in turn may increase HIV transmission.

The legal status of female sex work legitimizes violence against FSWs through endorsing stigma and discrimination, thereby encouraging the notion that violence against FSWs is acceptable. Thus, to reduce physical and sexual violence, strategies to secure and improve their work environment should be a critical component of the interventions. Further, prevention programs should incorporate factors that makes FSWs aware of how their actions could increase vulnerability to violence, HED, condom breakage, inconsistent condom use, and HIV.

Maintaining viral load suppression among HIV-positive FSWs plays a significant role in halting HIV transmission among the general population. However, the current study identified that the VLN and HIVDR among FSWs are high, which indicates that the transmission of HIV and HIVDR among FSWs and beyond will continue surging. Therefore, a large proportion of newly infected (treatment naïve) FSWs could have compromised first line therapies due to PDR. In addition, a high proportion of FSWs developed ADR, which suggests the frequency of treatment interruptions in this population, which needs to be better understood for intervention development. Thus, targeted interventions are needed to improve ART access, and routine virological monitoring should be established among FSWs to limit the spread of both HIV and HIVDR.

The challenges and barriers to PrEP uptake among FSWs need to be addressed in future interventions that aim to better facilitate the uptake of PrEP. Challenges associated with PrEP uptake indicate that user-friendly strategies need to be designed and implemented to counter these barriers and facilitate PrEP uptake. Further, the information dissemination materials and methods should consider FSWs' educational status and understanding level to achieve better HIV prevention.

To ensure a successful HIV prevention program for FSWs, addressing specific key social factors such as violence, police harassment, safer work environments, and minimizing stigma and decriminalization should be taken into consideration. The

government needs to acknowledge the vulnerability of this population group and begin safeguarding their human rights as part of addressing the overall HIV epidemic. In total, the results of these papers provide key information about the direction that these efforts should take by highlighting areas of particular concern in order to improve the health and wellbeing of FSWs in Ethiopia.

Acknowledgements

This thesis has been written to fulfil the graduation requirements of the Ph.D. program at Lund University's medical faculty department of global health and social medicine. I have reached this point due to the remarkable support I have received from numerous people in various ways. I wish to express my sincere gratitude in particular to:

My main supervisor and mentor, Anette Agardh, thank you for giving me the opportunity to pursue my Ph.D. studies in your research group. I have had the exceptional privilege to have you as a supervisor. It was impossible to reach this point without your unreserved support. Your constructive criticism and scientific guidance made me think independently. Thank you for your unwavering support, and for boosting my confidence throughout the study period.

I would like to thank my co-supervisors, Prof. Eduard Sanders, Dr.Taye Tolera, and Dr. Ebba Abate, for their excellent guidance and support during the study process.

Benedict Oppong Asamoah, my co-author. Thank you for your support during the analysis and write-up process of the second paper.

Dawit Assefa, my co-author. Thank you for your support during the analysis and write-up process of the third paper and unreserved support during the study process.

Jesper Sundewall, my co-author. Thank you for your support during the analysis and write-up of the fourth paper. Thank you for sharing your immense experience in qualitative study analysis.

Wudinesh Belete, my co-author. Thank you for your support during the data collection, analysis and write-up of the fourth paper.

Jelaludin Ahimed, my co-author. Thank you for your support during the analysis of the second paper. Particularly when conducting weighting.

Ditte Mårtensson, Elena Aguilar, and all the other colleagues at SMGH, thank you for your support.

To the PhD student group, thank you for your comments and suggestions on my research project and study process. It has helped me a lot to shape the research project.

I want to acknowledge my other colleagues at the Ethiopian Public Health Institute and the Institute for giving me the chance to continue my education; Abebe H/Selassie, Kidist Zealiys, Habteyes Hailu, Saro Abdella, and to the many others who have helped me achieve this goal, my thanks.

Million Hailu, thank you for your support throughout the whole study process.

My whole family thank you for your unreserved support and care. Without your generous support, this would not be possible.

I also wish to thank all of the study participants, without whose cooperation, I would not have been able to conduct this study.

Last but not least, I wish to express my sincere thanks to the survey coordination team, technical working groups, other investigators, the HIV lab team, and field teams for their individual and collective unreserved effort and contribution to making the present study a success.

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Appendix

Appendix I: Structured questioners – Paper I, II, III

SECTION 1. Screening interview			
Q.N	Questions and filters	Coding & response categories	skip to
10101	Respondent ID	Site ID |__|__| Study Type ID |__|__| Subject ID |__|__|__|	
	Consent	Signed 1 Accept not signed 2 Refused 3	
	Entry type	Interview 1 Lab result 2	
10102	Interviewer ID	|__|__|	
10103	Location	Addis ababa 1 Bahir dar 2 Hawassa 3 Mekele 4 Gambella 5 Adama 6 Kombolcha 7 samera-logia 8 Metema 9 Shashemene 10 Diredawa 11	
10104	Date (Ethiopian)	DD----MM----YY----	
10105	TIME(24 hours) started	HH -------- M----------	
	Coupon number	----------	
	Eligibility Criteria		
10106	Have you been living in this town for at least the last 30 days?	Yes 1 No 2	 Ineligible
10107	Have you exchanged sex for money or for other benefit in this town in the last 30 days?	YES 1 NO 2	 Ineligible
10108	How many different men have you sold sex in this town in the last 7 days?	if no register 000	
10109	How many different men have you sold sex in this town in the last 30 days?	001 - 003	Ineligible
10110	How old are you?	--------- If age < 15	Ineligible
	If the respondent is the seed	Skip to	10114
10111		Woman 1	

	Was the person who gave the coupon to you a woman or a man?	Man 2	Ineligible
10112	Do you know this person by name or by sight? *PROBE: is this friend or acquaintance?*	YES 1 NO 2	 Ineligible
10113	How did you get this coupon? Do not read the response category	From another sex worker 1 From someone else 2 Found on the ground 3 Others 4	 Ineligible Ineligible Ineligible
	Before we started this survey we distributed a keychain. Did you receive a keychain? [Make clear to respondent that this answer will not affect their participation] If yes, ask her to show it.	YES, I received and have it with me 1 YES, I received but do not have it with me 2 NO, I did not receive 3	10116 10116
10115	If respondent says yes but did not bring it, show 5 sample key chains and ask her to pick out the correct one.	Chooses correct keychain 1 Chooses an incorrect one 2 Doesn't choose anyone 3	
10116	Are you a member of a _____ [Sex worker association]	Yes 1 No 2	
	Is the respondent	Eligible 1 Ineligible 2	
Network questions			
I would like to first ask you some questions about other FSW that you may know. Please remember that no one will be able to find out what you tell me, so please be truthful in your answers			
	Think about the kind of people we are looking for in this survey (FSW in this city). Think about the people you know by name or sight who would be the right people to join the survey.		
10117	How many of these friends and acquaintances who are 15 years & above have you seen in the last 7 days? (Probe and make sure you get the recruit's best guess)	Average number [__|__|__]	
10118	How many of these friends and acquaintances who are 15 years & above have you seen in the last 30 days? (Probe and make sure you get the recruit's best guess)	Average number [__|__|__]	
SECTION 2. Background Characteristics			
10201	In which region were you born?	Amhara 1 Oromia 2 Snnpr 3 Tigrai 4 Addis Ababa 5 Dire Dawa 6 Harar 7 Afar 8 Somali 9 Benish.-Gumuz 10 Gambela 11 Outside Ethiopia 12	
10202	What is your nationality?	Ethiopian 1 Eritrean 2	

		Somalian 3 Sudanese 4 Kenyan 5 Djibuti 6 Other country 7	
10203	What is the highest grade of schooling you attained?	No education 0 Non-formal education 1 Primary 1st cycle 2 Primary 2nd cycle 3 Secondary school 4 Secondary preparatory 5 TVET 6 College diploma 7 Degree & above 8 No response 9	
10204	At what age did you start sexual intercourse?	Age in years |__|__| Don't know 98 Refused to answer 99	
10205	What is your current marital status?	Never married 1 Married 2 Cohabitation 3 Divorced 4 Separated 5 Widowed 6 Refused to answer 9	Skip to 10208 10207 10208 10207 10208
10206	How old were you when you first married/began cohabiting? Probe	|__|__| AGE Don't know 98 Refused to answer 99	
10207	How old were you when you first widowed /divorced?	|___|___| AGE I have never beenwidowed/divorced 97 Don't know 98 Refused to answer 99	
10208	Have you ever given birth?	Yes 1 No 2	 10211
10209	If Yes, How many of your children are surviving? `	|__|__| None 00	10211
10210	How many live together with you now?	|__|__| None 00	
	Are you currently using a modern contraceptive (besides condoms)?	None 1 PILL 2 IUD 3 Inject able 4 Implant 5 Sterilization 6 Emergency contraceptives 7	
10212	Many sex workers became pregnant as the result of their work and have to abort. How many pregnancies like this have you terminated?	|__|__| None 00	

SECTION 3. Transition to sex work			
10301	How old were you when you first started selling sex on a regular basis?	Age in completed years |___|___| Don't remember 97	
10302	What was your marital status when you first started selling on a regular basis?	Never married 1 Currently married 2 Cohabitation 3 Divorced 4 Separated 5 Widowed 6 Refused to answer 9	
10303	Did you have a job before started selling sex? What was your job immediately before you started selling sex?	None 0 House maid 1 Bar/hotel/entertainment 2 retail/trade 3 Farming/livestock 4 Other skilled manual 5 Other skilled non-manual 6 Other unskilled manual 7 Student 8 House wife 9 Don't know 98 refused to answer 99	
10304	Would you say someone forced you into selling sex?	No one 0 Middle person 1 Boss 2 Friends/co-workers 3 Sexual partner 4 Family members 5 others 6	
10305	Some people get cheated into sex work. Did this happen to you? If so, who cheated you?	No one 0 Middle person 1 Boss 2 Friends/co-workers 3 Sexual partner 4 Family members 5 others 6 Refused to response 9	
10306	Was there anyone who influenced you to start selling sex?	No one 0 Middle person 1 Boss 2 Friends/co-workers 3 Sexual partner 4 Family members 5 Others 6 Refused to response 9	
10307	Why did you start selling sex? <u>Circle all mentioned</u>	To help my families/children 1 To get better income 2 Due to my parents death 3 Divorced with my husband 4 Quarrel with family 5	

		No other option or job 6	
		Due to debts of money 7	
SECTION 4. Mobility and current work			
10401	How long ago did you move to this city?	0 to 3 months 1 4 to 6 months 2 7 to 12 months 3 13 to 23 months 4 2 and above years 5 I was born here and did not move 6	
10402	How many different cities or towns have you sold sex in the last 3 years? (including current city/town)	|__|__| Don't remember 97	
10403	What types of areas have you sold sex in? READ LIST Circle all mentioned	Addis ababa 1 Other regional capitals 2 Other cities or towns 3 Construction sites 4 Rural area 5	
Current work environment			
10404	How/Where do you usually meet your clients to sell sex?	Bar/ hotel 0 Local drink house (Arakebet, Tellabet, Tejbet) 1 Restaurant/cafe /cake bet 2 Spa / massage / beauty 3 Own home 4 Red light 5 Street 6 Sms/ phone 7 Internet 8 Other 9	
10405	Do you do any additional work there besides selling sex?	Yes 1 No 2	Skip to 10407
10406	Do you do any other kind of regular work to earn money? If so what is your main job?	None 1 Paid house maid 2 Bar/hotel/entertainment 3 Retail/trade 4 Farming/livestock 5 Other skilled manual 6 Other skilled non-manual 7 Other unskilled manual 8	
10407	How much do you earn on average in a month from selling sex?	|__|__|__|__|__|__| ETB	
10408	How much money do you earn in average in a month from your other sources besides selling sex?	|__|__|__|__|__|__| ETB	
10409	Are you obliged to share income from sex with anyone? With mostly who?	No one 1 Owner of workplace 2 Middle person 3 Regular sexual partner 4 Family 5	

		Others 6	
10410	Do you provide any regular financial or other support to anyone (including children)? Who do you support? PROBE: Anyone else? *CIRCLE ALL MENTIONED*	No one 1 Children 2 Parents 3 Siblings 4 Other relatives 5 Spouse 6 Friends 7 Others 8	10411
10411	Do you save money regularly? If yes how do you save money?	I don't save 1 Kept in bank 2 Equb 3 Saving & credit enterprise 4 Keep at home 5 Keepingwith relatives/friends/boss 6 Other 7	
10412	Do you currently have any debts that will take you more than one month to repay?	Yes 1 No 2 Refused to answer 9	
SECTION 5. Exposure To Sexual Risk : General			
	Last paying partner		
	Think of the most recent paying sexual partner you had:		
10501	What is your last paying partner's occupation?	Unemployed 0 Civil servant 1 Transport worker 2 Daily laborer 3 Student 4 Farmer 5 Uniformed service 6 Business/trade/retail 7 Others 8 Don't know 9	
10502	The last time you had sex with this partner, had the partner been drinking? A little or a lot?	Not drinking 1 Drinking a little 2 Drinking a lot 3 Don't know 8	
10503	The last time you had sex with this partner, had you been drinking? A little or a lot?	Not drinking 1 Drinking a little 2 Drinking a lot 3 Don't know 8	
10504	Did you use condom in the last sexual intercourse?	Yes 1 No 2 Don't remember 7	10506 10506
10505	Why didn't you use condom?	Condom was not available 1 Paid me more to not use a condom 2 Too expensive 3 Partner objection 4 Used other contraceptive 5 Forced by partner 6	

		Didn't think it was necessary 7	
10506	Has a condom broke or failed anytime in the last 30 days with any paying client?	Yes 1 No 2 Don't remember 7	
10507	With how many different paying partners did you have sex without condoms in the last 30 days?	|__|__|	
10508	It is common for some clients to ask for anal sex that means man inserts his penis in your anus. Have you ever had anal sex with a client? When?	Yes, in the last 30 days 1 Yes, before last 30 days 2 Never 3 Refused to respond 9	 10601 10601
10509	Did you use condom the last time you had anal sex?	Yes 1 No 2	
SECTION 6. Exposure to sexual risk: non-paying partners			
	Now I want to talk to you about partners who do not usually pay for sex.		
10601	How many different sexual partners have you had in the last 30 days who did not pay for sex?	NP VPART |__|__| None 00	 10603
10602	What is your relationship to the most recent non-paying partner?	Spouse 1 Other regular partner 2 One-time partner 3	10604
10603a	Do you have a current regular sexual partner?	Yes 1 No 2	10701
10603b	How long have you been having sexual relations with the most recent regular partner? *CIRCLE UNIT AND ENTER NUMBER*	Days 1 Months 2 Years 3	Number |__|__|
10604	Do you normally live together with this person?	Yes 1 No 2	
10605	What is your regular non-paying partner occupation?	Unemployed 0 Civil servant 1 Transport worker 2 Construction worker/daily laborer 3 Student 4 Farmer 5 Uniformed service 6 Business/trade/retail 7 Others don't mentioned above 8 Don't know 9	
10606	Did you use a condom during the last sexual intercourse with him?	Yes 1 No 2 Don't remember 7	
10607	When have you had your last anal sex experience with a non- paying partner?	Yes within the last12 months 1 Yes before the last 12 months 2 Never 3 Refused to answer 9	 10701 10701 10701
10608	How many times did you have anal sex with non-paying partners with in the last 3 months?	|__|__|__| if no 00	
10609	Do you use condoms last time you had anal sex (with non-paying partners)?	Yes 1 No 2	

SECTION 7. Alcohol And Khat			
10701	How often do you have a drink containing alcohol?	Never 0 Once a month or less 1 2 – 4 times a month 2 2 – 3 times a week 3 4 or more a week 4	10705
10702	How many standard drinks containing alcohol do you have on typical day? See the given picture	1 or 2 0 3 or 4 1 5 or 6 2 7 to 9 3 10 or more 4	
10703	How often do you have 6 or more drinks on one occasion?	Never 0 Less than once a month 1 Monthly 2 Weekely 3 Daily or almost daily 4	
10704	In the last 30 days have you ever drunk so much that you can't remember what happened the next day?	Yes, in last 30 days 1 Yes, before last 30 days 2 No 3 Don't remember 7	
10705	How many days in the week do you normally chew khat?	5-7 days per week 1 3-4 days per week 2 1-2 days per week 3 Less than once a week 4 Never 5	
10706	Some people use other drugs besides alcohol and khat for pleasure. Some are chewing, some are smoked, and some are injected with a needle. What type drugs have you used in the last 30 days? CIRCLE ALL MENTIONED	never used anydrugs 1 Chewing drugs 2 Smoked drugs 3 Other ingestable 4 Other injectatable 5 Other 6	
SECTION 8. STI			
10801	Have you had any unusual vaginal discharge in the past 12 months?	Yes 1 No 2 Don't know 8 Refused to answer 9	
10802	Have you had a genital ulcer in the past 12 months?	Yes 1 No 2 Don't know 8 Refused to answer 9	
	Check if the above Q10801 – 10802 any of symptom reported	Yes 1 No 2	If NO Skip to 10806
10803	Where did you go first for treatment the last time you had any of these symptom	Public hf 1 Private hf 2 Pharmacy 3 Home remedy, traditional or self treatment 4 STI confidental clinic 5	

		I did't seek treatment 6 Don't/can't remember 7	10806 10806
10804	What kind of treatment did you receive for your most recent problem? CIRCLE AL MENTIONED	Addis cure kit 1 Pills 2 Injection 3 Herbal remedies 4	
10805	Have you ever experienced any dishonor/ discrimination from health care providers as a result of selling sex? Which health care providers?	No discrimination 1 In public hf 2 In private hf 3 In pharmacy 4 In traditional/herbalist 5 Don't remember 7	
10806	For each of the following groups, say whether you feel accepted, neutral, or rejected by most people because of the work that you do? CIRCLE	1=Accepted, 2=Neutral, 3= Rejected, 4=D k Local police 1 2 3 4 Health workers 1 2 3 4 Work mates 1 2 3 4 Other community members 1 2 3 4 Family at home 1 2 3 4	
SECTION 9. Sexual violence			
	Now I'd like to ask you some questions about sexual violence and rape. With rape we mean when a man either forces or threatens to hurt you to have vaginal or anal sex against your will.		
10901	Have you ever been physically beaten by a sexual partner or client in the last 12 months?	Never 0 Yes, by a paying partner 1 Yes, by non paying partner 2 By both 4 Refused to answer 9	
10902	Have you ever been raped or forced to have sex against your will since you start selling sex? By who raped most recently?	No 0 By paying client 1 By non-paying partner 2 By employer 3 By policeman 4 Middle man 5 Someone you didn't know 6 Others 7 Refused to respond 9	11001
10903	The last time you were raped did you report to the police?	Yes 1 No 2 Refused to answer 9	
10904	The last time you were raped did you seek health care/treatment?	Yes 1 No 2 Refused to answer 9	
SECTION10. Knowledge And Attitudes Towards Hiv/Aids			
	Please indicate the main ways a person can protect her/himself against HIV infection?	Abstaining 1 Being faithful to one partner 2	

11001	*PROBE:* Any other? *CIRCLE ALL MENTIONED*	Proper and consistent condom use 3 Not sharing needles/sharps 4 Have partner get tested 5 Avoiding contact with body fluid of infected 6 Misconceptions 7	
11002	Can the virus that causes AIDS be transmitted from a mother to her baby during pregnancy? During delivery? During breast feeding? Circle all answered	During pregnancy 1 During delivery 2 During breast feeding 3	
	Do you mostly agree or disagree with the following statements: Interviewer: be sure to read the questions in a non-biased way (do not make it clear which is the "right" answer)		
11003	"*I am not as careful about HIV and sex now because there is better treatment for AIDS*"	Agree 1 Disagree 2 Unsure 7	
11004	*Once you have unprotected sex with someone, there is no reason to use condoms again to prevent HIV with that person.*	Agree 1 Disagree 2 Unsure 7	
SECTION 11. HIV Counselling And Testing			
11101	HOW LONG AGO WERE YOU LAST TESTED and received for HIV?	Months |__|__|__| Never tested 000 Don't remember 997 Refused to answer 999	 11201 11201
11102	How many times have you tested your HIV status in the last 12 Months?	|___|___| Don't remember 97 Refused to answer 99	
11103	Where did you test for HIV most recently?	Public hf 1 Private hf 2 Ngo hf 3 Confidential sti clinic 4 Mobile vct service 5 Hews/health post 6 Don't know 8 Refused to answer 9	
11104	Has your current regular partner ever shared his HIV results with you?	Yes 1 No 2 No regular partner 3	 11106 11106
11105	As far as you know, has your current partner ever tested positive for HIV'?	Yes 1 No 2	
The next questions are important for knowing the quality of care you received.			
11106	Have you ever tested positive for the HIV virus?	Yes 1 No 2 Refused to answer 9	 11201 11201
11107	Have you disclosed your status to your current regular non-paying partner?	Yes 1 No 2 I don't have non-paying partner 3 Don't remember 8	

		Refused to answer 9	
11108	How long ago did you first test HIV positive?	Months |__||__|__| If less than one month 000	
		Don't remember 997	
		Refused to answer 999	
11109	Have you ever attended a support group for HIV positive people? In the last 12 months?	Yes, in last 12 months 1	
		Yes, but not in last 12 months 2	
		Never 3	
11110	Are you currently taking any medication/treatment regularly? Select all that apply	Never 1	11201
		Cpt (co-trimoxazole) 2	11201
		Art 3	
		Pmtct drugs 4	11201
		Herbal 5	11201
		Holy water 6	11201
		Refused to answer 9	11201
11111	If ART checked, In what month and year did you start your treatment with ART? (Ethiopian)	Month |__|__| Unsure 97 Refused to answer 99 Year |__|__|__|__| Unsure 9997 Refused to answer 9999	
SECTION 12. Prevention Program Exposure			
11201	Where do you usually get condoms? *PROBE*: Any place else? CIRCLE ALL MENTIONED	Public hf 1 Private hf 2 Ngo 3 Bars/hotels/entertainments 4 Shops/kiosks 5 Health extension workers/healthpost 6 Peer outreach 7 Promotional events 8 Partners 9	
11202	In the last 30 days have you ever had a sex without condom because you didn't find one?	Yes 1 No 2 Don't remember 7	
11203	Have you ever been part of a guided peer group discussion concerning HIV? In the last 12 months?	Yes, in last 12 months1 Yes, before last 12 months2 Not at all 3 I don't remember 7	
11204	Are you currently a member of any association related to sex work?	Yes 1 No 2 Not awar e of the presens of the association 3	
11205	In the last 12 months, have you ever called into the AIDS hotline (952)?	Yes 1 No 2	
11206	Have you ever been a part of any Income Generation Activity? In the last 12 months?	Yes, in last year 1 Yes, before last year 2 No 3 Unsure 7	

		Refused to answer 9	
THANK YOU!			

Appendix II: In-depth Interview guide

Introduction: Hello my name is ------- and as per the consent you have given I would like ask you few questions. Thank you in advance for your participation.

Objective: To explore the experience of FSWs with regard to risky sexual behavior, PrEP use and strategies to minimize the risk.

Therefore the interview guide will try to explore

1. What makes you decide to use or not use condom
    - Being under the influence of Alcohol/drug(either the FSW or the client)
    - Money issue
    - Violence (the client) or other etc…
2. What strategies you use to overcome/minimize the risk (to minimize sex without condom, which will minimize the exposure to STI/HIV)
3. PrEP use experience

Interviewer Initials: _____

Date: _____

Start time _____

End time: _____

Participant information

Study number: _____

Age: ____

Background

- Can you tell me about yourself and where you come from?
  Probe: Marital status? Has Children?
- Can you tell me a bit about your schooling history
- Please tell me how you started getting money in return for sex?
  Probe: Age, marital status, prior work experience,

General Introduction

- Selling sex can be a risky business; can you tell me your thoughts about this?
- What sort of worries do you have, and how do you deal with them?
- Can you tell me about a typical risky situation? How do you deal with that sort of situation?
- What do you experience as the most difficult challenge with regard to protecting your own health?

Clients

Next, I would like to discuss about your clients and some challenges you may have experienced, including physical violence.

- Can you tell me a bit about your clients? Their life status, work etc..?
- What do you usually look for - in a client?
  Probe: tell me Examples of client you have said 'no' to? And Examples of clients you wanted to say 'no', but didn't? Describe.
- Tell me about any experiences you might have had of being forced to have sex? What was the reason?
  Probe: Threatened, Beaten, Raped by a client?
- Have you ever heard about women being raped or beaten doing this work? What do you think was the reason
- What do you do to avoid clients that you do not want?

Condom use

In the next section, I'd like to discuss about condoms use and challenges:

- Can you tell me about using condom with your clients?
  Probe: Advantage? disadvantages?
- How do you handle a situation related with condom?
  Probe: slipping or tearing/breakage? How do you think it happened? How common is that? Did you continue using condom despite the slippage or tearing? Any other problems?
- How do you decide whether to use a condom or not with a client's?
  Probe: what sort of situations might make you reluctant to use condoms?
- How do you negotiate about using condoms with a client; how do you make sure they are used properly?

Probe: Who normally suggests using a condom? Who buys? Who puts on? Who takes off? Anything else important to consider?

- How does the type of relationship you have with your customer affect the use or non-use of condom?
- What is your experience with a client who does not want to use condom?

  Probe: Are there differences with different kinds of sex acts? If you want to use, how did you convince them? What happened when you refuse to have sex without condom?
- Tell me about the time when you wanted to use a condom but didn't? What was the reason?

  Probe: condom access, fear of the client?

Alcohol

Next, I would like to discuss about alcohol consumption and challenges

- Can you tell me about the influence of alcohol drinking during sex work

  Probe: can you tell me your experience after having excessive alcohol? Can you tell me your experience with a drunken client? How does it affect their sexual act?
- What do you do to minimize excessive alcohol drinking?

  Probe: if you drink too much, if the client drinks too much?
- Can you tell me how you manage safe sex after you drink or with a drunken client?
- What kind of support do you think that help you to minimize excessive alcohol use?

  Probe: from whom?

Health

Next, I would like to discuss about health issues and some challenges you may have experienced.

- Can you tell me about the potential health risks connected with your work?
- Can you tell me about your STI infection experience?
- How do concerns about STI affect your work condition?

Probe: How do you minimize your risk? What resources are available? How accessible are they? How do you use them? Example?

- How much do you worry about HIV? How serious do you think HIV infection is these days?

  Probe: How do sex workers you know minimize their risk? How do you minimize your risk? How concerns about HIV do affected your work? Describe.

Question on PrEP

- What do you know about PrEP?
  - Prevention vs treatment
  - How does it work?
- Would you please describe your experience being on PrEP?

  Probe: stigma; fear of PrEP safety; misconceptions, other?
- Did you experience any side effects? How did you cope with them?

  Probe: Call the clinic? Came back to the clinic? Consulted a friend?
- What worries do you have in taking PrEP?

  Probe: concerns such as frequency risky (condom less) sex; fear for stigma/discrimination;
- Do you have problems that influence your adherence? What would you say could help you to better adhere to PrEP?

  Probe: alcohol use, drug abuse; time spent at the clinic;
- What has been the most challenging for you taking PrEP?

Closure

In general is there anything that you want to discuss, that was not covered during our conversation? Or is there anything you would like to add?"

Conclusion: Thank you very much for your time and for talking with me.

Paper I

BMJ Open

Prevalence and correlates of physical violence and rape among female sex workers in Ethiopia: a cross-sectional study with respondent-driven sampling from 11 major towns

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To cite: Amogne MD, Balcha TT, Agardh A. Prevalence and correlates of physical violence and rape among female sex workers in Ethiopia: a cross-sectional study with respondent-driven sampling from 11 major towns. *BMJ Open* 2019;**9**:e028247. doi:10.1136/bmjopen-2018-028247

► Prepublication history for this paper is available online. To view these files please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2018-028247).

Received 28 November 2018
Revised 02 July 2019
Accepted 08 July 2019

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ABSTRACT

Objective This study examined the prevalence and correlates of physical violence and rape among female sex workers (FSWs) in Ethiopia.

Design A cross-sectional study using respondent-driven sampling technique.

Setting Eleven major towns in Ethiopia.

Participants 4900 FSWs.

Main outcome measures The prevalence of experiences of physical beating and rape.

Results Among FSWs, 17.5% reported physical beating within the last year and 15.2% reported rape since they started selling sex. FSWs aged 35+ years (AOR 0.59, 95% CI 0.38 to 0.92) were less exposed to physical beating than those aged 15–24 years. FSWs working on the street (AOR 1.92, 95% CI 1.53 to 2.39), in red-light houses (AOR 1.63, 95% CI 1.12 to 2.38) and in local drinking houses (AOR 1.35, 95% CI 1.02 to 1.78) experienced more physical beating than FSWs working in bars/hotels. FSWs who consumed alcohol four or more days in a week (AOR 1.92, 95% CI 1.21 to 3.04), and who chewed khat frequently experienced more physical violence. Rape was associated with having a low monthly income, drinking alcohol four or more days per week (AOR 2.33, 95% CI 1.47 to 3.7), experience of heavy episodic drinking in a month (AOR 1.71, 95% CI 1.24 to 2.38) and chewing khat 3–4 days per week (AOR 2.15, 95% CI 1.55 to 2.98). Condom breakage was more frequent among FSWs who reported both physical beating (AOR 1.51, 95% CI 1.25 to 1.84) and rape (AOR 1.26, 95% CI 1.03 to 1.55).

Conclusion FSWs in Ethiopia are vulnerable to physical and sexual violence, and the risk increases when they are younger, street-based and high consumers of alcohol or khat. Therefore, targeted efforts are needed for prevention and harm reduction.

Strengths and limitations of this study

- The study involves multiple sites (11 large towns) across the country with a large sample size.
- The study used a respondent-driven sampling, a technique that is recommended for hard to reach populations.
- Sexual and physical violence are sensitive topics that are subject to underreporting because of social desirability bias.
- Recall bias could have occurred because participants were asked about physical violence in the last year and rape since they started selling sex.
- Due to a cross-sectional study design, the influence of alcohol use/khat chewing must be interpreted with caution, since the participants' current consumption status might not be an accurate indicator of the consumption status at the time of the violence.

INTRODUCTION

As per WHO definition, violence is the intentional use of physical force or power against another person or group, which has a high likelihood of resulting in injury, death, or sexual or psychological harm.[1] Violence against women is a global phenomenon, as more than one in three women worldwide is beaten, coerced into sex or abused in her lifetime.[2] Furthermore, violence is one of the main contributors to poor sexual and reproductive health among women, leading to unintended pregnancy, self-induced abortions, gynecological problems, sexual dysfunction and sexually transmitted infections (STIs), including HIV.[3 4]

In most countries, female sex work is either illegal or has an uncertain legal status. For example, prostitution is not illegal but approaching sex workers in public is illegal; this makes authorities reluctant to offer protection or support, which in turn legitimises violence and discrimination against sex workers.[5] In the case of Ethiopia, it is illegal to operate a brothel or procure sex workers as a commercial activity, but the sale of sex by women is neither prohibited nor legally recognised as a profession.[6] Female sex workers (FSWs) frequently

face harassment and violence, not only because of their illegitimate status but also as a manifestation of gender inequality and discrimination directed towards women.[7 8]

Violence against FSWs can be perpetrated by anyone, including police officers, intimate partners and clients. In Adama and Mekelle towns in Ethiopia, ~60% and 75% of FSWs, respectively, reported lifetime violence.[9 10] In the same study in Adama, 8% of FSW reported forced sex since they started sex work.[10] In another study conducted among homeless street females in Bahirdar town, 11.4% of them reported having been raped during the last 1 year period.[11] In Uganda, 40% of FSWs reported physical abuse, and 49% had been raped at least once in their lifetime.[12] In another study conducted in Hunan, China and Karnataka, India, 16% and 9% of FSWs, respectively, reported work-related violence.[13 14]

Several risk factors have been found to have an association with physical and sexual violence against FSWs. Socioeconomic characteristics, risky sexual behaviours and substance abuse are the most mentioned factors worldwide.[9 10 15 16] A randomised controlled trial study in Kenya and South Africa showed that alcohol consumption reduction by FSWs had a significant contribution to violence reduction.[17 18] Moreover, establishments where alcohol and other drugs are consumed are associated with an increased likelihood of people becoming violent towards sex workers.[8 19] However, other studies suggest that FSWs who work outdoors face more violence than those who work indoors.[20 21]

Violence towards FSWs may also be associated with condom use and condom breakage. Studies conducted among FSWs have found several intentional and unintentional factors associated with condom breakage during sex work. These factors included being drunk or high on drugs, wearing unfitting condoms, incorrect condom use and having violent or rough sex.[22 23] Moreover, violence towards FSWs may also be linked to disagreement over condom use, which increases the risk of acquiring HIV and other STIs.[21 24–26] In Ethiopia, the weighted HIV prevalence among FSWs is estimated to be 23%,[27] while it is 1.2% in the general population,[28] which shows the magnitude of the potential risk exposure among FSWs. In addition, violence also prevents sex workers from seeking appropriate health services.[26 29 30]

In general, 120 000–160 000 FSWs are estimated to live in Ethiopia, working in different venues, mainly in bars and hotels, Key-mebrat (red lighthouses), local drinking houses and on the street.[27] Currently, the number of FSWs is growing, with increasing numbers of young girls entering the sex trade.

This study explores the prevalence and correlates of physical violence and rape among FSWs in Ethiopia. Successful strategies for handling the trauma may vary by the type of violence experienced. Therefore, identification of risk factors that are specific to various types of violence has the potential to inform the development of evidence-based prevention programme. In addition, generating such types of evidence based on national level data will help to promote effective prevention for FSWs.

METHODS

Study design

This study was part of a larger study concerning HIV prevalence and related risk factors among FSWs and long-distance drivers that was carried out in Ethiopia in 2014. A cross-sectional study design using respondent-driven sampling (RDS) technique was used for data collection. RDS is a complex sampling method based on a chain-referral design and recommended for hard-to-reach populations. At all data collection sites, initial FSW 'seeds' were selected to start the sampling process. Seeds were selected purposively to represent the type of sex worker, age category and geographic location. They were identified through formative assessments with key stakeholders working with FSWs and representatives of FSWs. The selected seeds were those who were well-connected with their community and reported large social networks.

A maximum of three recruits per seed was allowed and only one-time participation was ensured by using a fingerprint-scanning device. Recruitment pattern (who recruited whom) was tracked and network size was determined.

Study area, period and population

The study locations were the seven major regional towns and the four main transport corridor towns. The seven major regional towns were: Addis Ababa, Bahir Dar, Mekelle, Hawassa, Adama, Gambela and Dire Dawa. The four transport corridor towns were Semera-Logia (Addis Ababa-Djibouti route), Kombolcha (Addis Ababa-Mekelle route), Metema (Addis Ababa-Metema route) and Shashemene (Addis Ababa-Moyale route).

The source populations were all FSWs living in those selected 11 towns. For the purpose of the study, FSWs were defined as follows: 'women who practice sexual activity with the pre-conditions of financial or in-kind benefits'. The inclusion criteria were receiving money or other benefits for sex with four or more people within the last 30 days, being 15 and above years old, properly recruited by a peer (presenting with the coupon), and giving consent both for the interview and blood drawing.

Sample size

The source study protocol calculated that a sample size of 400 FSWs was needed in each town using anticipated HIV prevalence of 25%, 6% precision, 95% CI and design effect of two. However, the number of FSWs who participated in each town was not exactly 400, and the total number of FSWs who participated in the study was 4900.

Data collection procedure

Six seed FSWs were selected to initiate coupon-based recruitment. Eligible FSWs who provided informed consent to participate were administered a face-to-face

interview in a private room by a nurse with a structured questionnaire in Amharic language. They then provided blood specimens for HIV, CD4 and viral load testing in a private room. When the process was completed, participants were provided with up to three coupons and instructed to recruit their FSW peers into the study. To compensate the time and costs of transport, a primary incentive of 100 ETB (US$5.0) and additional 50 ETB ($2.5) for each eligible peer she enrolled into the study was given. An electronic data base for tracking coupons and recruitment was established with participant ID, fingerprint code and a preprinted label that was scanned. The data collection tools and questionnaire were pretested in a pilot study; feedback from the pilot study was used to finalise the data collection tools and field logistic and operational procedures. The questionnaire included: sociodemographic characteristics, sexual risk exposure, sexual behaviours, condom use, history of STI symptoms, alcohol and drug use consumption, violence-related issues, knowledge of HIV transmission and HIV-testing history.

Variables

Violence was assessed with two dependent variables, which were physical beating during the last 1 year and rape since sex selling started. The following questions were asked: 'When exchanging sex for money during the last 1 year, have you ever been physically beaten by a sexual partner or client?' and 'Have you ever been raped or forced to have sex against your will since you start selling sex?'. Responses were dichotomised into a yes and no variable for analysis. For both of the questions, all who had reported beating and rape at least once were considered as having experienced violence (yes).

The different time periods used to assess experiences of physical beating and rape were based on the presumed frequency of the two different types of violence. Physical beating might occur more frequently, while rape presumably occurs less frequently. Therefore, to measure the general burden of the two experiences, we specifically selected the time period that might be appropriate for the recall of the particular experience.

The independent measures included current age, monthly income from selling sex, marital status, educational status, sex-selling venue, khat chewing, alcohol drinking, HIV status and condom breakage.

Current age was a continuous variable and for the purpose of analysis categorised as 10-year intervals: younger,[15–24] middle age,[25–34] and older one (35+), with the younger age group used as the reference category. Monthly income from selling sex was an open-ended question and for the analysis was categorised into 1000 birr ($50) intervals considering the cost of living in the country. Educational status was categorised as no formal education, primary first cycle (grades 1–4), primary second cycle (grades 5–8) and secondary and above for analysis, in accordance with the country education system.

In addition, sex workers were categorised based on their sex-selling venue, where bar/hotel was used as the reference because it is the most common FSW working venue. In addition, this venue category has better security than the other venues, and there were greater numbers of FSWs in this category.

Alcohol consumption was measured by different indicators, including frequency of alcohol consumption, number of drinks per specific day and frequency of heavy episodic drinking (HED) (six or more standard drinks per day).

Frequency of khat chewing was assessed according to the number of days that they chewed in a week. Khat (*Catha edulis*) is a stimulant leaf, and after chewing khat, an individual may become talkative, alert, feel excitement, increased self-esteem and increased imagination.[31] Khat chewing is also popular among FSWs, as it is a means to spend the daytime, to be active during the night for sex work and to socialise with each other.

Data analysis

Statistical analysis was performed using SPSS V.20. Descriptive statistics were used to provide summary measures (means, frequencies). ORs (crude and adjusted) and 95% CI were obtained using bivariate and multivariate logistic regression analysis. Those independent variables significantly associated with the outcome variable in the bivariate analysis were included in the multivariate analysis. In addition, correlation analysis was performed to examine potential multicollinearity; no correlation was found between the variables. Cases with missing data were excluded from the analyses. Significance was accepted at p value <0.05.

During data collection, we did not specifically assess where FSWs experienced the violence (in the current town or in another town). Because FSWs are highly mobile from one town to another, it would be inaccurate to assume that their experiences of violence occurred in the town from which they were sampled. Therefore, during analysis, we did not conduct any statistical analysis that assessed the contribution of the sampling site (participant's town) to the experience of violence.

Ethical considerations

Permission for data use was obtained from the Ethiopian Public Health Institute (EPHI). The protocol was cleared at the Scientific and Ethical Research Office of EPHI, the Ethiopian Science and Technology Ministry Ethical Committee and CDC-Atlanta IRB. Individual written informed consent was obtained from each participant for the interview and blood sample collection while the study was conducted.

Patient and public involvement

During the design or implementation of the study, no patients were involved in the development of the research question and outcome measures. Nevertheless, due to the nature of the RDS methodology, an assessment was

conducted to identify seeds and hotspot areas for the actual data collection. This assessment was conducted in collaboration with organisations working with FSWs and an active member of FSWs in those organisations. The primary results will be disseminate by publication in peer-reviewed journals and presented at the national level for stakeholders working with FSWs.

RESULTS

Sociodemographic and other background characteristics

A total of 4900 FSWs participated in the study. Demographic, socioeconomic and other background characteristics of the participants are shown in table 1. The majority of the participants were between 15 and 24 years old with a mean age of 24 years (SD=5.7); 44% of them were divorced, separated or widowed. A quarter of them reported being uneducated and 40% of them earned on average less than $50 per month. Regarding sex selling starting age, the majority started selling sex between the ages of 18 and 24 years, although ~25% started before the age of 18. FSWs work in different eating, drinking and recreation establishments, as well as other venues; 33% recruited their clients in bars/hotels, followed by 26.5% on the street, and 20% in local drinking houses (table 1).

Behavioral and other related factors

Table 2 shows the prevalence of behavioural and other factors. The majority (70%) of the respondents consumed alcohol, and of those, 15.8% had drunk so much on a typical day within the last 30 days that they did not remember what happened the next day. About half of the respondents chewed khat, and 23.8% of them chewed almost every day (5–7 days a week).

Regarding condom use, 25.5% of them reported condom breakage within the last 30 days prior to the study. HIV/AIDS status of the respondents was also assessed and a quarter of them (23%) were HIV positive. With regard to physical and sexual violence experience, 17.5% of them reported physical beating within the last 12 months and 15.2% reported having been raped since they started selling sex (table 2).

Bivariate regression analysis outcome

Table 3 shows the bivariate logistic regression results; each independent variable was analysed separately against the two outcome variables. The variables that were significantly associated with physical violence were age, educational level, average monthly income from selling sex, current marital status, sex-selling venues, frequency of alcohol consumption, alcohol containing drinks on a typical day, frequency of HED, frequency of khat chewing in a week and condom breakage. Variables significantly associated with rape were educational level, average monthly income from selling sex, frequency of alcohol consumption, alcohol containing drinks on a typical day, frequency of HED, frequency of khat chewing in a week

Table 1 Distribution of sociodemographic and other background characteristics among 4900 female sex workers across 11 towns, Ethiopia

Variable	Frequency	Percentage
Age (years)		
15–24	2831	57.8
25–34	1700	34.7
35+	369	7.5
Total	4900	100.0
Missing	0	
Mean age of respondents=24.16 SD=5.7		
Educational status		
No education	1224	25.0
Primary first cycle (1–4)	764	16.0
Primary second cycle (5–8)	2062	42.0
Secondary and above	831	17.0
Total	4881	100.0
Missing	19	
Sex-selling venues		
Bar/hotel	1613	33.0
Local drinking houses	983	20.1
Spa/massage/beauty salon/own house	261	5.3
Red-light houses	429	8.8
Street	1295	26.5
Other	304	6.2
Total	4885	100.0
Missing	15	
Current marital status		
Never married	2698	55.2
Married/cohabited	37	0.8
Separated/divorced	1976	40.5
Widowed	173	3.5
Total	4884	100.0
Missing	16	
Sex selling starting age		
Less than 15	120	2.5
15–17	1088	22.3
18–24	2864	58.7
25–29	583	12.0
30 and above	220	4.5
Total	4875	100.0
Missing	25	
Monthly income from selling sex		
Less than 1000 (<$50)	1932	39.6
1001–2000 ($50–$100)	1554	31.8
2001–3000 ($100–$150)	812	16.6
3001–4000 ($150–$200)	318	6.5
4001–5000 ($200–$250)	150	3.1
Above 5000 (>$250)	117	2.4
Total	4883	100.0
Missing	17	

Table 2 Behavioural and other related factors among 4900 female sex workers across 11 towns, Ethiopia

Variable	Frequency	Percentage
Frequency alcohol consumption		
Never	1493	30.6
Once a month or less	222	4.5
2–4 days a month	492	10.1
2–3 days a week	1394	28.5
4 or more days a week	1283	26.3
Total	4884	100.0
Missing	16	
Alcohol containing drinks on a typical day		
1 or 2	806	23.8
3 or 4	1383	40.8
5 or 6	742	21.9
7 to 9	296	8.7
10 or more	164	4.8
Total	3391	100.0
Missing	0	
Frequency of heavy episodic drinking		
Never	1863	54.9
Less than monthly	236	7.0
Monthly	299	8.8
Weekly	630	18.6
Daily or almost daily	363	10.7
Total	3391	100.0
Missing	0	
Drunk so much and cannot remember what happened the next day		
Yes, in last 30 days	534	15.8
Yes, not in last 30 days	233	6.9
No	2609	77.2
Do not remember	4	0.1
Total	3380	100.0
Missing	11	
Frequency of khat chewing		
Never	2431	49.8
Less than once a week	577	11.8
1–2 days per week	429	8.8
3–4 days per week	284	5.8
5–7 days per week	1162	23.8
Total	4883	100.0
Missing	17	
Condom breakage in the last 30 days		
Yes	1243	25.5
No	3635	74.5
Total	4878	
Missing	22	
HIV status		
Negative	3708	76.0
Positive	1173	24.0
Total	4881	100.0
Missing	19	
Ever been raped or forced to have sex since start selling sex		
No	4142	84.8
Yes	742	15.2
Total	4884	100.0
Missing	16	
Physically beaten in the last 12 months		
No	4026	82.5
Yes	855	17.5
Total	4881	100.0
Missing	19	

and condom breakage. HIV status was not significantly associated with either physical violence or rape.

Multivariate analysis of factors associated with physical violence (physically beaten)

Table 4 shows the results of the multivariate analysis used to identify factors associated with physical violence after simultaneously adjusting for all measures included in the analyses. FSWs aged 35 years or above (AOR 0.59, 95% CI 0.38 to 0.92) were significantly less likely to experience physical violence when compared with the younger age group (15–24 years). FSWs who had attended primary first cycle education (AOR 0.71, 95% CI 0.52 to 0.97) were also less likely to experience physical beating than those who reported no education. On the other hand, FSWs who worked on the street (AOR 1.92, 95% CI 1.53 to 2.39), in red-light houses (AOR 1.63, 95% CI 1.12 to 2.38) and in local drinking houses (AOR 1.35, 95% CI 1.02 to 1.78) had an increased odds of experiencing physical violence compared with FSWs who worked in bars/hotels. Moreover, substance use was significantly related to physical violence. FSWs who consumed alcohol four or more days in a week (AOR 1.92, 95% CI 1.21 to 3.04), those who did not remember what happened the next day due to heavy alcohol consumption both in the last 30 days (AOR 1.98, 95% CI 1.58 to 2.49) and before the last 30 days (AOR 1.85, 95% CI 1.35 to 2.53), and FSWs who chewed khat 3–4 days per week (AOR 1.58, 95% CI 1.13 to 2.21) and 5–7 days per week (AOR 1.43, 95% CI 1.13 to 1.80) had more likelihood of experiencing physical violence. Condom breakage experience within the last 30 days prior to the study was also significantly associated with physical violence (AOR 1.51, 95% CI 1.25 to 1.84).

Multivariate analysis of factors associated with sexual violence (rape)

Table 5 shows the results of the multivariate logistic regression analyses used to identify factors that were significantly associated with rape after simultaneously adjusting for all measures included in the analyses. FSWs with a monthly income of $50 to $200 were significantly less likely to experience rape compared with those with a monthly income of below $50. Drinking alcohol four

Table 3 Bivariate logistic regression analyses of independent variables associated with physically beaten in the last 12 months and ever been raped since start selling sex, OR and 95% CI

Variables	Physical beating OR (95% CI)	Rape OR (95% CI)
Age (years)		
15–24*		
25–34	1.02 (0.87 to 1.19)	1.02 (0.86 to 1.21)
35+	0.52 (0.37 to 0.74)	0.88 (0.64 to 1.20)
Educational level		
No education*		
Primary first cycle (1–4)	1.01 (0.79 to 1.31)	1.45 (1.14 to1.85)
Primary second cycle (5–8)	1.35 (1.11 to 1.63)	1.08 (0.88 to1.32)
Secondary and above	1.49 (1.18 to 1.87)	1.09 (0.85 to1.41)
Monthly income from selling sex		
Less than 1000 birr (<$50)*		
1001–2000 birr ($50–$100)	1.44 (1.20 to 1.73)	0.69 (0.58 to 0.85)
2001–3000 birr ($100–$150)	1.67 (1.35 to 2.07)	0.51 (0.39 to 0.66)
3001–4000 birr ($150–$200)	1.61 (1.19 to 2.17)	0.65 (0.46 to 0.92)
4001–5000 birr ($200–$250)	2.12 (1.44 to 3.14)	1.01 (0.66 to 1.55)
Above 5000 birr (>$250)	1.62 (1.01 to 2.58)	0.75 (0.44 to 1.27)
Current marital status		
Never married*		
Married/cohabited	1.05 (0.46 to 2.41)	0.69 (0.24 to 1.96)
Separated/divorced	0.93 (0.80 to 1.09)	1.03 (0.88 to 1.21)
Widowed	0.59 (0.37 to 0.95)	1.39 (0.95 to 2.06)
Sex-selling venues		
Bar/hotel*		
Local drinking houses	0.87 (0.69 to 1.09)	–
Spa/massage/beauty salon/own house	0.45 (0.28 to 0.71)	–
Red-light houses	0.95 (0.71 to 1.27)	–
Street	1.51 (1.26 to 1.82)	–
Other	1.37 (1.01 to 1.86)	–
Frequency alcohol consumption		
Never*		
2–4 days a month	1.82 (1.35 to 2.44)	1.74 (1.27 to 2.38)
2–3 days a week	2.07 (1.66 to 2.57)	1.87 (1.48 to 2.36)
4 or more days a week	3.54 (2.87 to 4.37)	3.43 (2.75 to 4.28)
Alcohol containing drinks on a typical day		
1 or 2*		
3 or 4	1.39 (1.09 to 1.76)	1.16 (0.92 to 1.46)
5 or 6	2.03 (1.58 to 2.62)	1.09 (0.84 to 1.43)
7 to 9	2.19 (1.59 to 3.03)	0.98 (0.68 to 1.41)
10 or more	2.76 (1.88 to 4.03)	1.78 (1.20 to 2.65)
Frequency of heavy episodic drinking		
Never*		
Less than monthly	1.43 (1.03 to 1.98)	1.39 (0.99 to 1.95)
Monthly	1.23 (0.90 to 1.66)	1.59 (1.18 to 2.13)

Continued

Table 3 Continued

Variables	Physical beating OR (95% CI)	Rape OR (95% CI)
Weekly	1.73 (1.39 to 2.14)	1.03 (0.80 to 1.31)
Daily or almost daily	1.97 (1.53 to 2.55)	1.69 (1.29 to 2.21)
Drunk so much and cannot remember what happened the next day		
No*		
Yes, in the last 30 days	2.90 (2.37 to 3.56)	1.66 (1.33 to 2.07)
Yes, before last 30 days	2.22 (1.65 to 2.99)	1.27 (0.91 to 1.78)
Frequency of khat chewing in a week		
Never*		
Less than once a week	1.24 (0.96 to 1.60)	0.89 (0.67 to 1.19)
1–2 days per week	1.67 (1.28 to 2.18)	2.89 (2.26 to 3.69)
3–4 days per week	2.49 (1.87 to 3.34)	2.92 (2.19 to 3.89)
5–7 days per week	2.48 (2.08 to 2.96)	1.47 (1.21 to 1.79)
Condom breakage		
No*		
Yes	1.99 (1.69,2.33)	1.62 (1.37 to 1.92)
HIV test result		
Negative*		
Positive	1.04 (0.88 to 1.24)	0.88 (0.73 to 1.07)

*Reference category.

or more days per week (AOR 2.33, 95% CI 1.47 to 3.7), experience of heavy drinking in the last 30 days and not remembering what happened the next day (AOR 1.34, 95% CI 1.05 to 1.72), experience of HED in a month (AOR 1.71, 95% CI 1.24 to 2.38), experience of HED almost daily (AOR 1.49, 95% CI 1.06 to 2.11) and chewing khat 1–2 days (AOR 2.13, 95% CI 1.61 to 2.83) and 3–4 days (AOR 2.15, 95% CI 1.55 to 2.98) per week were positively associated with rape. Moreover, condom breakage (AOR 1.26, 95% CI 1.03 to 1.55) was significantly more frequent among FSWs who reported rape.

DISCUSSION

According to this study, 17.5% of FSWs in Ethiopia had been physically beaten within the last 12 months and 15.2% had been raped since they started selling sex. Age, sex-selling venues and high consumption of alcohol and khat were significant predictors of physical violence (beating). On the other hand, the significant predictors of sexual violence (rape) were low income and high consumption of alcohol and khat.

The prevalence of both physical violence and sexual violence (rape) was lower than the prevalence found in studies conducted in Uganda, Ivory Coast and Kenya.[9 12 30 32] However, when compared with the studies conducted in Adama (Ethiopia), China, India and Mexico, the current study reported a higher prevalence of both physical and sexual violence.[10 11 13 14 33] The difference in the definition of violence used might be one of the possible explanations for the difference between the current result and those found in other studies in Africa. Most of the studies assessed all forms of physical and sexual violence while the current study assessed solely physical beating and forced penetrative sex (rape). On the other hand, differences in results across settings might also be due to differences in background and contextual factors such as socioeconomic status and cultural aspects.

Several studies showed that younger FSWs are more exposed to physical and sexual violence[13 34] in line with the current findings that younger FSWs (15–24 years) were at higher risk for physical violence when compared with their older counterparts (35+ years). Perpetrators find it easier to manipulate younger FSWs and this might play a role in their increased exposure to violence. That younger FSWs are especially vulnerable to violence has important implications due to the increasing number of younger FSWs who are entering the sex trade. Therefore, to minimise the vulnerability of younger FSWs, intervention programme need to create awareness about the factors that increase the likelihood of violence and to ensure that younger FSWs are particularly addressed in such programme.

Even though sex work is not a legally recognised profession in Ethiopia, most of the establishments where the sex

Table 4 Multivariate logistic regression analysis of factors associated with physical violence (physically beaten) in the last 12 months among female sex workers across 11 towns in Ethiopia, OR and 95% CI

Variables	OR (95% CI)
Age (years)	
15–24*	
25–34	1.04 (0.82 to 1.22)
35+	0.59 (0.38 to 0.92)
Educational level	
No education*	
Primary first cycle (1–4)	0.71 (0.52 to 0.97)
Primary second cycle (5–8)	0.98 (0.77 to 1.26)
Secondary and above	1.14 (0.85 to 1.53)
Monthly income from selling sex	
Less than 1000 birr (<$50) *	
1001–2000 birr ($50–$100)	1.13 (0.90 to 1.41)
2001–3000 birr ($100–$150)	1.14 (0.87 to 1.48)
3001–4000 birr ($150–$200)	1.12 (0.77 to 1.61)
4001–5000 birr ($200–$250)	1.44 (0.93 to 2.24)
Above 5000 birr (>$250)	1.12 (0.63 to 1.99)
Current marital status	
Never married*	
Married/cohabited	0.68 (0.24 to 1.89)
Separated/divorced	1.08 (0.88 to 1.29)
Widowed	0.87 (0.48 to 1.59)
Sex-selling venues	
Bar/hotel*	
Local drinking houses	1.35 (1.02 to 1.78)
Spa/massage/beauty salon/own house	1.04 (0.58 to 1.84)
Red-light houses	1.63 (1.12 to 2.38)
Street	1.92 (1.53 to 2.39)
Other	1.39 (0.98 to 1.99)
Frequency alcohol consumption	
Never*	
2–4 days a month	1.25 (0.77 to 2.04)
2–3 days a week	1.32 (0.84 to 2.06)
4 or more days a week	1.92 (1.21 to 3.04)
Alcohol containing drinks on a typical day	
1 or 2*	
3 or 4	1.08 (0.84 to 1.39)
5 or 6	1.15 (0.85 to 1.57)
7 to 9	1.09 (0.74 to 1.64)
10 or more	1.14 (0.72 to 1.81)
Frequency of heavy episodic drinking	
Never*	
Less than monthly	1.07 (0.75 to 1.52)
Monthly	0.84 (0.59 to 1.18)
Weekly	1.07 (0.82 to 1.39)
Daily or almost daily	0.99 (0.71 to 1.38)
Drunk so much and cannot remember what happened the next day	
No*	
Yes, in the last 30 days	1.98 (1.58 to 2.49)
Yes, before last 30 days	1.85 (1.35 to 2.53)
Frequency of khat chewing in a week	
Never*	
Less than once a week	1.04 (0.77 to 1.42)
1–2 days per week	1.30 (0.96 to 1.77)
3–4 days per week	1.58 (1.13 to 2.21)
5–7 days per week	1.43 (1.13 to 1.80)
Condom breakage	
No*	
Yes	1.51 (1.25 to 1.84)

*Reference category.

workers are based (hotels, bars/restaurants, nightclubs and so on) operate legally with working licenses. Nevertheless, some FSWs work on the street and in red-light houses where they manage their own working area. Consequently, the extent to which physical violence occurs may vary according to their working area. The present study revealed that FSWs who mainly work in bars and hotels face less physical beating when compared with FSWs who work on the street, in red-light houses and local drinking houses. This finding is in line with studies conducted in New York City and England.[20 21] This might be due to the level of protection in their working areas and/or due to the type of clients who frequents those localities. This means that engaging bar/hotel managers in the prevention activities could be an additional strategy to decrease violence against FSWs.

On the other hand, FSWs who work on the street, in red-light houses and local drinking houses experienced more violence. Most of these venues are located in the slum areas of the cities, and such areas are often the focus of police efforts to control various unwanted activities. In this regard, FSWs are targets of harassment, physical violence and arrest by police. The actions of the police towards FSWs might also serve to legitimise violence against FSWs in the community (especially among FSWs residing in slum areas), thus increasing such acts of violence. Therefore, to minimise the harm in these

Table 5 Multivariate logistic regression analysis of factors associated with sexual violence (rape) since sex selling start among female sex workers across 11 towns in Ethiopia, OR and 95% CI

Variables	OR (95% CI)
Monthly income from selling sex	
Less than 1000 birr (<$50) *	
1001–2000 birr ($50–$100)	0.62 (0.49 to 0.77)
2001–3000 birr ($100–$150)	0.42 (0.32 to 0.57)
3001–4000 birr ($150–$200)	0.45 (0.29 to 0.69)
4001–5000 birr ($200–$250)	0.84 (0.53 to 1.33)
Above 5000 birr (>$250)	0.62 (0.34 to 1.15)
Current marital status	
Never married*	
Married/cohabited	0.57 (0.17 to 1.97)
Separated/divorced	1.01 (0.83 to 1.22)
Widowed	1.61 (0.98 to 2.63)
Educational level	
No Education*	
Primary first cycle (1–4)	1.06 (0.79 to 1.43)
Primary second cycle (5–8)	0.83 (0.65 to 1.07)
Secondary and above	0.92 (0.68 to 1.25)
Frequency of alcohol consumption	
Never*	
2–4 days a month	1.15 (0.69 to 1.89)
2–3 days a week	1.24 (0.78 to 1.96)
4 or more days a week	2.33 (1.47 to 3.73)
Drunk so much and cannot remember what happened the next day	
No*	
Yes, in the last 30 days	1.34 (1.05 to 1.72)
Yes, before last 30 days	1.07 (0.75 to 1.52)
Frequency of heavy episodic drinking	
Never*	
Less than monthly	1.61 (1.12 to 2.32)
Monthly	1.71 (1.24 to 2.38)
Weekly	1.04 (0.78 to 1.38)
Daily or almost daily	1.49 (1.06 to 2.11)
Frequency of khat chewing in a week	
Never*	
Less than once a week	0.83 (0.59 to 1.16)
1–2 days per week	2.13 (1.61 to 2.83)
3–4 days per week	2.15 (1.55 to 2.98)
5–7 days per week	1.06 (0.83 to 1.36)
Condom breakage	
No*	
Yes	1.26 (1.03 to 1.55)

*Reference category.

localities, involving the police force in violence prevention activities is crucial and should be one of the first step. In addition, a peer education programme led by the sex workers could be an additional strategy. Such a programme could help FSWs to create an information sharing platform to discuss the incidences of violence, types of perpetrators and so on, which could raise awareness and help them to become more alert.

Furthermore, an association between alcohol use and higher frequency of physical violence and rape was reported. In particular, FSWs who consume alcohol >4 days per week and those with experience of HED were significantly more likely to experience violence. Several studies conducted in Ethiopia, Uganda and Kenya also reported similar findings.[9 10 12 19] A large proportion of FSWs use alcohol prior to or during sex to help them to solicit clients and overcome their shyness.[35 36] In particular, high level of alcohol consumption places FSWs at a disadvantage by intensifying their vulnerability.[8] Research reviews also report that alcohol use impairs FSWs' ability to detect the risk of violence and increases their vulnerability to risk-prone situations.[37 38] The consequences of HED are not just limited to the physical effects of intoxication but further expose them to violence and risky sexual behaviours.

Correspondingly, chewing khat more days in a week was significantly associated with experience of physical violence and rape. After chewing khat, some of the users consume alcohol-containing beverages to decrease the level of stimulation. Although there is no previous study on the relationship between khat chewing and experience of violence among FSWs, most FSWs chew khat before departing for work. In the bar, they drink alcohol to minimise the effect, which in turn exposes them to HED and violence. Further studies should assess the independent contribution of khat chewing to increasing violence occurrence.

The extent to which alcohol use and khat chewing are risk factors for the occurrence of experiences of violence must be interpreted with caution. Since physical beating was measured within the last 12 months and rape was measured since they started selling sex, the participants' current khat chewing or alcohol consumption status might not be an accurate indicator of their consumption patterns at the time of the violence. In addition, the current use of substances might be a means to cope with the trauma related to the experience of violence.

In addition, the resistance to condom use from clients and the violence experience may create a difficult situation for FSWs with regard to the proper use of condoms, which further exposes FSWs to HIV and other STIs. In this study, there was a significant relationship between condom breakage and history of physical beating and rape. Even though there was no significant association between HIV and violence, the proportion of HIV positive FSWs in the sample was high (23%). A study conducted in Benin reported a similar finding concerning the association between condom breakage and violence, but unlike our study there was a significant association between HIV and violence experience.[23] This finding indicates that solely providing condoms will not be effective to prevent HIV and other STIs transmission. Instead, working on

factors that contribute to improper use of condoms (such as violence) could be an additional strategy for HIV prevention programme.

In general, our study demonstrates that sex workers are particularly vulnerable to physical beating and rape. Nevertheless, the harm reduction programme among FSWs in Ethiopia is poor. Given the associations between violence and unprotected sex, the HIV control programme may not accomplish its goal of reducing the number of new infections without also addressing violence. Therefore, combining both programme could yield better results with regard to attaining epidemic control as well as reducing the harm associated with violence. In addition, this study shows that different factors (such as sex-selling venues, the age of FSWs, level of alcohol use and so on) were associated with violence among FSWs, signifying the need for different approaches to minimise the incidence of violence.[39] At the individual level, efforts to reduce violence could focus on developing educational materials and creating awareness for sex workers about their legal rights and about how to prevent, reduce and respond to violence.[40] In addition, involving the community in the prevention programme could play a vital role especially towards reducing stigma and discrimination towards FSWs, which in turn would create a suitable environment for FSWs to stand up for their rights. Furthermore, involving police and law enforcement authorities to reduce harassment could play a greater role in violence reduction.

Finally, there were some similarities but also differences concerning the predictors of rape and physical violence. For example, being in the younger age group was a significant predictor of physical beating but not rape, and having lower income was associated with rape but not with physical beating. Nevertheless, based on the current data, it is difficult to draw any conclusions about why one variable would matter for physical beating but not for rape. The reasons underlying the differences are currently unknown, and further research might be required to gain an understanding of the patterns observed.

Methodological considerations

There are a limited number of studies on violence among FSWs in Ethiopia and the existing studies are restricted to one city.[9 10] One of the strengths of this study is that it involves multiple sites (11 large towns) across the country. The second strength is the sampling technique; the study used a RDS, which is a strategy recommended for hard-to-reach populations and which is believed to give a representative sample of the target population. The third strength is the assessment of FSWs' HIV status on site using the national testing algorithm. In addition, the pilot study conducted prior to the actual implementation added strength to the main study protocol.

This study also had limitations. First, sexual and physical violence are sensitive topics that are subject to underreporting because of social desirability bias. Second, recall bias could have occurred because participants were asked about physical violence in the last year and rape since they started selling sex. We tried to minimise underreporting through intense interviewer training. In addition, since it was a cross-sectional study, participants were assessed only once; thus, it would be difficult to infer the temporal association between a risk factor and the outcome measures, that is, physical violence and rape.

Furthermore, the results regarding correlates of physical and sexual violence among FSWs in Ethiopia might have limited generalisability across settings. However, these results are likely to be relevant for other FSWs in other African countries that have a similar setting as Ethiopia, and may inform targeted prevention strategies for this key population.

CONCLUSION

In general, FSWs are vulnerable to physical and sexual violence, and the risk increases when they are younger, street-based and are high consumers of alcohol or khat. Therefore, to reduce physical and sexual violence, strategies to secure and improve their work environment should be a critical component of targeted interventions. Increasing awareness regarding the role of khat chewing and alcohol drinking towards vulnerability to violence should be an integral component of HIV prevention and violence reduction programme. In addition, targeted efforts should be made for the younger FSWs in order to reduce their vulnerability.

Acknowledgements We would like to express gratitude to the study participants and the data collectors.

Contributors MDA and AA developed the study design. MDA analysed and interpreted the data and drafted the manuscript. AA was involved in the data analysis and interpretation, and in the writing of the manuscript. TTB was involved in the interpretation of the data and contributed to the writing of the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No additional data available.

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Paper II

PLOS ONE

RESEARCH ARTICLE

Determinants and consequences of heavy episodic drinking among female sex workers in Ethiopia: A respondent-driven sampling study

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OPEN ACCESS

Citation: Amogne MD, Agardh A, Abate E, Ahmed J, Asamoah BO (2021) Determinants and consequences of heavy episodic drinking among female sex workers in Ethiopia: A respondent-driven sampling study. PLoS ONE 16(5): e0252432. https://doi.org/10.1371/journal.pone.0252432

Editor: Kimberly Page, University of New Mexico Health Sciences Center, UNITED STATES

Received: October 26, 2020

Accepted: May 14, 2021

Published: May 28, 2021

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: https://doi.org/10.1371/journal.pone.0252432

Data Availability Statement: The data is owned by Ethiopian public health institute and is available based on request. Anyone who wants to get data

Abstract

Background

Female sex workers (FSW), due to their working conditions, have an increased likelihood of heavy episodic drinking (HED), which is associated with risky sexual behavior. Nevertheless the specific contribution of HED to risky sexual behavior among FSWs in Ethiopia is not well documented for prevention activities.

Objective

The purpose of this study was to explore the determinants and consequences of HED among FSWs in Ethiopia.

Methods

A cross-sectional study using respondent-driven sampling was conducted among 4886 FSWs in 11 major towns in Ethiopia in 2014. A structured interview was performed, and data were examined using descriptive statistics and multiple logistic regression analyses.

Results

Most (66%) FSWs consumed alcohol, and the prevalence of HED was 29.1%. Compared to street-based FSWs, those who worked in bars/hotels and local drinking houses had 2.19 and 1.29 times higher odds of HED, respectively. FSWs who started selling sex when younger than 18 years (compared to those who started when older than 25 years) and those who were forced into selling sex had 1.48 and 2.91 times higher odds of HED, respectively. FSWs with more income from selling sex and FSWs who chewed khat reported increased odds of HED. Moreover, FSWs with experience of HED reported 1.27 and 1.44 times higher odds of physical beating and condom breakage/slippage, respectively. Furthermore, the population attributable risk fraction of HED among FSWs showed that 6.2% of physical beating and 8.9% of condom breakage/slippage could be attributed to HED.

from the institute should write email to the director general (Dr. Ebba) copying the director of data management (Dr. Alemnesh). The email should be brief on the objective of the study and the data set to obtain; future information will be followed after the first contact. Their details are below. Director General: Dr. Ebba: ebbaabate@yahoo.com Dr. Alemnesh: alemmirkuzie@yahoo.com.

Funding: The study was funded by the President's Plan for AIDS Relief (PEPFAR) through Ethiopian Public Health Association (EPHA) under the terms of PS001229.

Competing interests: The authors have declared that no competing interests exist.

Conclusion

In general, several factors increase the experience of HED, and HED in turn increases the likelihood of violence and condom breakage. These factors could inform programs and intervention activities among FSWs populations.

Introduction

Excessive use of alcohol has serious social, economic, and health-related consequences [1, 2]. When compared with men, women are more vulnerable to the adverse consequences of alcohol use such as violence, unintended pregnancy etc. [3]. Women who are engaged in a stigmatized profession such as selling sex may be at increased risk of the negative health effects of alcohol use [4].

The harms associated with alcohol depend on the volume, frequency of consumption, and contextual factors [5, 6]. Most FSWs work in alcohol-serving venues (hotels, bars and local drinking houses), on the street, or in red light houses. Because of their working situation, environment, and other factors, FSWs are more exposed to heavy episodic drinking (HED); for example, FSWs who work in alcohol-serving venues are expected to facilitate alcohol sales [6–11].

Previous studies show that younger FSWs experience more HED than older FSWs. A study in China reported that FSWs who started selling sex at a younger age experienced more HED [11]. FSWs forced into the sex trade also may have increased vulnerability to abusing alcohol and other substances as a coping mechanism [12, 13].According to studies in Kenya, Philippines and the US Virgin Islands, FSWs who reported alcohol abuse were more likely to report having used other drugs [10, 14, 15].

In Ethiopia, the stimulant leaf khat (Catha edulis) is popular, although chronic use of khat or high doses may have adverse health and socioeconomic consequences [16]. Khat chewing may contribute to reduced productivity, loss of working hours, malnutrition, and diversion of income, and for chronic users it is associated with hypertension, insomnia, liver toxicity, oral cancer, loss of appetite, and gastrointestinal effects [17]. When a stimulant such as khat is combined with alcohol, it might mask the effect of alcohol, thereby increasing the chance of HED [18]. Young people often chew khat during the daytime and go to bars to drink alcohol at night to purposely reduce the stimulant effect [19]. In Ethiopia, FSWs often chew khat to pass the time during the day and to increase energy during the night for sex work and to socialize with other FSWs [19].

The consequences of HED for FSWs are not merely limited to the physical effects of intoxication on the body but also increase the risk of violence and risky sexual behaviors [15, 20–22]. Studies among FSWs from Malawi, Kenya, China, and South India reported an association between alcohol use and inconsistent condom use [15, 23–26]. Another study among FSWs in Kenya also reported that HED (33%) in the past month was significantly associated with unprotected sex, violence, and sexually transmitted infections [6]. Yet, in the aforementioned study and another study in Kenya, HED (having $\geq$5 drinks) was not found to be significantly associated with HIV infection [6, 10].

Moreover, excessive alcohol use can impair FSWs' abilities to detect the risk of violence and increases their involvement in risk-prone situations [27, 28]. A study in China reported that FSWs who drank alcohol before sex were significantly more at risk for sexual coercion from their clients [29]. In addition, a study in Kenya and South Africa also showed that reducing alcohol consumption among FSWs significantly decreased violence [30, 31].

In general, studies among FSWs conducted in different countries found that the venue, income, FSW age, and other related factors were associated with HED among FSW, and those with HED in turn were exposed to violence and risky sexual behaviors [6, 20, 24, 31].

However, little is known about the determinants and consequences of HED among FSWs in Ethiopia, although few studies have investigated the potential role of socio-demographic and other contextual factors [32, 33]. In addition, the relationship between HED and violence and risky sexual behaviors is not well documented in Ethiopia. Therefore, the purpose of this cross-sectional study was to explore the determinants and consequences of HED among FSWs in Ethiopia.

Methods

Study design

This analysis was part of a larger cross-sectional study concerning HIV prevalence and related risk factors among FSWs in Ethiopia in 2014. Respondent driven sampling (RDS) was used to collect the data. RDS is a chain referral sampling technique recommended for hard-to-reach populations with a mathematical model that weights the sample [34].

Study area, period, and population

The study was conducted in seven major regional towns (Addis Ababa, Mekelle, Bahir Dar, Adama, DireDawa, Gambela, and Hawassa) and four main transport corridor towns in Ethiopia (Metema, Kombolcha, Semera-Logia, and Shashemene). This analysis included all data collected from FSWs living in these 11towns.

For the purposes of this study, we defined FSW as women who practice sexual activity with the preconditions of financial or in-kind benefits. FSWs were included in the study if they received money or other benefits for sex with $\geq$4 people within the last 30 days, were aged$\geq$15 years, were properly recruited by a peer (presented the coupon), and gave consent both for the interview and blood sample collection.

Sample size

A minimum sample size of 400 was calculated for each town using anticipated HIV prevalence of 25%, 6%precision, 95%confidence interval (CI), and design effect of two. Because of the RDS sampling requirement for equilibrium, the number of FSWs who participated in each town was not exactly 400 and the total number of FSWs who participated was 4886.

Data collection procedure

Six FSWs, called seeds, were selected to initiate coupon-based recruitment in each town. Seeds were selected purposively to represent the geographical and occupational (e.g., brothel vs. street-based) diversity of the target populations. Seeds were identified through formative assessments (key informant interviews and in-depth interviews) with key stakeholders and representatives of different key population groups.

Following informed consent, participants were interviewed in a private room by a nurse counselor with a structured questionnaire in the Amharic language and were asked to provide blood samples for HIV testing. The questionnaire was piloted before the actual implementation of the study in town that was not included as a study site. Subsequently, participants were provided with up to three coupons and instructed to recruit their FSW peers into the study. FSWs were given a primary incentive of 100 ETB (US$5.00) and an additional 50 ETB (US $2.50) for each eligible peer recruited and enrolled into the study. The exchange rate of ETB to USD is according to 2014 exchange rate. Fingerprint recognition software was used to create a

unique study identification number for each participant to help prevent the same participant from enrolling more than once.

Variables

According to World Health Organization criteria, HED is defined as "the proportion of adults (15+ years) who have had at least 60 grams or more of pure alcohol on at least one occasion in the past 30 days. A consumption of 60 grams of pure alcohol corresponds approximately to 6 standard alcoholic drinks [35]. Accordingly, the survey tool asked the following question: "How often do you have 6 or more drinks on one occasion?" A drink was defined as a drink of beer, liquor, or other local drinks such as tella, tej, or areke. The response alternatives were: 0, Never; 1, Less than once a month; 2,Monthly; 3, Weekly; and 4, Daily or almost daily. For the purpose of this analysis, respondents who selected 2 through 4 were categorized as engaging in monthly HED. Those who never drank were grouped with those who did not have HED.

To examine potential determinants of HED, we used the following independent variables: current age, age when the participant started selling sex, whether participant was forced to sell sex, whether participant supported others (financial or other support), monthly income from selling sex, educational status, sex selling venue, khat chewing frequency, and ever used any other drugs. Both the independent and dependent variables were selected based on previous evidence and on the objectives of the study.

To examine the potential consequences of HED, we included the following measures as dependent variables: HIV status, violence, condom breakage/slippage, and inconsistent condom use. During multiple regression analyses, each dependent variable was adjusted for age (sex selling starting age), average income, sex selling venue, khat chewing, being forced to sell sex, and educational level. Current age was a continuous variable and was categorized in 10-year intervals: younger age (15–24 years), middle (25–34 years), and older ($\geq$35 years), with the younger age category used as a reference group. Age at start of sex work was also a continuous variable and was categorized as minor ($<$18 years), younger (18–24 years), and older ($\geq$25 years). Monthly income from selling sex was an open-ended question and was categorized as $<$1000 ETB ($<$US$50), 1001–2000 ETB (US$51–$100), 2001–3000 ETB (US$101–$150), 3001–4000 ETB (US$151–$200), 4001–5000 ETB (US$201–$250), and $>$5000 ETB ($>$US$251), based on the cost of living in Ethiopia. Educational status was categorized as no formal education, primary first cycle (grade 1–4), primary second cycle (grade 5–8), and secondary and above, based on Ethiopia's education system. FSWs were categorized according to the primary location of work, including street-based, red light houses, and bar/hotel. Khat chewing frequency (days per week)was also assessed: never, less than once, 1–2 days/week, 3–4 days/week, and 5–7 days/week. Information was obtained about ever using any other drug besides alcohol and khat during the last 30 days and was categorized as "yes" or "no." Using any other drug at least once was categorized as "yes."

Violence was defined as physical beating during the past year. Responses were dichotomized as "yes" or "no" for analysis. FSWs who reported a physical beating at least once were considered exposed to violence. Condom breakage/slippage and inconsistent condom use were assessed in terms of the last 30 days before the study. Inconsistent condom use was measured with the question, "With how many different paying partners did you have sex without condoms in the last 30 days?" Not using condoms at least once was considered inconsistent condom use.

Data analysis

Statistical analysis was performed using SPSS, version 20 (Chicago, IL). Descriptive statistics were used to provide summary measures (means and frequencies). For each record in the data

set, the RDS-based weights were applied. RDS weights were generated using RDS-Analyst software. In addition to this weight, information on estimated number of FSWs in each town, as well as number of completed interviews in each town was applied to obtain a final weight.

Crude and adjusted odds ratios with 95% CI were obtained using bivariate and multivariate logistic regression analyses models. Before conducting multivariate analysis, we performed correlation analysis to examine potential multicollinearity. P-values <0.05 were considered statistically significant, and cases with missing data were excluded from the analyses.

Estimation of HED-attributable risk fraction among HED exposed and total FSW population

We estimated attributable risk fractions (AF) of HED for the occurrence of physical beating, condom breakage/slippage, and inconsistent condom use among FSWs (who reported HED) and the entire FSW population. The proportions were calculated to measure the effects that could be avoided if HED was prevented under an assumption of a causal link between HED and the listed variables.

Attributable risk fraction (AF) among HED-exposed FSWs was calculated as: [36]

$$AF = 100(OR - 1)/OR$$

The population AF (PAF) among total FSW population was calculated as:

$$PAF = P \cdot AF = 100P \cdot (OR - 1)/OR$$

where OR is the odds ratio generated from multivariate logistic regression analysis and P is the proportion of HED among the FSW population.

Ethical considerations

The data set was obtained from the Ethiopian Public Health Institute (EPHI). The protocol was cleared at the Scientific and Ethical Research Office (SERO) of EPHI, Ethiopian Science and Technology Ministry Ethical Committee, and CDC-IRB. Individual written informed consent was obtained from each participant for the interview and blood sample collection before the study was conducted. Permission was obtained from the ethical review committee to collect consent from FSWs between the ages of 15 to 18 because they are considered to be emancipated minors. For FSW under the age of 18 who indicated need for additional service, procedures were in place to refer to relevant service providers.

Results

Socio-demographic characteristics

A total of 4886 FSWs participated in the study, and most (59.0%) were aged 15–24 years, with a mean age of 24.17years (standard deviation [SD], 5.94). Most (59.1%) FSWs started selling sex between the ages of 18 and 24 years and 55.9% attended primary first or second cycle education. Of the participants, 38.3% sold sex on the street, 59.9% were never married, and 32.8% earned a monthly average income of less than 1000 ETB (US$50; Table 1).

Behavioral and other related factors

Of the participants, 30.4% reported that they were forced into the sex trade and48.9% supported others (financial or other support). Of the participants, 26.8% reported condom breakage/slippage within the past 30 days before the study, and 20.7% were HIV positive. Of the participants, 19.6% reported physical beating within the past 12 months. 52.9% chewed khat at

Table 1. Distribution of socio-demographic and other background characteristics among female sex workers in 11 towns in Ethiopia (2014).

Variable	Frequency	Percentage
Age, years		
15–24	2882	59.0
25–34	1588	32.5
≥35	416	8.5
Total	4886	100.0
Missing	0	
Mean age = 24.17 years SD = 5.94		
Educational status		
No Education	1228	25.2
Primary 1st cycle (grade 1–4)	780	16.0
Primary 2nd cycle (grade 5–8)	1942	39.9
Secondary and above	923	18.9
Total	4873	100.0
Missing	13	
Sex-selling venues		
Street	1874	38.3
Local drinking houses	868	17.8
Spa/Massage/Beauty salon/Own house	159	3.2
Red light houses	476	9.7
Bar/Hotel	1143	23.4
Others	367	7.5
Total	4886	100.0
Missing	0	
Current marital status		
Never Married	2925	59.9
Married/Cohabited	57	1.2
Separated/Divorced	1753	36.0
Widowed	143	2.9
Total	4878	100.0
Missing	8	
Age when started to sell sex, years		
<18	1216	24.9
18–24	2889	59.1
≥25	781	16.0
Total	4886	100.0
Missing	0	
Mean age when started to sell sex = 20.66		
SD = 5.31		
Average monthly income from selling sex		
≤1000 ETB (≤$50)	1603	32.8
1001–2000 ETB (US$51–$100)	1574	32.2
2001–3000 ETB (US$101 –$150)	929	19.0
3001–4000 ETB (US$151–$200)	491	10.1
4001–5000 ETB (US$201 –$250)	167	3.4
>5000 ETB (>US$251)	122	2.5
Total	4886	100.0
Missing	0	

SD-Standard deviation

https://doi.org/10.1371/journal.pone.0252432.t001

least once per week, and 10.8% used other drugs. Furthermore, 66% of FSWs drank alcohol, and the prevalence of HED among all FSWs was 29.1% (Table 2).

Determinants of HED in bivariate logistic regression analysis

Bivariate logistic regression was used to identify significant determinants of HED. Variables significantly associated with monthly HED experience included educational status, monthly income, sex selling venue, age when started selling sex, being forced into selling sex, providing regular support to others (financial or other), and frequency of khat chewing (Table 3).

Determinants of HED on multivariate logistic regression analysis

In multivariate logistic regression analysis, having a monthly income greater than 1000 ETB (US$50) was a significant predictor of HED; as income increased, the odds of HED also increased. FSWs who worked in bars/hotels (adjusted odds ratio [aOR], 2.19[95% CI: 1.81–2.66]) and in local drinking houses (aOR, 1.29 [95% CI: 1.002–1.67]) had higher odds of HED compared to those who worked on the street. FSWs who worked in spas, massage parlors, beauty salons, or their own house (aOR, 0.46 [95% CI: 0.25–0.83]) had lower odds of HED than street-based FSWs. FSWs who started selling sex before the age of 18 years had 1.48 (1.13, 1.95) and between 18–24 years 1.59 (1.25, 2.03) times higher odds of HED than FSWs who started selling sex after the age of 25 years. FSWs who were forced into the sex trade had 2.91 (2.45, 3.46) times increased odds of HED than FSWs who chose to start selling sex. In addition, FSWs who reported chewing khat at least once per week had higher odds of HED than non-users; as the number of days of chewing khat increased, the odds of HED also increased. Educational status and those who reported support for others were no longer significant when adjusted for other variables (Table 4).

Consequences of HED in bivariate and multivariate logistic regression analysis

Bivariate and multivariate logistic regression analyses were performed using HED as a predictor and condom breakage/slippage, inconsistent condom use, physical beating, and HIV status as dependent variables. In bivariate analysis, HED was significantly associated with each dependent variable except for HIV status. In multivariate analysis, FSWs with HED had 1.27times higher odds of physical beating than those without HED. FSWs with HED had 1.44 times higher odds of condom breakage/slippage than those without HED (Table 5).

AF of HED on outcome variables

Table 6 shows the HED AF among the FSWs with HED and the entire FSW population. The proportion of HED in the total FSW population was 29.1% and was used to calculate the PAF. The results showed that 6.2% of the risk of physical beating and 8.9% of condom breakage/slippage could be attributed to HED among FSWs.

Discussion

To our knowledge, this is the first study of FSWs that used RDS and includes 11 towns in Ethiopia. Alcohol use was common among FSWs, and the prevalence of HED was high (29.1%). Factors such as starting to sell sex before the age of 25years, being forced into selling sex, working in a bar/hotel, having a higher income, and chewing khat frequently were significant determinants of HED. In turn, HED was significantly associated with physical beating and condom breakage.

Table 2. Behavioral and other related factors among female sex workers in 11 towns in Ethiopia (2014).

Variable	Frequency	Percentage
Someone forced you into selling sex		
No	3401	69.6
Yes	1485	30.4
Total	4886	100.0
Missing	0	
Provide any regular financial or other support to family member and/or to others		
No	2496	51.1
Yes	2390	48.9
Total	4886	100.0
Missing	16	
Inconsistent condom use in the past 30 days		
No	4521	92.5
Yes	365	7.5
Total	4886	100.0
Missing	0	
Condom breakage/slippage in the past 30 days		
No	3572	73.2
Yes	1307	26.8
Total	4879	100.0
Missing	7	
Frequency of alcohol consumption		
Never	1660	34.0
Once per month or less	208	4.3
2–4 times per month	494	10.1
2–3 days per week	1384	28.3
4 or more days per week	1140	23.3
Total	4886	100.0
Missing	0	
Frequency of khat chewing per week		
Never	2302	47.1
Less than once	545	11.2
1–2 days	391	8.0
3–4 days	283	5.8
5–7 days	1364	27.9
Total	4885	100.0
Missing	0	
Ever used any other drugs		
No	4358	89.2
Yes	528	10.8
Total	4886	100.0
Missing	0	
Monthly heavy episodic drinking (HED)		
No	3466	70.9
Yes	1420	29.1
Total	4886	100.0
Missing	0	
Physically beaten in the past 12 months		

(*Continued*)

Table 2. (Continued)

Variable	Frequency	Percentage
No	3930	80.4
Yes	955	19.6
Total	4885	100.0
Missing	1	
HIV status		
Negative	3857	79.3
Positive	1009	20.7
Total	4866	100.0
Missing	20	

https://doi.org/10.1371/journal.pone.0252432.t002

A national household-based study in Ethiopia reported a 1-month HED prevalence of 12.4% (men, 20.5%; women, 2.7%) [37]. Although these findings are not directly comparable with our results, the difference in monthly HED prevalence observed among the general female population and FSWs in our study is considerable and supports the disproportional risk of HED among FSWs. The HED prevalence in our study (29%) was comparable with that among FSWs in Kenya (33%) [6].

HED was significantly associated with average monthly income in our study, which supports findings from a study conducted in Malawi, showing that alcohol use facilitates FSWs' solicitation with clients and is a help in price negotiation [23].

Furthermore, the type of venue used by FSWs to sell sex played a role in alcohol drinking and increased HED. Our study showed that FSWs who worked in a bar/hotel or local drink house had higher odds of HED than street-based FSWs. FSWs working in these venues are expected to facilitate the alcohol sales, which in turn increases HED. Similar studies conducted in Kenya, India, and Indonesia and a meta-analysis involving several countries reported that higher alcohol consumption is more prevalent in a setting where alcoholic drinks are sold [6–10].

Early adolescent alcohol use is associated with an earlier age of first sexual intercourse and greater number of sexual partners [38]. Our study showed that FSWs who started selling sex before the age of 18 years experienced more HED. A similar study conducted in China also reported that FSWs who had their sexual debut at a younger age were significantly more often intoxicated with alcohol before having sex with their client than older FSWs [11]. Although we were unable to determine whether FSWs started drinking alcohol before or after they started selling sex, starting to sell sex at a younger age increased the odds of HED. This association underlines the importance of alcohol risk reduction interventions targeting young FSWs.

Moreover, being forced into sex work increases the vulnerability(risk for rape, inconsistent condom use, etc.) of women/girls by removing their basic autonomy [13]. These FSWs tend to use substances including alcohol as a coping mechanism, which subsequently increases their risk to become a chronic user [12, 13]. Our study also shows that FSWs who reported being forced into selling sex were significantly more likely to experience HED. To address the problem of sex trafficking and its consequences, it is crucial to identify the individuals behind such trafficking and to involve law enforcement officers in these efforts. Another strategy could be to increase and improve the knowledge and ability of law enforcement professionals to identify victims of sex trafficking.

A study conducted among frequent khat users in Addis Ababa, the capital of Ethiopia, reported that khat use was a significant predictor of harmful drinking [19]. Although that study is not directly comparable with our study, our results showed that FSWs who chewed

Table 3. Bivariate logistic regression analysis results of monthly Heavy Episodic Drinking (HED) in relation to predictor variables among female sex workers in 11 towns in Ethiopia.

Variables	N	OR (95%CI)	P-Value
Age, years			
15–24 (ref)	2880	1.0	
25–34	1590	1.09 (0.95, 1.25)	0.205
≥35	416	0.85 (0.67, 1.09)	0.182
Educational level			
No Education (ref)	1230	1.0	
Primary 1st cycle (1–4)	780	1.23 (0.98, 1.53)	0.069
Primary 2nd cycle (5–8)	1941	1.97 (1.66, 2.34)	< 0.001
Secondary and above	922	3.05 (2.51, 3.70)	< 0.001
Average monthly income from selling sex			
≤1000 ETB (≤US$50) (ref)	1608	1.0	
1001–2000 ETB (US$51–$100)	1575	1.90 (1.60, 2.25)	< 0.001
2001–3000 ETB (US$101–$150)	927	3.66 (3.04, 4.40)	< 0.001
3001–4000 ETB (US$151–$200)	489	3.14 (2.51, 3.93)	< 0.001
4001–5000 ETB (US$201–$250)	166	6.00 (4.30, 8.36)	< 0.001
>5000 ETB (>US$251)	122	4.07 (2.79, 5.95)	< 0.001
Sex-selling venues			
Street(ref)	1866	1.0	
Local drinking houses	872	0.45 (0.36, 0.55)	< 0.001
Spa/Massage/Beauty salon/Own house	159	0.26 (0.15, 0.45)	< 0.001
Red Light houses	477	0.55 (0.42, 0.70)	< 0.001
Bar/Hotel	1145	1.70 (1.45, 1.98)	< 0.001
Others	367	1.80 (1.43, 2.26)	< 0.001
Age when started to sell sex, years			
<18	1216	1.69 (1.37, 2.10)	< 0.001
18–24	2889	1.87 (1.54, 2.26)	< 0.001
≥25 (ref)	781	1.0	
Someone forced you into selling sex			
No (ref)	3404	1.0	
Yes	1482	5.04 (4.41, 5.76)	< 0.001
Provide any regular financial or other support			
No	2494	2.05 (1.81, 2.33)	< 0.001
Yes (ref)	2392	1.0	
Frequency of khat chewing per week			
Never(ref)	2304	1.0	
Less than once	546	2.03 (1.58, 2.61)	< 0.001
1–2 days	390	3.67 (2.84, 4.73)	< 0.001
3–4 days	282	4.59 (3.47, 6.06)	< 0.001
5–7 days	1364	14.84(12.48, 17.65)	< 0.001

Abbreviations: OR, crude odds ratios; CI, confidence intervals.

https://doi.org/10.1371/journal.pone.0252432.t003

khat more frequently also experienced more HED. According to different studies, when a stimulant, such as khat, is combined with alcohol, it masks alcohol's effects, so that people cannot assess their level of intoxication, which can result in over-consumption [18, 39]. Therefore, targeting khat chewing among FSWs is an essential part of strategies to reduce HED among FSWs.

Table 4. Multivariate logistic regression analysis of monthly Heavy Episodic Drinking (HED) in relation to predictor variables among female sex workers in 11 towns in Ethiopia (2014).

Variables	N	aOR (95%CI)	P-value
Educational level			
No education(ref)	1230	1.0	
Primary 1st cycle (1–4)	780	1.12 (0.86, 1.46)	0.407
Primary 2nd cycle (5–8)	1941	1.46 (1.18, 1.80)	< 0.001
Secondary and above	922	2.20 (1.72, 2.81)	< 0.001
Average monthly income from selling sex			
≤1000 ETB (≤US$50)(ref)	1608	1.0	
1001–2000 ETB (US$51–$100)	1575	0.99 (0.81, 1.23)	0.961
2001–3000 ETB (US$101–$150)	927	1.49 (1.18, 1.88)	0.001
3001–4000 ETB (US$151–$200)	489	1.36 (1.02, 1.80)	0.034
4001–5000 ETB (US$201–$250)	166	3.94 (2.64, 5.89)	0.001
>5000 ETB (>US$251)	122	1.46 (0.92, 2.32)	0.112
Sex-selling venues			
Street(ref)	1866	1.0	
Local drinking houses	872	1.29 (1.002, 1.67)	0.051
Spa/Massage/Beauty salon/Own house	159	0.46 (0.25, 0.83)	0.010
Red light houses	477	0.81 (0.60, 1.10)	0.181
Bar/Hotel	1145	2.19 (1.81, 2.66)	0.001
Other	367	1.62 (1.22, 2.15)	0.001
Age when started to sell sex, years			
<18	1216	1.48 (1.13, 1.95)	0.005
18–24	2889	1.59 (1.25, 2.03)	< 0.001
≥25 (ref)	781	1.0	
Someone forced you into selling sex			
No(ref)	3404	1.0	
Yes	1482	2.91(2.45, 3.46)	< 0.001
Provide any regular financial or other support to family member and/or to others			
No	2494	1.17 (0.99, 1.38)	0.070
Yes (ref)	2392	1.0	
Frequency of khat chewing per week			
Never(ref)	2304	1.0	
Less than once	546	1.99 (1.52, 2.59)	< 0.001
1–2 days	390	3.31 (2.51, 4.36)	< 0.001
3–4 days	282	4.62 (3.42, 6.24)	< 0.001
5–7 days	1364	11.15 (9.20, 13.50)	< 0.001

Abbreviations: aOR, adjusted odds ratios; CI, confidence interval.

https://doi.org/10.1371/journal.pone.0252432.t004

Even though condom use was high in our study, reported condom breakage/slipping was also high. FSWs who reported condom breakage/slipping and inconsistent condom use reported significantly more HED, and this is a major concern for HIV/sexually transmitted infection prevention programs. Our findings are similar to those of studies conducted in India and South Africa [40, 41]. Although an individual may know how to use a condom, proper condom utilization may be affected by the state of mind during sexual intercourse. It is counter-intuitive to consider that improper use of a male condom during usage could be affected by the FSWs alcohol consumption level. However, during sexual intercourse with FSWs, it is not uncommon for FSWs to put the condom on the client.

Table 5. Bivariate and multivariate logistic regression analysis showing the effect of monthly Heavy Episodic Drinking (HED) on outcome variables among female sex workers (FSW) in 11 towns in Ethiopia (2014).

Predictor variable	Dependent variables Crude OR (95% CI)			
	Physical beating	Condom breakage/slippage	Inconsistent condom use	HIV status
HED				
No (ref)	1.0	1.0	1.0	1.0
Yes	1.29 (1.11, 1.50)	2.31(2.02, 2.64))	1.68 (1.35, 2.09)	1.04 (0.90, 1.22)
P-value	0.001	< 0.001	< 0.001	0.578
	Adjusted OR (95% CI)			
	Physical beating	Condom breakage/slippage	Inconsistent condom use	
HED				
No (ref)	1.0	1.0	1.0	
Yes	1.27 (1.05, 1.53)	1.44 (1.21, 1.70)	1.30 (0.99, 1.72)	
P-Value	0.014	< 0.001	0.059	

Abbreviations: OR, odds ratios; CI, confidence interval.

HED was adjusted for sex selling starting age, average income, sex selling venue, khat chewing, start selling sex by force, and educational level variables

https://doi.org/10.1371/journal.pone.0252432.t005

In our study, HIV infection was not significantly associated with HED, although the prevalence of HIV was high (20.8%). This finding is similar to results reported in studies conducted in Kenya [6, 10] but differs from other studies conducted in Botswana, South Africa, Rwanda, and Zambia which reported a significant association of HIV with HED [20–22]. Because of the cross-sectional study design, changes in alcohol consumption patterns over time could not be measured; therefore, we could not determine whether current drinking patterns differed from those at the time of HIV infection [6].

Another factor found to be significantly associated with HED was violence. Alcohol use is one of the most important risk indicators of increased violence against FSWs [42, 43].Alcohol use impairs FSWs' ability to detect the risk of violence and increases their vulnerability to risk-prone situations [27, 28].

Overall, our study shows that the proportion and associated consequences of HED among FSWs might require prevention and harm reduction efforts. Nevertheless, Ethiopia does not have any programs focusing on HED harm reduction among FSWs. Combining HED reduction programs with other ongoing programs such as HIV programs could help reduce HED and sustain epidemic control.

The strengths of this study included the large sample of FSWs from11 cities and the sampling technique (RSD), which is recommended for hard-to-reach populations.

Our study had several limitations; the first is the findings are subject to social desirability bias. Secondly, we defined HED as ≥6 drinks per occasion, which might not be the definition used by other studies; this potential difference in definitions may have implications with regard to the risk factors that we identified. In addition, caution is needed when making inferences regarding causality; because this was a cross-sectional study, cause could not be

Table 6. Heavy Episodic Drinking (HED) attributable risk fraction for the occurrence of physical beating, rape, condom breakage/slippage, and inconsistent condom use among female sex workers in 11 towns in Ethiopia (2014).

Predictor variable	Outcome variable	Attributable risk fraction (AF) (%)	Population attributable risk fraction (PAF) (%)
HED	Physical beating	21.3	6.2
	Condom breakage/slippage	30.6	8.9

https://doi.org/10.1371/journal.pone.0252432.t006

established. In addition, due to RDS method **FSWs with** small **network size might not be adequately represented**.

Conclusion

We found that FSWs who started sex work before the age of 18 years, who had higher income from selling sex, who worked at venues where alcohol is sold, who were forced into sex work, and who chewed khat more frequently had increased likelihood of HED. In turn, HED increased the odds of violence, condom breakage, and inconsistent condom use. Increasing awareness of these factors and their consequences could help minimize the risks associated with HED for FSWs. In general, these results are likely to be relevant for FSW programs in other countries with a similar setting as Ethiopia and may inform targeted prevention strategies for FSWs.

Supporting information

S1 Questionnaire.
(DOCX)

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Paper III

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: Female sex workers (FSWs) have high risk of acquiring and transmitting HIV infection. We determined viral load non-suppression (VLN) rates, and patterns of HIV drug resistance (HIVDR) among FSWs in Ethiopia

Methods: A cross-sectional biobehavioural survey was conducted among FSWs aged ≥18 years in 11 towns in Ethiopia in 2014. Whole-blood specimens were collected for HIV testing, $CD4^+$ T-cell counts, viral load (VL), and HIVDR genotyping.

Results: Among the 4900 participants, 1172 (23.9%) were HIV-positive, and of these 1154 (98.5%) had a VL result. Participants were categorized into ART (n=239) and ART-naïve (n=915) groups based on self-report. The 521 specimens (ART group, 59; ART-naïve, 462) with VL ≥1000 copies/mL were subjected to HIVDR genotyping. Genotyping was successful for 420 (80.6%) samples, and 92 (21.9%) had drug-resistance mutations (DRMs). Pre-treatment drug resistance (PDR) was detected in 16.5% ART-naïve participants (95% confidence interval [CI]: 12.8%–20.3%). Non-nucleoside reverse transcriptase inhibitors (NNRTIs), nucleoside reverse transcriptase inhibitors (NRTIs), and dual-class DRMs were detected in 55 (14.4%), 40 (10.5%), and 35 (9.2%) of the participants, respectively. Among 239 ART group participants, 59 (24.7%) had VLN. HIVDR genotyping was successfully performed for 39 (66.1%). DRMs were detected in 29 (74.4%). All 29 had NNRTI DRMs, 23 (79.3%) had NRTI or dual-class DRMs.

Conclusions: The high VLN and HIVDR rates among FSWs underscores the need for targeted programmatic intervention to improve ART access and routine 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]. 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 [10, 11]. 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, 12].

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 and towns (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 [13]. 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.

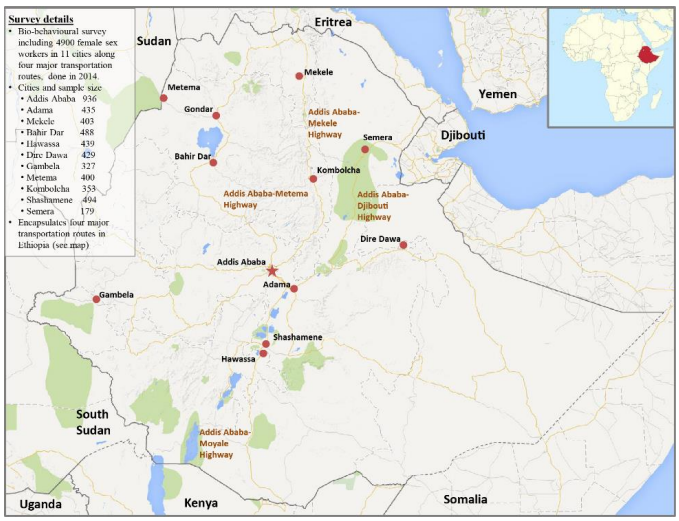

Figure 1. Map of the cities and towns in Ethiopia included in the 2014 study of HIV drug resistance in female sex workers. Details of the study are shown in the box. This figure was modified from Google Maps (https://www.google.com/maps/place/Ethiopia).

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 [14]. 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 [15], 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) [16]. 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) [17]. 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 [18]. 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 [19].

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. This project was reviewed in accordance with CDC human research protection procedures 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 serology, VL and the genotyping results. Of 4900 participants, 1172 (23.9%) had 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 [15]. 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).

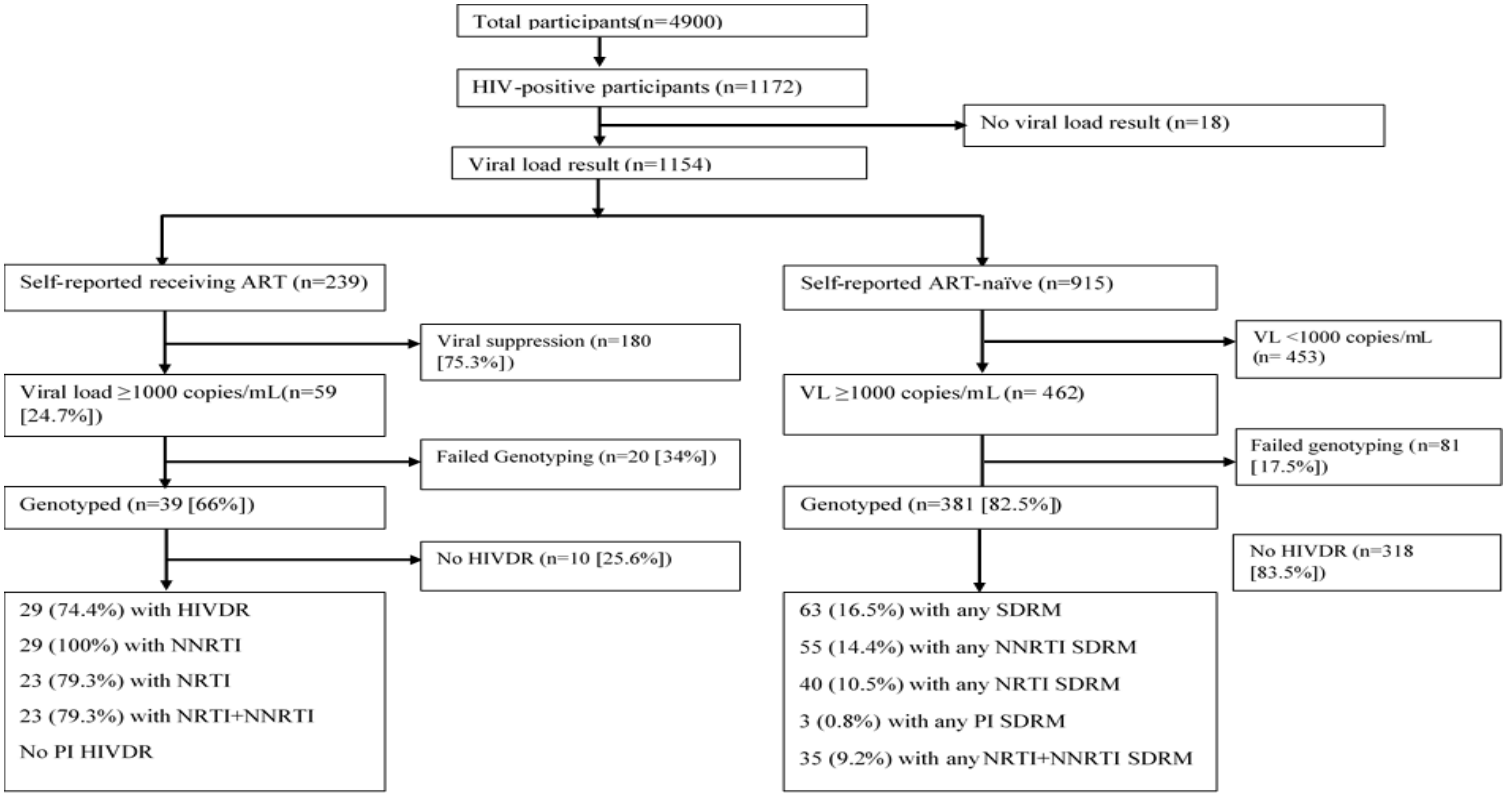

Figure 2. Flow chart of study participants selection and genotypic analysis of drug-resistant HIV in female sex workers. Abbreviations: ART, antiretroviral therapy; VL, viral load; SDRM, surveillance drug-resistance mutation included in the WHO 2009 SDRM list; HIVDR, HIV drug resistance; NNRTI, non-nucleoside reverse transcriptase inhibitor; NRTI, nucleoside reverse transcriptase inhibitor; PI, protease inhibitors

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% and 27.0% 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.

Table 1. Frequency of pre-treatment drug-resistance mutations detected among female sex workers (n=381) 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.

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).

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)
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

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 ($p<0.001$).

(Table 3)

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 of sex transactions/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)
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; §Facilities other than those mentioned in the list

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%) [14, 20-26]. Consistent with our findings, other studies have reported high PDR levels (10%–48%) among FSWs in different countries, including those in sub-Saharan Africa [25, 27-31]. Moreover, previous studies also have shown a higher PDR rate among communities and groups with high-risk behaviours [26, 32]. 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 [33]. Similar findings have been reported in other LMICs, which depend on standardized first-line ART [34, 35]. 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 [11, 36].

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 [36-38]. 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 [34, 35].

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 [39, 40] and would be expected to be found at low frequencies among individuals with PDR. Nevertheless, M184V is one of the most detected PDR mutation in most countries, including sub-Saharan African countries [35].

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%) [41-44]. 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 [45-48]. A recent report from Ethiopia also showed that only 26% of HIV-positive FSWs were receiving ART [49]. Consistent with our results, several studies in sub-Saharan Africa have shown high levels of VLN among FSWs [25, 50-53]. 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 [13, 54].

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, 55-57]. 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 [55, 56]. 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 [58].

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 [59, 60]. 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.

The predominant DRMs detected among our participants with VLN were M184V and K103N, which likely result from 3TC/FTC and NVP/EFV-based first-line regimens used in Ethiopia. This finding is consistent with the results of several studies, including a systematic review from sub-Saharan Africa [61, 62].

We found that age ≥35 years, $CD4^+$ T-cell counts <350 cells/mm^3 and being forced into selling sex were significantly associated with VLN. In addition, ADR and PDR were significantly associated with low $CD4^+$ T-cell counts (<350 cells/mm^3). Participants aged ≥35 years experienced higher prevalence of VLN compared to 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 [25]. 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 [63].

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 [13]. 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 [64]. 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 [47, 48, 65]. 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 [66]. 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.

Acknowledgments

We express our deep appreciation to the study participants and all staff involved in the survey. We also acknowledge the support given by the EPHI research laboratory team and CDC in Ethiopia and in Atlanta.

Funding: This research has been supported by the President's Emergency Plan for AIDS Relief (PEPFAR) through HHS/CDC under the terms of 5U2GGH001178, the Swedish Research Council, and a donation to PM and PB through the Medical Faculty, Lund University.

Transparency declaration

The authors declare that they have no competing interests.

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.

Disclaimer: The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the funding agencies.

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Paper IV

Experiences of female sex workers concerning condom failure and the role of pre-exposure prophylaxis (PrEP) in Ethiopia: a qualitative study

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Abstract

Background: Female sex workers (FSW) remain a highly exposed group for HIV/STIs due to different factors including condom failure. In Ethiopia, Pre-exposure prophylaxis (PrEP) has recently been introduced as an intervention strategy to prevent new HIV infections, but knowledge about FSWs' experiences of condom failure and PrEP use remains scarce. Therefore, this study explores FSWs' experiences concerning condom failure and their attitudes towards, and experiences of, PrEP uptake.

Method: A qualitative study using in-depth interviews was conducted among 17 FSWs in Addis Ababa. A manifest and latent content analysis method were applied to identify categories and emerging themes.

Result: Three themes were identified: The first theme, "Struggling with the continuous risk of condom failure", described the factors that make FSWs more vulnerable to condom failure, including clients' and FSWs' own behavior, and the strategies FSWs used to minimize the harm resulting from condom failure. The second theme, "Doubting the feasibility of PrEP as a protection strategy", described issues that deter FSWs from PrEP uptake, including FSWs' misconceptions about PrEP and their lack of confidence. The third theme, "Being challenged by the negative aspects associated with PrEP use" described FSWs' adverse experiences of PrEP side effects and adherence challenges including pain, stigma, and substance use.

Conclusion: Despite FSWs' efforts to minimize the risk of HIV/STI infection, factors that increase their exposure to condom failure remain, including the demands and/or behavior of the clients and FSWs' own actions and/or poor awareness. Challenges associated with one of the harm-reducing mechanisms, PrEP uptake, indicate that user-friendly strategies need to be designed and implemented to counter these barriers and facilitate PrEP uptake.

Keywords: Condom use, PrEP challenge, side effect, FSWs, Ethiopia

Introduction

Female sex workers (FSW) are highly vulnerable to sexually transmitted infections (STI), HIV, and unintended pregnancy due to a number of adverse circumstances, including large numbers of sex partners, unsafe working conditions, inconsistent condom use, frequent alcohol and other substance use, exposure to violence, and economic deprivation (1–4). According to a meta-analysis from 111 studies worldwide, FSWs are 13.5 times more likely to be infected by HIV than other women of reproductive age (5). Moreover, FSWs often have little ability to mitigate these challenges because of social marginalization and criminalized work environments (3).

Condom failure is when breaking, leaking, or slipping-off occurs during penetrative sexual activity, and such failure is a frequent experience among FSWs (6–8). In a study among 4,886 FSW in Ethiopia, 25.5% reported condom breakage/slippage at least once in the past month preceding the survey (9). In the aforementioned study, heavy episodic drinking among FSWs was found to be one of the factors that increased condom breakage/slippage (9). Further, a study among 291 FSWs conducted in India also found that lack of experience and incorrect handling of the male condom contributed to condom breakage (10). Studies among FSWs in China (N= 200) and South Africa (N= 100) also found that poor condom fit, the duration and roughness of the sex act, and the use of drugs and alcohol contributed to condom breakage/slippage (11, 12). To minimize the incidence of condom failure, interventions including learning about proper condom use and applying condoms self, have been recommended (13).

Daily oral pre-exposure prophylaxis (PrEP) is recommended for FSW and HIV-negative partners of serodiscordant couples in Ethiopia since 2020 (14). Ethiopia has an estimated 2,884 PrEP users, a low rate of 0.3 per 10,000 population compared to 15.5 per 10,000 population in Kenya (15). Currently, the Ministry of Health has launched a national scale-up of the service to be offered at all ART-providing facilities and drop-in centers. PrEP is a relatively new intervention offered to FSWs and could potentially reduce their risk of HIV infection due to condom failure. However, knowledge is currently scarce concerning FSWs' attitudes towards and experiences of PrEP use in Ethiopia.

Thus, in order to better support FSWs' HIV prevention efforts in a setting where PrEP is becoming available, increased knowledge is needed about FSWs' experiences of condom failure and how they view PrEP use in this regard. To our knowledge, this is the first study exploring the

experiences of FSWs with regard to condom failure and daily oral PrEP in Ethiopia. The aim of the study was to explore FSWs' experiences concerning condom failure and their attitudes towards and experiences of PrEP use.

Material and methods

Study setting and design

The study was conducted in Addis Ababa, the capital of Ethiopia, with an estimated population of 4 million. Sex work takes place on the streets and in bars, hotels, red light houses, massage houses, and small establishments that sell local drinks.

The study participants were invited to the study using the snowball sampling method where the first interviewee was contacted through the drop-in center. FSWs are a hard-to-reach population; therefore, we used a Population Service International (PSI) drop-in center since this NGO had established a good relationship with this group. At the time of data collection PSI was the only organization with drop-in center in Addis Ababa. Drop-in centers (DICs) are community-based centers, aiming at offering confidential, comprehensive, and anonymous services for female sex workers including: HIV testing, STI diagnosis and treatment, family planning and risk reduction counselling (16). Inclusion criteria for participation in the current study were aged 18 years or older, currently engaged in sex work, and written informed consent prior to the study. Each participant was invited to a private location for an interview that lasted an average of 45 minutes. Permission was obtained from each study participant to audio record the interview. The data collection process was finalized after reaching a consensus among the researchers that information saturation had been attained.

The interviews were conducted by the first and third author, who were experienced in sexual and reproductive health matters and fluent in the local language (Amharic). They used a semi-structured interview guide (Supplementary document 1) that included participants' demographic characteristics and views about their working situation, condom use, alcohol consumption, HIV and sexually transmitted infection risks, and PrEP. Four pilot interviews were conducted to test the flow of the interview and the in-depth interview guide. The pilot interviews were used to modify and revise the interview guide. The final two pilot interviews utilized the revised interview guide and were therefore included in the analysis. After completion of the interview, each

participant was compensated with ~US$8 (300 Eth-birr) for transportation and time spent during the interview.

Data analysis

Data analysis was performed according to manifest and latent qualitative content analysis as described by Graneheim and Lundman (17). The unit of analysis was the interview, and the interview texts were sufficiently rich to allow for an exploration of the latent level. First, the recorded interview was transcribed in Amharic and then translated into English. Both interviewers read through each transcription independently and identified sentences that had a particular meaning (i.e. meaning units). The meaningful units were then coded by the first author. Codes were grouped into categories and subcategories based on similar ideas.

The two interviewers discussed the resulting categories until they reached a consensus. Then the categories were shared with the other co-authors for further discussion. Finally, a thorough discussion of the categories among all the authors facilitated the identification of emergent themes.

Ethical considerations

The study protocol was approved by the Ethiopian Public Health Institute review board (EPHI-IRB). FSWs are one of the vulnerable groups highly exposed to stigma and discrimination. Thus, extra care was taken to maintain the confidentiality and privacy of the study procedure; all personal identifiers were removed and then replaced with code numbers. In addition, individual informed consent was sought from each participant before the interview.

Results

A total of 17 FSWs participated in the study, with a median age of 25 years (range: 21-35). All but one participant had primary school or no formal education. Ten participants reported taking PrEP, one participant had stopped taking PrEP, and six participants never started it (Table 1). Three themes emerged during the analysis: 1) Struggling with the continuous risk of condom failure, 2) Doubting the feasibility of PrEP as a protection strategy, and 3) Being challenged by the negative aspects associated with PrEP use. The first theme was supported by three categories: a) Difficulties associated with clients' behavior, b) Dealing with their own inadequacies, and c) Minimizing harm due to condom failure. The second theme was supported by two categories: a) Misconceptions and barriers towards taking PrEP, and b) Lacking confidence in self-efficacy. The third theme was

supported by three categories: a) Having to deal with adverse side effects, b) Facing risk of stigma, and c) Feeling challenged by adherence needs (Table 2). The details of each theme and category are discussed below where the themes are shown in bold, and the categories are underlined.

Table 1: Characteristics of study participants

Characteristic	**Frequency**
Median age = 25 years (range: 21-35)	
PrEP uptake status	
Number of FSWs on PrEP	**10**
Discontinued taking PrEP	**1**
Not started PrEP*	**6**
Educational status	
No formal education	**5**
Some grade of elementary school	**11**
Secondary and above	**1**
Marital status	
Never married	**12**
Divorced	**5**
Number of children	
0	**8**
1	**7**
2	**2**
Current meeting location of clients	
Street	**14**
Bar and/or street	**3**

***One FSW was HIV (self-identified) positive so was not offered PrEP**

Table 2: The themes, category and sub-categories

Theme	**Categories**	**Sub-Categories**
Struggling with the continuous risk of condom failure	Difficulties associated with clients' behavior/demand	Deliberate condom breakage/ slippage and piercing
		Men's focusing only on sexual satisfaction leading to struggle (rough sex) and taking a long time
		Drunk clients
		Poor quality of condom brought by clients
		Size of penis
	Dealing with their own inadequacies	FSWs getting drunk
		Getting involved (FSWs) in the sex (level of absorption)

		Letting a client have sex in different positions/ allowing clients to take control over the position
		Not having proper condom use knowledge/skill
		Negligent FSWs face frequent breakage/slippage
	Minimizing harm due to condom failure	Changing condoms
		Getting rid of harmful fluids
		Taking PrEP
Doubting the feasibility of PrEP as a protection strategy	Misconceptions and barriers towards taking PrEP	Perceiving PrEP as an alternative, and not supplement, to condom use
		Perceiving no difference between taking PrEP daily and taking ART after being positive
		Not liking to take PrEP everyday
		Doubting effectiveness of PrEP for HIV protection
	Lacking confidence in self-efficacy	Fear of being negligent regarding condom use with client
		Fear of forgetting taking the pill while drunk as a reason not to start taking PrEP
		Fear of not being able to manage the side effects.
Being challenged by the negative aspects associated with PrEP use	Having to deal with adverse side effects	Having nausea and nightmares; gastritis and back pain; bloating, and sometime diarrhea
	Facing risk of stigma	Being seen as HIV positive when taking PrEP
		The PrEP container is similar with ART
	Feeling challenged by adherence needs	Worrying that drinking and using khat might interfere with PrEP adherence
		Forget taking PrEP in the morning due to sleeping

Struggling with the continuous risk of condom failure

Female sex workers encountered several risks during their work and these risks mainly emanated from the demand and actions of the clients or from the action and/or reluctance of FSWs. One of the main risks in the everyday life of a FSW was condom use failure, which was primarily due to condom breakage/slippage.

Difficulties associated with clients' behavior/demand

Condom failure was partly due to factors associated with the client's behavior. Some of the clients who demanded sex without a condom even tried to break/slip/tear the condom deliberately. It was

mentioned that when sexual intercourse takes a long time, some clients might attempt to break the condom deliberately to finish sooner.

"*There are guys who do not want to use condoms. I experienced deliberate condom breakage; the guy tears it with his finger while we are having sex and tries to continue, but I shout and make him stop. [P 08, age 25,]*.

Another FSW mentioned that those clients who know their status (HIV) might break the condom deliberately because they do not care. When asked "why do you think he starts to tear the condom?" she replied: "*I don't know, maybe to finish the sex or he already knows his status (HIV) and might not care." [P 03, age 23]*

To cope with deliberate tearing, FSWs tried to maintain control by putting on the condom for clients. By doing so, they could be able to manage proper condom use and avoid deliberate tearing. One FSW said that *"I put the condom on clients because some men try to tear it".* The other strategy reported was to identify clients who try to break condoms deliberately and avoid going with them when they come for the second time.

The other reason mentioned which compromised condom use was the client's focus solely on sexual desire leading to rough sex and condom breakage. One of the participants described this as follows:

"You know, it happens when you struggle. Some men do not think about their health; they only follow their feeling, and when they struggle the condom bursts, although I put it on him properly. When it happens, I often go to a clinic for testing and until now I am healthy, thanks to God". [P 16, age 25]

On the other hand, some drunk clients took too long a time during sex, causing the condom to break or slip.

"Yes, I have faced a drunken client and most of the time they nag you and give you a hard time. Their behavior changes from time to time and when they have sex, they don't do it properly. Therefore, I always try to control everything. During sex, they might last long which might cause condom breakage." [P 17, age 23]

In addition, the quality and storage of the condom were also mentioned as reasons for condom breakage/slippage. In particular, the condom that the client brings was believed to have low quality

due to poor storage and also subjected to deliberate tearing. Furthermore, condom use could be compromised by the size of the penis. FSWs experienced that the client's penis size could cause the breakage, or due to the small size of the penis, the condom slips.

"Sometimes when a client takes a too long time it breaks and slips if the client's penis size is small. I had a client with a small size and I try several times, but the condom does not fit, so I quit going with him." [P 03, age 23]

Dealing with their own inadequacies

FSWs' own behavior and inadequacies also contributed to condom use failure. One of the issues mentioned was alcohol consumption among the FSWs. According to the FSWs, most of the time it was possible to control the condom use with a drunk client if the FSW was not drunk, but if she was drunk too, it was impossible to use a condom let alone to manage proper condom use. As described by one of the participants:

"*I don't remember the whole thing; in the morning there was a condom on the ground (she laughs). Most of the time if I get drunk, I do not go with a client; I do not trust myself". [P 02, age 30]*

The active involvement of FSWs in the sexual intercourse was also mentioned as a contributor to condom breakage/slippage and also could make FSWs unable to respond to the breakage in time. Thus, when FSWs were actively engaged in the sexual intercourse, they might be less conscious of the condom. In addition, allowing clients to take control over the position during sex was also mentioned as a reason for compromised condom use. Trying to maintain awareness during sexual intercourse with a client and taking action when the condom breaks/slips were mentioned as strategies to control condom use.

"*If you let them have different positions of sex and give them freedom, you might also get involved emotionally in the sex and compromise the condom use. So I do not allow that; I only have normal sex position". [P08, age 25]*

The other reason mentioned for breakage and slippage was lack of proper condom use knowledge by FSWs. Most of the time FSWs put the condom on for the client to assure proper condom use, but sometimes due to poor knowledge they faced frequent condom breakage. They mentioned that especially when starting to sell sex, most of them might not know how to use condoms properly, leading to condom use failure. In addition, it was mentioned that FSWs who were negligent could

face frequent condom breakage/slippage. Thus, providing education on proper condom use especially for new FSWs was mentioned as one of the main prevention activities. In particular, continuing the support provided by the DIC system was mentioned as the preferred way of reaching FSWs.

"*The support should continue with the DIC system. Female sex workers have to get awareness training; they come from different lifestyles and also go through different things so they need to get an education. Currently, the DICs are not operating as before, so they should continue educating FSWs like they did previously. Not only for the current FSWs but also for the future generation. I am watching the new generation of young girls joining the sex work; they only see the money they get; they have no idea what's coming next. Therefore, they need to get an education, it should continue." [P 06, age 25]*

Minimizing harm due to condom failure

Despite FSWs' actions to avoid condom failure, they sought to minimize the harm done after condom breakage/slippage occurrence. The first thing they did was to change the condom swiftly when it broke during sexual intercourse. The other action to minimize the harm after condom breakage was to either wash, jump and/or urinate to get the fluid out of the body.

"When breakage happens, I try to urinate right away to wash out the fluids" [P8, age 25,].

Furthermore, taking PrEP was also reported by some FSWs to minimize the chance of contracting HIV.

"While I am at work, I might face condom breakage and contract HIV and that worries me. I want to build another life out of sex work, being in this life worries me. So, I try to use condoms properly and also use drugs (PrEP)". [P 12, age 25]

Doubting the effectiveness of PrEP as a protection strategy

Different factors contributed to FSWs' feelings of doubt about PrEP, leading some to avoid taking PrEP. Doubts about PrEP as a protection strategy were fueled by misconceptions and barriers towards taking PrEP and by lack of confidence.

Misconceptions and barriers towards taking PrEP

Some FSWs did not understand the role of PrEP and condom use; they considered PrEP as an alternative to condom use, so they chose condoms over PrEP.

"*When I ask the nurse the advantage of the PrEP during condom breakage, she said that it is as good as the condom and my understanding was, if it is only as good as the condom, then the condom is enough. So I didn't start it." [P 08, age 25]*

Another misunderstanding was comparing taking PrEP with taking ART for HIV. The fact that PrEP was taken daily was compared with ART for HIV, which is also being taken on a daily basis. However, some FSWs did not understand that PrEP is just for risk periods only.

"Some women say, if we are going to take it daily, what is the difference between being HIV positive and taking ART? So they say we will take the treatment when we become positive." [P 12, age 25]

The burden to take a daily pill was mentioned by some as a barrier not to start, while the effectiveness of PrEP for HIV protection was also doubted.

"*I don't know, I do not want to start it, taking it every day……Can it really protect from HIV?" [P15, age 22]*

Nevertheless, not all FSWs misunderstood the advantage of PrEP; one FSW when asked about being reluctant to use condoms due to taking PrEP and she replied as follows:

Never, it is the reverse for me, the drug gives me strength to be confident about using condoms. I think about my child, then I think about myself, if something happened to me [P 05, 25].

Lacking confidence in self-efficacy

Some FSWs mentioned reasons not to start taking PrEP that emanated from poor confidence and/or self-doubt. FSWs reported that PrEP could make them more reluctant to use condoms, and might make them accept being offered sex without a condom. In addition, the possibility of forgetting PrEP, especially during alcohol drinking, was also mentioned as a reason not to start taking it.

"*I don't know, I am afraid of taking it. It might also make me negligent about condom use. If I use the PrEP, when the client requests me, I might go without a condom. In addition, I might forget to take it when I get drunk so to avoid that, I prefer not to start taking the drug." [P 02, age 30]*

Some FSWs believed that the side effects of PrEP could be greater than the protection they obtained from it. In addition, fear of not being able to manage the side effects was mentioned as a reason; although they had not started taking PrEP, what they heard from other FSWs about the side effects of taking PrEP made them fear starting it.

"*Because I was afraid of the drug's side effect. I asked a woman who started to take it and she said it gives nausea, vomiting and also gastric pain. So I decided not to take the drug." [P 08, age 25]*

Being challenged by the negative aspects associated with PrEP use

FSWs with experience of PrEP described a number of negative aspects which they perceived as challenging, and for some, these were reasons to stop taking it.

Having to deal with adverse side effects

Among those FSWs who had taken or were currently taking PrEP, adverse side effects were experienced as a challenge. The reported side effects occurred during the starting period of taking PrEP (approximately 15 days). Having nausea, gastritis, bloating, nightmares, back pain, and sometimes diarrhea were the side effects reported. One FSW had stopped taking it due to the pain in the stomach and other FSWs mentioned that they were going to quit or had thought about quitting.

"It is for the prevention of HIV; it has been 3 months since I started taking it. When I start taking, I used to feel nausea, vomiting and also bloating and false alarm to go to the bathroom, and sometimes diarrhea too. Then I go to the clinic and told them that I was going to quit but they told me that it is temporary. They also told me not to quit unless I get out of this life. As they say, the pain was only for 15 days, then it stops." [P 03, age 23]

Facing risk of stigma

The attitude and perception of other FSWs towards PrEP appeared to be one of the challenges. The similarity of the PrEP and ART containers opened the door for pre-judgment, and this led some FSWs to hide the bottle when taking it.

"*Yes, I take it with me in the bag. I have a friend who said you are HIV positive after looking at the tablet, then I told her that it is a preventive medicine, but she couldn't believe me. She is also a sex worker, so I brought her to the DIC and they told her everything. Then after checking for liver and HIV, she also started taking it. When she first said that I was positive, I was shocked and started to hide when I take it. The drug container is similar to ART, so at first, you might shock." [P 03, age 23]*

Feeling challenged by adherence needs

As with any other medicine, maintaining good adherence to the PrEP was mentioned as one of the challenges, especially since the FSW's job involves substance use and going far from home. Also, the working hours mostly are at night, so most FSWs spend the morning time sleeping, which makes FSWs who take in the morning forget to take it.

"I drink alcohol and chew Khat, it is not advised to drink with the drug and that worries me. When it's cold, I drink to cope. Sometimes I sleep and forget to take it; especially if you take it in the morning, you could forget." [P 12, age 25]

The size of the pills was also mentioned as a challenge. One FSW said that the drug looks like a tablet which is given for cows in the countryside; you have to use more water to swallow it.

Discussion

The results show that despite FSWs' struggles to ensure proper condom use, condom failure remains a challenge, both due to the clients' behavior and factors related to their own inadequacies. When condom failure occurred, FSWs tried to minimize its adverse consequences with various strategies, and some, but not all, FSWs used PrEP. PrEP acceptability was compromised by different factors including fear of the side effects and doubts as to the effectiveness of protection. Those who had started taking PrEP reported various challenges including adverse side effects, stigma, and problems with maintaining adherence.

A common occurrence was that client's behavior and demands created uncomfortable situations for FSWs, sometimes leading to deliberate condom breakage/slippage. Studies in Kenya and India also reported that clients who prioritized sexual pleasure purposely interfered with condom use (10, 18, 19). Similar to the current study, a qualitative study conducted in Kenya also mentioned that condom breakage/slippage could either be intentional or unintentional (18). Besides the deliberate act, due to the influence of alcohol or other substances use, clients could compromise condom use unintentionally. Therefore, becoming aware of client-related factors that lead to condom failure could help FSWs manage their own protection better.

Although FSWs attributed most of the breakages to the actions of clients (18), FSWs' actions and negligence also caused condom failure. Similarly, findings from a study in India showed that FSWs under the influence of alcohol could not control condom use, and therefore, the failure rate could be high (20). In addition, as found in the current study, their emotional involvement with the sexual intercourse could increase the friction leading to breakage. Also, when they became too

actively involved or absorbed in the sex, their ability to manage and feel condom breakage/slippage could be compromised. Having sex in a position where FSWs cannot control the actions of the client also opens the door for condom failure. Therefore, programs need to make a special effort to identify FSWs who appear to be more susceptible to breakage/slippage and provide information and skills to minimize their risk for HIV/STI infection (13, 20). Although they work under difficult conditions, FSWs try to maintain their safety by controlling the condom use process. In addition, as shown in the current study and in a review of studies conducted among FSWs (21), some took PrEP to be protected from HIV during condom breakage/slippage incidents (21).

PrEP is one of the prevention methods that was recently introduced in Ethiopia (14). Following Ethiopian national comprehensive HIV prevention, care, and treatment guidelines, the Ministry of Health in collaboration with partners has started PrEP as an additional HIV prevention service for FSWs (14). The continuous risk of condom failure shown in the current study suggests that PrEP may play a key role in HIV prevention strategies, if uptake among FSWs could be ensured. However, our study identified several misconceptions with regard to the prevention benefits of PrEP which could have implications for PrEP uptake. FSWs reported that they thought PrEP was an alternative to condom use, and some FSW preferred using condoms rather than PrEP. Some even compared taking PrEP daily with taking ART for HIV treatment. Such misconceptions might be due to poor comprehension of the part of the FSWs or poor communication skills from the provider side. Therefore, PrEP providers should be aware that may FSWs have a low level of education and will need engaging information sessions to fully appreciate the value of PrEP, especially as misconceptions regarding side effects persist in the community. To support PrEP uptake and persistence, the toolkits should be easily understandable by FSWs (22). Studies conducted in Baltimore and South Africa also suggested the need for provision of proper PrEP education to increase the uptake (21, 24).

The disbelief in the effectiveness of PrEP was also another reason to avoid PrEP, and it is consistent with prior research conducted among young adults in rural Kenya, Uganda and Botswana (25, 26). In the aforementioned study, some of the individuals wanted to see evidence if PrEP really works (24). In addition, taking the pills daily was mentioned as a burden, indicating that a low level of information might cause a barrier for PrEP uptake. There is an urgent need to provide PrEP information among FSWs including how PrEP should be taken and adhered to.

Strategies should be designed for how to communicate proper information about PrEP with the aim of changing the attitude of FSWs towards PrEP.

Our study also showed that preconceptions and lack of confidence played a role in avoiding PrEP. Some anticipated that their drinking and Khat chewing status might interfere with PrEP, and others mentioned that PrEP taking could make them negligent about condom use. Such cases illustrate that the role of service providers is vital. Service providers should anticipate such issues and discuss how to overcome fear and use PrEP for protection against HIV. On the other hand, FSWs who were taking PrEP mentioned that taking it improved their condom use since it boosted their confidence in protection. Therefore, creating a peer to peer education program to allow these two different attitudes meet and discuss could help to strengthen PrEP programming for FSW

On the other hand, our study showed that FSWs who were taking PrEP also faced various challenges which emanated from community perceptions about PrEP. A study conducted in Uganda reported that stigma related to the similarities of PrEP with ART made some FSWs fear taking PrEP, because they could be perceived as if they had HIV (24). Due to that, some FSWs try to hide when taking it, which eventually affects their adherence. Systematic reviews of studies conducted in low and middle income countries reported that adherence could be impacted by the complexity of the FSW's lifestyle (21, 27). They mostly work at night, might use substances, and thus spend the morning time sleeping. Those who start taking it therefore could forget taking it on time and could even forget taking it at all. Studies conducted in South Africa, Benin, Senegal, and Uganda reported a lower retention rate of PrEP, especially among young FSWs, which could be attributed to similar challenges like substance use (27–30). Although not conducted among FSWs, studies targeting couples across Africa found that women who had experienced verbal, physical or economic abuse from a partner were more likely to have low PrEP adherence (32, 33). It is known that most FSWs experience abuse, frequently exposing them to stress and forgetting (31). Therefore, PrEP education programs should target common challenges associated with PrEP use in order to support uptake and adherence.

Furthermore, the study identified several side effects that not only were considered negative by those who had started taking PrEP but also created fear among those who did not take it. Service providers should make FSW aware that side effects will be temporary and usually disappear within two weeks. In general, good and ongoing counseling is key for successful PrEP service roll-out

(21). It helps to increase enrollment, maximize adherence and reduce attrition for the success of the service. Service provider's knowledge and skills need to be built through ongoing mentoring and training based on evidence from studies such as the current one and others (21, 24).

Methodological considerations

The study was conducted using an in-depth interview which allowed participants to express their experiences and concerns. A semi-structured interview guide helped to ensure consistency in the interview process. We used a private venue for the interviews to create an environment where the participants could freely discuss personal issues. Moreover, two researchers (one male and one female, respectively) conducted the in-depth interviews; which may help to reduce the bias from one interviewer. No differences were observed in the quality of the interview data obtained between the two interviewers. Furthermore, the analytical process was conducted through discussion with all authors, which helped to achieve consensus and to ensure the credibility of the results.

The presentation of the various steps in the analytical model makes the process accessible to other researchers and readers of the paper. In addition, the use of quotations in the text provides evidence that the interpretation of the findings was based on the current data.

Although the data collection process was finalized after saturation of information was achieved, it cannot be excluded that additional participants might have provided other perspectives. The fact that most FSWs working in different setting face similar challenges makes the results of the current study in all probability transferable to FSWs in other settings and countries.

Most of the participants were from one type of sex selling venue (street) which might introduce some limitations. The views and attitudes of FSWs from other types of venues might be missed. However, to our knowledge, this is the first study that explores the uptake of PrEP among FSWs in Ethiopia. It may serve as the basis for future studies and may offer suggestions for strengthened PrEP education programs for FSW.

Conclusion

Despite FSWs' efforts to minimize the risk of HIV/STI through proper condom use, factors that increase their exposure to condom failure remain, including the demands and/or behavior of the clients and FSWs' own actions and/or poor awareness. Challenges associated with one of the harm-

reducing mechanisms, PrEP uptake, indicate that user-friendly strategies need to be designed and implemented to counter these barriers and facilitate PrEP uptake. There is a need for programs to consistently support FSWs' struggle against HIV infections. Programs should alert FSWs that PrEP is a method that they can control, which can support the condom use process. The information provided to FSWs should take into consideration their education and understanding to achieve better HIV prevention strategies.

Abbreviations

FSW: Female sex workers

STI: Sexually transmitted infection

HIV: Human immunodeficiency virus

HED: Heavy episodic drinking

PrEP: Pre-exposure prophylaxis

ART: Anti-retroviral treatment

PSI: Population service international

NGO: Non-governmental organization

DIC: Drop-in centers

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethiopian Public Health Institute review board (EPHI-IRB) reference number: EPHI 6.13/803. All methods were carried out in accordance with the relevant guidelines and regulations, including the Declaration of Helsinki and the Dutch Law on Scientific Research. In addition, individual informed consent was sought from each study participant before the interview. They received an explanation of the purpose of the study and were reassured about the study confidentiality and anonymous participation. They were told that they were free to withdraw from the study at any time without penalty.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analyzed during this study are included in this article

Competing interests

The authors declare that they have no competing interests.

Funding

This study was funded by Ethiopian public health institute. The funder had no role in the design of this study and will not have any role during its execution, analyses, interpretation of the data, or decision to submit results

Authors contributions

MD developed the study design, collected the data, analyzed and interpreted the data and drafted the manuscript. ES was involved in the study design, data analysis and data interpretation and contributed to the writing of the manuscript. WB was involved in the data collection, contributed to the analysis and interpretation of data. JS contributed to the study design and the interpretation of data and reviewed the manuscript. AA developed the study design, was involved and contributed to the analyses and interpretation of data, and the writing of the manuscript. All authors contributed to and approved the final manuscript.

Acknowledgments

We would like to acknowledge all study participants and PSI drop in center staffs

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Additional information

The In-depth interview guide used for data collection

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Printed by Media-Tryck, Lund 2021
NORDIC SWAN ECOLABEL 3041 0903

FACULTY OF MEDICINE

Division of Social Medicine and Global Health
Department of Clinical Sciences, Malmö

Lund University, Faculty of Medicine
Doctoral Dissertation Series 2021:150
ISBN 978-91-8021-157-4
ISSN 1652-8220