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Factors associated with non-adherence to antiretroviral therapy among female sex workers living with HIV in Hyderabad, India

Ramesh R Allam[1], Mayuko Takamiya[2], Rashmi Pant[1], Sabitha Gandham[1], Vijay V Yeldandi[1], Jaya Thomas[3], Maria L Ekstrand[4] and Mark S Dworkin[2]

Abstract

We determined factors associated with non-adherence (consuming <90% of monthly antiretroviral therapy) among female sex workers (FSWs). An interviewer-administered questionnaire was used in a sample of 100 South Indian FSWs living with HIV. We examined demographics, food insecurity, side effects, stigma, alcohol/substance use and self-efficacy. Non-adherence was assessed by self-report, pill-count and combined measures. Prevalence ratios and 95% confidence intervals (CIs) were calculated at p-value <0.1. Thirty-seven percent (33/90) of FSWs were non-adherent by pill-count, 29% (28/95) by self-report and 52% (51/99) by the combined measure. Seventy-six percent (76/100) of FSWs reported experience of at least one form of food insecurity in the past six months. In the regression analysis, arrest in the past year was independently associated with the combined measure of non-adherence (crude prevalence ratios 1.7, 95% CI 1.0–2.8). A successful combination adherence intervention should consider several of the socio-behavioral factors identified in this study including arrest and food insecurity.

Keywords

Human immunodeficiency virus, antiretroviral therapy, sex workers, sexual behavior

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Introduction

A global scale-up of antiretroviral therapy (ART) has been the primary contributor to a 48% decline in deaths from AIDS-related causes from a peak of an estimated 1.9 million in 2005 to 1.0 million in 2016.[1] India has the third largest number of people living with human immunodeficiency virus (PLHIV) in the world and an human immunodeficiency virus (HIV) prevalence among adults aged 15–49 years of 0.26%. Among the estimated 2.1 million PLHIV in 2015 in India, 1.7 million are diagnosed and 1.2 million are receiving free ART.[2] As a result of ART access, a significant decrease in morbidity and mortality has been reported in India.[3] Since 2004, the ART initiative funded by the Indian government has provided free ART to more than 1.2 million Indians living with HIV.[4] Current first-line ART regimens include combinations of efavirenz, lamivudine, tenofovir disoproxil fumarate and zidovudine.[5] However, the National AIDS Control Program (NACP) still struggles to maintain stable adherence to ART. After CD4 cell count, ART non-adherence is the second strongest

[1]SHARE INDIA, Medchal, India
[2]University of Illinois at Chicago School of Public Health, Chicago, IL, USA
[3]Chaithanya Mahila Mandali, Secunderabad, India
[4]Department of Medicine, University of California San Francisco, San Francisco, CA, USA

Corresponding author:
Mark S Dworkin, Division of Epidemiology and Biostatistics, University of Illinois at Chicago School of Public Health, 1603 W. Taylor Street, MC 923, Chicago, IL 60612, USA.
Email: mdworkin@uic.edu

predictor of progression to AIDS and death, and poor adherence is the most common cause of therapeutic failure.[6] Suboptimal levels of adherence are highly associated with inadequate viral suppression, progression of disease, lower quality of life and risks of comorbidities.[7]

In India, female sex workers (FSWs) have been identified as one of the key affected populations along with transgender persons, injection drug users (IDU) and men who have sex with men.[8] FSWs also have the lowest levels of adherence to ART.[9,10] Other factors that may complicate the lives of FSWs include poverty,[11] illiteracy,[12] human trafficking,[13] violence,[14] arrest,[15] food insecurity,[16–18] stigma[19,20] and mental health struggles such as depression,[21,22] alcohol[23,24] and/or substance abuse.[25–27] Several of these factors, including food insecurity and depression, have been shown in some studies to be associated with ART adherence.[9,18,21] There are a few studies examining factors associated with ART adherence in FSWs.[28–31] An epidemiological study of persons living with HIV on ART in Hyderabad revealed that working in the sex industry was significantly associated with non-adherence. To our knowledge, no published studies have focused on determining factors associated with ART adherence in FSWs living with HIV in South India. To help development of interventions to promote ART adherence in FSWs in India, we performed an exploratory study to determine factors associated with ART non-adherence.

Methods

Study population and participant recruitment

A total of 100 FSWs were recruited from October 2017 to May 2018 at the non-government organization (NGO) Chaithanya Mahila Mandali (CMM) in Hyderabad, India, using convenience sampling. With a network of outreach workers and peer educators, the NGO has extensive experience with vulnerable populations and is supported by the National AIDS Control Organization (NACO) for prevention of HIV. With CMM's list of known FSWs living with HIV, outreach workers contacted eligible FSWs through word of mouth and enrolled participants using a screening questionnaire. Inclusion criteria were (1) being an FSW, (2) having HIV-positive status and (3) receiving ART.

Study design

In this cross-sectional study, interviewer-administered questionnaires were translated from English into the local languages Telugu and Hindi, and pilot tested with outreach workers and peer educators to ensure the quality of translation and appropriateness of the contents. Responses were collected in the language of participant's choice. A trained local investigator from SHARE INDIA administered the questionnaires to all participants. Participants were provided compensation equivalent to $10 USD for their travel and participation.

Measurement

The demographic and sexual behavior variables included age, language comprehension and fluency, educational level, marital status, type of sex worker, religion, number of dependent children, monthly household income, monthly income from sex work, number of sexual partners during a typical week, number of vaginal or oral intercourses during a typical week, arrest in the past year, history of TB infection, experiences of side effects from ART, commuting time for ART pick-up, difficulty in commuting for ART pick-up, years of taking ART and knowledge of ART. A variable on dependence on sex work was created and defined as (i) reported last month income from sex work (dichotomized at median value), (ii) weekly number of sex partners and (iii) weekly number of intercourses.

Food insecurity questions were adopted from the Avahan-III Baseline Evaluation Survey,[14] which are tailored to the context of people living with HIV/AIDS in India. Food insecurity in the past six months was assessed as reporting yes to either one of the two following questions: (1) '*In the past 6 months, did you ever eat less than you felt you should because there wasn't enough money to buy food*?'; (2) '*In the past 6 months, were you ever hungry but didn't eat because you couldn't afford enough food?*' Additionally, they self-reported (SR) the number of days in the past month that food insecurity was a barrier to taking their ART. To assess whether food insecurity or responsibility to feed children leads to transactional sex, FSW were asked '*Did you have any time when you had sex with someone to provide food for yourself?' and* whether they think providing enough for their children is 'easy'.

Self-report (SR) and pill-count (PC)-based medication adherence were measured and analyzed separately and then combined to produce a more sensitive medication adherence measure because each of these measures have limitations and we hoped to reduce social desirability bias. We defined 'adherent' (or optimally adherent) as those with $\geq$90% adherence on both measures and 'non-adherent' as <90% by either measure. India's NACP defines optimal adherence to ART as $\geq$95% of pills consumed. For this study, the cut-off

was lowered to $\geq$90%[32] because emerging available ART regimens have evolved and become more forgiving of non-adherence and results for 90% adherence are likely to be more useful for planning. SR adherence was calculated based on responses to a question on number of doses of their ART they have missed in the past month and their ART regimens (once vs. twice daily). PC adherence was calculated from PC of ART bottles, number of pills in full bottles, ART regimens and number of days between the last ART pick-up date and the interview date. Clinical data were abstracted from their 'Green Book' (a booklet that patients present at medical appointments) including hemoglobin level, baseline and current CD4 cell count and ART regimens. Anemia was defined as hemoglobin (Hb) $\leq$ 10 mg/dl per the WHO definition.[33]

Stigma was assessed using three Likert scale questions adapted from the HIV Stigma Scale[34]: 'I feel the need to hide my HIV-positive status', 'I feel isolated since learning I have HIV' and 'I think people with HIV are often rejected when others find out'. A positive response to any of the three questions was considered experiencing stigma. This cut-off was chosen to create a dichotomous variable that explored 'any' stigma. Separate questions were also asked to assess whether they felt comfortable with healthcare workers, family and other FSWs. Participants were asked two Likert scale questions about response-efficacy on ART adherence; 'I believe I will be fine if I don't take HIV pills as prescribed' and 'I believe HIV will not make me sick if I don't take HIV pills as prescribed'. Adherence motivation and self-efficacy questions were adapted from an adherence study conducted in Africa and modified in Indian context.[35]

Statistical analysis

Regression analysis was performed both for the self-report adherence and PC adherence. The primary exposure variables in the models is food insecurity, and the secondary exposure variables are: financial dependence on sex work, sexual behavior, substance abuse and arrests in the past year. In bivariate analysis, crude prevalence ratios (cPRs) of primary and secondary exposure variables were calculated for ART-adherent vs. non-adherent groups. PRs were reported with 95% confidence interval (CI). Since this was an exploratory study with small sample size, borderline significant results were considered of potential importance. Chi square tests and Fisher's exact tests when frequencies in cells were $<$5 were computed to estimate the statistical significance of prevalence ratios. To estimate the relationship between adherence and food insecurity adjusting for covariates, multivariable logistic regression modeling was used. Model building included covariates that were conceptually important and significantly associated, respectively, with PC and SR adherence. A forward selection approach was used to select a final model. As it was an exploratory study, we included results that had less than or equal to 0.1 in the final model. The data analysis was generated using SAS software Version 9.4 (Cary, NC, USA).

Human subject protection

We explained the objectives, methods, benefits and risk of our study to the participants in a written informed consent. The consent form was read to subjects upon their request. Institutional review board approval for the study was provided by the University of Illinois at Chicago in the US and the Mediciti Institute of Medical Sciences in India.

Results

Descriptive analysis

Among the 100 FSWs (Table 1), more than half were in the age group 30–39 years and had no primary education (54% and 52%, respectively). Forty-four percent of women were married, 37% widowed, 16% separated or divorced, and 3% single. Most FSWs were either street-based or home-based (49% and 41%, respectively). Median monthly household income was 8000 rupees (123USD) and median monthly income from sex work was 2000 rupees (31USD). The median number of both oral and vaginal intercourse and of sexual partners during a typical week was three. Seventy percent of the FSWs had one or more dependent children. Nineteen women who reported having other income sources revealed they gained additional income from housekeeping (11/19), construction labor (4/19), government pension (4/19) and tailoring work (1/19). Among 66 women with available data on hemoglobin level, 82% were anemic. Almost all FSWs (97%) reported experiencing stigma from isolation or rejection for having HIV (Table 2).

PCs were performed on all participants who brought their pill bottles (N = 91); however, one of them did not have information on drugs prescribed to them, which made it impossible to calculate PC adherence. Among the 90 FSWs with complete information on PC adherence, 37% were non-adherent. Among 95 FSWs who SR adherence, 29% were non-adherent. Using the combined measure of adherence, 52% took less than 90% of their pills (51/99). The prevalence of non-adherence was 59% for street-based and 49% for home-based sex workers. Most FSWs (76%) reported that they had experienced at least one form of food insecurity in the past six months. In addition, nearly

Table 1. Demographic characteristics and clinical information of FSWs living with HIV in Hyderabad, India (n = 100), and bivariate analysis with a combined adherence measure (n = 99).

		Combined adherence (n = 99)			
Characteristics	Frequencies, n (%) (n = 100)	Non-adherent (n = 51)	Adherent (n = 48)	PR (95% CI)	χ^2 test p-value
Demographics					
Age (years)					
18–29	16 (16)	6	10	(ref)	0.47
30–39	54 (54)	29	24	1.5 (0.7–2.9)	
40 and older	30 (30)	16	14	1.4 (0.7–2.9)	
Language fluency					
Telugu only	70 (71)	35	35	1.0 (0.6–1.5)	0.85
Hindi only	3 (3)	2	1	1.3 (0.5–3.1)	
Multiple	26 (26)	13	12	(ref)	
Missing	1				
Ability to read					
Yes	39 (39)	19	19	(ref)	0.87
No	60 (61)	31	29	1.0 (0.7–1.5)	
Missing	1				
Education					
None	52 (53)	26	26	1.0 (0.6–1.6)	0.93
Any primary school (1–7 grades)	22 (22)	12	10	1.1 (0.6–1.9)	
High school (8–10 grades) and above	25 (25)	12	12	(ref)	
Missing	1				
Marital status					
Married	44 (44)	19	24	(ref)	0.20
Other – all non-married including the following:	56 (56)	32	24	1.3 (0.9–1.9)	
Single	3				
Separated	15				
Divorced	1				
Widowed	37				
Type of sex worker					
Street-based	49 (49)	29	20	1.2 (0.8–1.8)	0.07
Home-based	41 (41)	20	21	(ref)	
Lodge-based	1 (1)	1	0	2.1 (1.5–2.8)	
Multiple	9 (9)	1	7	0.3 (0.04–1.6)	
Street-based		29	20	1.3 (0.9–2.0)	0.13
Others		22	28	(ref)	
Religion					
Hinduism	88 (88)	43	44	(ref)	0.53
Islam	6 (6)	4	2		
Christianity	6 (6)	4	2		
Number of dependent children					
0	26 (27)	13	13	(ref)	0.83
1	33 (34)	16	17	1.0 (0.6–1.6)	
2 or more	37 (39)	20	16	1.1 (0.7–1.8)	
Missing	4				
Last month's household income					
≤median (8000 rupees)	54 (54)	25	29	(ref)	0.26
>median	46 (46)	26	19	1.2 (0.9–1.8)	
Last month's income from sex work					
≤median (2000 rupees)	49 (49)	18	32	(ref)	0.0012
>median	50 (51)	33	15	1.9 (1.3–2.9)	
Missing	1				

(continued)

Table 1. Continued

Characteristics	Frequencies, n (%) (n = 100)	Combined adherence (n = 99)			
		Non-adherent (n = 51)	Adherent (n = 48)	PR (95% CI)	χ^2 test p-value
Number of sexual partners					
≤median (3) per week	69 (69)	33	36	(ref)	0.27
>median (3) per week	31 (31)	18	12	1.3 (0.9–1.8)	
Number of intercourses					
≤median (3) per week	55 (55)	25	30	(ref)	0.18
>median (3) per week	45 (45)	26	18	1.3 (0.9–1.9)	
Dependence on sex work					
Dependent		38	26	1.6 (1.0–2.5)	0.05
Not dependent		13	21	(ref)	
Arrest in the past year					
Yes	10 (10)	9	1	1.9 (1.4–2.6)	0.017
No	88 (90)	41	46	(ref)	
Missing	2				
Clinical information					
History of TB infection					
Yes	20 (21)	9	10	0.9 (0.5–1.5)	0.72
No	77 (79)	40	37	(ref)	
Missing	3				
Anemia (hemoglobin level ≤10 gm/dL)					
Yes	54 (82)	33	20	1.5 (0.7–3.0)	0.19
No	12 (18)	5	7	(ref)	
Missing	34				
Baseline CD4 cell counts					
≤350 cells/μl	60 (70)	28	32	0.8 (0.5–1.2)	0.26
>350 cells/μl	26 (30)	15	10	(ref)	
Missing data	14				
Current CD4 cell counts (range: 14–1261 cells/μl)					
≤350 cells/μl	21 (24)	7	13	0.7 (0.3–1.2)	0.14
>350 cells/μl	67 (76)	36	31	(ref)	
Missing data	12				
ART-related information					
Has experienced any side effects from ART					
Yes	34 (34)	19	14	1.2 (0.8, 1.7)	0.39
No	66 (66)	32	34	(ref)	
Commuting time for ART pick-up					
≤30 min	30 (30)	16	13	(ref)	0.69
>30 min	69 (70)	35	34	0.9 (0.6–1.4)	
Missing	1				
Difficulty in commuting for ART pick-up					
Yes	25 (25)	15	10	1.2 (0.8–1.8)	0.53
No	74 (74)	36	37	(ref)	
Missing	1				
ART regimens					
Taken once daily	46 (46)	31	22	(ref)	0.1
Taken twice daily	53 (54)	20	25	0.8 (0.5–1.1)	
Missing	1				
Duration of taking ART					
≤2 years	23 (23)	13	10	(ref)	0.68
2< years ≤5	44 (44)	18	15	1.0 (0.6–1.6)	
>5 years	33 (33)	20	23	0.8 (0.5–1.3)	

(continued)

Table 1. Continued

Characteristics	Frequencies, n (%) (n = 100)	Combined adherence (n = 99) Non-adherent (n = 51)	Adherent (n = 48)	PR (95% CI)	χ^2 test p-value
Knows the name of ART drugs					
Knows all the names accurately	3 (3)	1	2	(ref)	0.51
Not all the names accurately	94 (97)	49	44	1.6 (0.3–7.9)	
Missing	3				

[a]FSW were asked if they knew the name of their ART drugs and what was the name if they answered yes. The self-reported name of ART was later checked against the name of ART on their ART bottle.

half of FSWs (49%) reported that their experiences of food insecurity interfered with taking their ART medication in the past month with 15% reporting that this interference had occurred on more than seven days. The majority (70%) also reported that it took more than 30 min to travel to their health center for ART pick-up and 25% reported that they found it difficult to commute for ART pick-up. The duration of taking ART was ≤ 2 years for 23%, >2–5 years for 44% and >5 years for 33%.

Bivariate analysis

Factors associated with PC non-adherence. The factors with at least borderline significant association with PC non-adherence were being a street-based sex worker (cPR 1.4, 95% CI 0.8–2.4), having a greater than median monthly income from sex work (cPR 1.7, 95% CI 1.0–3.0), having intercourse more than the median per week (cPR 1.7, 95% CI 1.0–2.9), having had sex in exchange of food in the last six months (cPR 2.2, 95% CI 1.1–4.4), having a baseline CD4 cell count 350 or less (cPR 0.6, 95% CI 0.4–1.1) and believing HIV will not make them sick if they do not take HIV medication as prescribed (cPR 1.7, 95% CI 1.0–3.0). Reporting that food insecurity was a barrier to taking ART in the past month (>7 days vs. 0 day) was associated with PC non-adherence (cPR 1.9, 95% CI 1.0–3.8). Furthermore, a dose–response relationship was observed between PC adherence and food insecurity interfering with taking ART in the past month; the longer duration of food insecurity they experienced in the past month, the more likely they were to be non-adherent (cPR for 1–7 days 1.2, 95% CI 0.6–1.5, for >7 days 1.9, 95% CI 0.7–2.1).

Factors associated with SR non-adherence. The factors with at least borderline significant association with self-SR non-adherence were having two or more dependent children (cPR 3.1, 95% CI 1.0–9.7), greater than median monthly household income (cPR 2.1, 95% CI 1.1–4.0), greater than median monthly income from sex work (cPR 1.8, 95% CI 0.9–3.5), reporting a past year arrest history (cPR 3.3, 95% CI 2.0–5.4), any substance use in the past year (cPR 1.9, 95% CI 1.0–3.5), reporting to choose to buy alcohol/substance over food if they had to choose (cPR 2.5, 95% CI 1.2–5.1) and having used alcohol or other substances to cope with life as a FSW (cPR 2.2, 95% CI 1.1–4.3).

Factors associated with the combined measure of non-adherence. The combined non-adherence measure was associated with greater than median monthly income from sex work (cPR 1.9, 95% CI 1.3–2.9), arrest in the past year (cPR 1.9, 95% CI 1.4–2.6), being street-based compared to other sex work (cPR 1.3, 95% CI 0.9–2.0) and dependence on sex work (cPR 1.6, 95% CI 1.0–2.5).

Multivariate regression models

We included food insecurity in the final regression model as a barrier to taking ART in the past month, dependence on sex work and arrest in the past year. In the model, only arrest in the past year was independently associated with the combined measure of non-adherence (cPR 1.7, 95% CI 1.0–2.8) (Table 3).

Discussion

This exploratory study among FSWs living with HIV in South India demonstrated that approximately half of the FSWs did not achieve at least 90% adherence. Although street-based FSWs had the highest prevalence of non-adherence, the prevalence for home-based was also substantial. Food insecurity was common and nearly half reported food interfering with ART adherence. Among the significant associations with non-adherence having a history of arrest in the past year was identified with SR and the combined adherence measure, food insecurity was identified with PC adherence and alcohol/substance use was identified with SR adherence.

Table 2. Food insecurity, stigma, alcohol/substance use and self-efficacy information of FSWs living with HIV in Hyderabad, India (n = 100), and bivariate analysis with a combined adherence measure (n = 99).

		Combined adherence (n = 99)			
	Frequencies n (%)	Non-adherent (n = 51)	Adherent (n = 48)	PR (95%CI)	χ^2 test p-value
Food insecurity					
Ever eating less than they should because there was not enough money to buy food in the last six months					
Yes	73 (73)	36	36	0.9 (0.6–1.4)	0.62
No	27 (27)	15	12	(ref)	
Ever being hungry but did not eat because they could not afford enough food in the last six months					
Yes	73 (73)	37	35	1.0 (0.6–1.5)	0.97
No	27 (27)	14	13	(ref)	
Having any time when they had sex with someone to provide food for themselves in the last six months					
Yes	64 (64)	32	31	1.0 (0.6–1.4)	0.84
No	36 (36)	19	17	(ref)	
Food insecurity (yes to at least one of food insecurity questions above)					
Insecure	76 (76)	39	36	1.0 (0.7–1.6)	0.86
Secure	24 (24)	12	12	(ref)	
Reporting that not having food interferes with taking their HIV medication in the past month					
0 day	51 (51)	24	27	(ref)	0.41
1–7 days	34 (34)	18	16	1.0 (0.6–1.5)	
≥7 days	15 (15)	7	3	1.2 (0.7–2.1)	
It is easy for me to provide enough food for my children[a]					
Yes	28 (38)	13	15	(ref)	0.47
No	40 (55)	22	18	1.2 (0.7–1.9)	
Missing	5 (7)				
Taking care of children interferes with my ability to take medication without missing any doses[a]					
Yes	39 (53)	22	17	1.3 (0.8–2.1)	0.34
No	29 (38)	13	16	(ref)	
Missing	5 (7)				
HIV stigma perceptions					
Feels comfortable with healthcare workers at ART pick-up locations					
Yes	87 (87)	45	41	(ref)	0.70
No	13 (13)	6	7	0.9 (0.5–1.6)	
Feels comfortable with disclosing HIV experiences with family					
Yes	75 (76)	41	33	(ref)	0.21
No	24 (24)	10	14	0.7 (0.4–1.2)	
Missing	1				
Feels comfortable with disclosing HIV experiences with other female sex workers					
Yes	73 (74)	40	32	(ref)	0.20
No	26 (26)	11	15	0.8 (0.5–1.3)	
Missing	1				
Feels the need to hide my HIV-positive status (stigma one)					
Yes	88 (88)	44	43	0.9 (0.5–1.5)	0.61
No	12 (12)	7	5	(ref)	
Feels isolated since learning I have HIV (stigma two)					
Yes	71 (72)	34	36	0.8 (0.6–1.2)	0.33
No	28 (28)	17	11	(ref)	
Missing	1				
Feels people with HIV are often rejected when others find out (stigma three)					
Yes	91 (92)	45	45	0.7 (0.4–1.0)	0.18
No	8 (8)	6	2	(ref)	
Missing	1				
Experiencing any HIV stigma from the three stigma questions above (self-stigma)					
Yes	97 (97)	50	46	1.6 (0.3–7.8)	0.52
No	3 (3)	1	2	(ref)	

(continued)

Table 2. Continued

		Combined adherence (n = 99)			
	Frequencies n (%)	Non-adherent (n = 51)	Adherent (n = 48)	PR (95%CI)	χ^2 test p-value
Alcohol/substance use					
Any substance use in the last six months					
Yes	19 (19)	12	7	1.3 (0.8–1.9)	0.28
No	80 (81)	39	40	(ref)	
Missing	1				
Alcohol drinking					
No	55 (69)	25	29	(ref)	0.68
Yes	25 (31)	15	11	1.2 (0.8–1.9)	
(if yes)					
Less often than daily	19 (24)	11	8	1.2 (0.7–1.9)	
Daily	6 (7)	3	3	1.2 (0.6–2.6)	
Missing	20				
Alcohol and substances help relieve my mental stress					
Yes	25 (30)	13	12	1.1 (0.7–1.7)	0.75
No	57 (70)	27	29	(ref)	
Missing	18				
I have tried to cope with my life as a FSW by using either alcohol or substances					
Yes	25 (30)	14	11	1.2 (0.8–1.9)	0.43
No	57 (70)	26	30	(ref)	
Missing	18				
I have tried to cope with my life with HIV-positive status by using either alcohol or substances					
Yes	24 (29)	14	10	1.3 (0.8–2.0)	0.30
No	58 (71)	26	31	(ref)	
Missing	18				
I would choose to buy alcohol/substances over food if I had to choose					
Yes	19 (23)	13	6	1.6 (1.0–2.4)	0.06
No	63 (77)	27	35	(ref)	
Missing	18				
Self-efficacy					
I believe I will be fine if I do not take HIV pills as prescribed					
Agree	20 (20)	10	7	1.0 (0.6–1.6)	0.87
Disagree	80 (80)	41	38	(ref)	
I believe HIV will not make me sick if I do not take HIV pills as prescribed					
Agree	17 (17)	10	7	1.2 (0.7–1.8)	0.51
Disagree	83 (83)	41	41	(ref)	
How often you feel depressed in the past week					
Rarely or none of the time	83 (83)	43	39	1.1 (0.6–1.9)	0.67
More than rarely	17 (17)	8	9	(ref)	

[a]Analysis was restricted to women who reported having at least one dependent child (n = 73).

Table 3 Binomial regression model for the combined measure of non-adherence among FSWs living with HIV in Hyderabad, India (n = 85).

Variable	PR (95%CI)	χ^2 test p-value
Not having food interferes with taking their HIV medication, for ≥7 days vs. <7 days	1.21 (0.78–1.87)	0.40
Dependence on sex work, ≤median vs. >median	1.33 (0.82–2.16)	0.24
Arrest in the past year, yes vs. no	1.69 (1.01–2.82)	0.04

In India, the law does not punish sex workers who are >18 years old and do not solicit business publicly, although maintaining a brothel for soliciting customers in a public place, owning or managing a brothel, prostitution in a hotel, child prostitution, pimping and pandering are punishable. These, along with laws relating to public nuisance, contribute to FSW arrests.[36,37] Policing practices such as fines, bribes, confiscation of condoms or syringes or drugs aggravate HIV risk, particularly for these FSWs.[38] Understandably, these practices also create greater challenges for treatment adherence due to mobility to avoid harassment.[15] We suspect that these practices disproportionately affect street-based sex workers and this might explain their higher prevalence of non-adherence. By the nature of their work location, street-based workers are more likely to encounter police. Additionally, street-based workers live lives more vulnerable to disruption and distraction as studies have shown that they are at higher risk for HIV and sexually transmitted infections, violence, depression, and child-related financial strain.[12,39–41]

Outside of our study, there is evidence that the relationship between FSWs and law enforcement is strained. Our finding of an association of non-adherence with arrest is plausible since FSWs with HIV are likely separated from their medication when arrested. We suspect these incarcerated women are unlikely to request access to their ART given the stigma of having HIV and fear that disclosure could affect their ability to attract clients. Arrest or fear of arrest by police in this population is a barrier across the HIV care cascade from HIV diagnosis to adherence and retention in care.[42] Incarceration creates barriers to sex workers' access to services because they experience prejudice, stigma and discrimination that deprive them of ART.[43] Formative discussions with FSWs in Hyderabad in preparation for this study revealed that many of these women are concerned about arrest and fear that police will find them with ART (unpublished). If arrested, the duration of separation from their ART may be for weeks or months.[44] The relationship between these women and the police is strained. A study of 835 FSWs in Andhra Pradesh revealed that 11% had sex with police, 12% gave police gifts to avoid trouble and 7% reported that police had confiscated their condoms.[45] Given that police interaction is associated with ART adherence, intervention on non-adherence in FSW should consider addressing this problem. Erausquin et al. performed a large study in Andhra Pradesh that demonstrated potential impact on HIV and risk behaviors among FSWs by performing meetings intended to sensitize local police officials to challenges faced by FSWs.[46] The experience and success observed in that work could inform future interventions on FSWs and ART adherence.

The high prevalence of food insecurity and its association in bivariate analysis support consideration of providing food supplements as part of adherence interventions. Additionally, we found a high prevalence of anemia in these women which may be due to nutritional deficiency. Discussions with the NGO that serves these women anecdotally revealed FSWs may prioritize food for children over feeding themselves. In our study, three quarters of FSWs experienced food insecurity in the past six months, and half of the participants reported that food insecurity had interfered with adherence to ART in the past month. Whereas occasional food insecurity may not be associated with non-adherence, our study suggests that duration of food insecurity is an important factor.

Findings from our study extend previous research showing that food insecurity adversely effects adherence.[18] Food insecurity has been associated with sex work,[47,48] lower CD4 cell counts and suboptimal ART adherence.[49] A study from Swaziland[50] as well as formative discussions (unpublished) with FSWs in Hyderabad before conducting this study revealed that many FSWs are concerned about taking ART on an empty stomach. This concern could lead to non-adherence to avoid feeling ill when they need to work.

Other factors that should be considered when designing an intervention in addition to police arrest and food insecurity are counseling to address alcohol and substance use. The prevalence of alcohol use in our study was about 30%, which is similar to other global studies of FSWs.[24,25] Several studies have reported that FSWs use substances to cope with their extreme life situation of being sex workers and HIV-positive.[51–53] Although not statistically significant in our study, affirmative responses to alcohol or substance use questions had elevated prevalence ratios. In our sample, a substantial minority experience heightened mental stress since they admitted that, if they had to choose, they would buy alcohol or substances instead of food. This finding was associated with SR non-adherence.

In our study the prevalence of stigma was 97%. In the context of adherence to ART, stigma and social stress lead to multiple adverse consequences, including depression, reduced quality of life, delay of treatment-seeking, missed pills and medical appointments and delay of prescription refills.[54,55] One way to help FSWs is to provide them with vocational training to transition out of their stigmatized work. Some of these FSWs living may benefit from adherence counseling focused on improving their understanding of the adverse health consequences that result from not taking their ART as prescribed.

Despite the limitation of a small sample size, the study provides useful information to guide intervention development for this generally hard to reach population. Although some findings were not identical for SR vs. PC adherence, a potential strength of this study was the inclusion of a combined adherence measure. Not having PC data on all the FSWs was a limitation and non-adherence from PC may be an underestimate because some women had PC adherence greater than 100%. Additionally, SR non-adherence may be an underestimate because participants may not have wanted to disclose non-adherence in self-report (social desirability bias). Despite these limitations, understanding HIV care and treatment engagement experiences of FSWs have important implications for ART intervention development.

This study demonstrated a high prevalence of non-adherence among FSWs living with HIV – a finding relevant to the control of the HIV epidemic. Additionally, this study identified socio-behavioral factors associated with adherence that may guide adherence intervention development. A successful intervention needs to address the impact of police interaction and arrest, improve knowledge of HIV including the rationale for taking ART as prescribed, provide stigma coping strategies and address alcohol/substance use. Additionally, this intervention should acknowledge some aspects of food insecurity, a highly prevalent problem for many of the FSWs. Based on these findings, a combination behavioral intervention that includes sensitization of police concerning the impact of arrest on viral suppression, relief from food insecurity and educational meetings for FSWs that address knowledge and coping may be beneficial. Further research is needed to explore the independent association of arrest and related police interaction including documenting the relationship between the duration of incarceration and separation from medications and its impact on viral suppression.

Authors' contributions

MSD, MT and RRA conceived and designed the study protocol; MT, JT and SG piloted the data collection instrument and performed data quality checks. MT, RP, RRA and MSD analyzed and interpreted the data. MSD, RRA, MT and RP drafted the article; VVY, MLE and MSD critically revised the article for intellectual content. All authors read and approved the final article. MSD is the guarantor of the paper.

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ORCID iD

Rashmi Pant https://orcid.org/0000-0003-3424-1155

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