Cohort Analysis of Program Data to Estimate HIV Incidence and Uptake of HIV-Related Services Among Female Sex Workers in Zimbabwe, 2009–2014

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Background: HIV epidemiology and intervention uptake among female sex workers (FSW) in sub-Saharan Africa remain poorly understood. Data from outreach programs are a neglected resource.

Methods: Analysis of data from FSW consultations with Zimbabwe's National Sex Work program, 2009–2014. At each visit, data were collected on sociodemographic characteristics, HIV testing history, HIV tests conducted by the program and antiretroviral (ARV) history. Characteristics at first visit and longitudinal data on program engagement, repeat HIV testing, and HIV seroconversion were analyzed using a cohort approach.

Results: Data were available for 13,360 women, 31,389 visits, 14,579 reported HIV tests, 2750 tests undertaken by the program, and 2387 reported ARV treatment initiations. At first visit, 72% of FSW had tested for HIV; 50% of these reported being HIV positive. Among HIV-positive women, 41% reported being on ARV. 56% of FSW attended the program only once. FSW who had not previously had an HIV-positive test had been tested within the last 6 months 27% of the time during follow-up. After testing HIV positive, women started on ARV at a rate of 23/100 person years of follow-up. Among those with 2 or more HIV tests, the HIV seroconversion rate was 9.8/100 person years of follow-up (95% confidence interval: 7.1 to 15.9).

Conclusions: Individual-level outreach program data can be used to estimate HIV incidence and intervention uptake among FSW in Zimbabwe. Current data suggest very high HIV prevalence and incidence among this group and help identify areas for program improvement. Further methodological validation is required.

Key Words: HIV/AIDS, Zimbabwe, sex worker, program data, HIV incidence, cascade

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KEY MESSAGES

- Although there are a range of approaches to surveillance HIV among high-risk, marginalized groups such as female sex workers (FSW) in sub-Saharan Africa, these all have limitations and there remains a highly damaging paucity of data from these populations to guide public health action
- Data collected through outreach programs that provide services to female sex workers are a potentially valuable but neglected resource.
- We developed a cohort analysis approach to estimating HIV incidence and intervention uptake among female sex workers using data from over 31,000 outreach program contacts with 13,000 women in 26 sites covering all provinces in Zimbabwe, 2009–2014.

- The data suggest very high incidence (10%–12% per year) among female sex workers in Zimbabwe and suggest program retention, repeat HIV testing, and linkage to treatment can all be improved. The analysis approach could be used to track whether improvements are being realized over time.
- The approach has many potential biases, but these are worthy of better characterization through further study characterization because all feasible approaches to surveillance among this group are flawed and data triangulation is needed.

INTRODUCTION

Tracking HIV epidemiology and intervention uptake among populations at high risk of infection is essential. One such group are female sex workers (FSW) in sub-Saharan Africa.[1] Sex work-related behaviors are illegal and/or stigmatized in many countries, including Zimbabwe.[2,3] Sex workers in Zimbabwe most commonly solicit clients in bars, start sex work at 22–23 years of age, and report 2 clients per week. Many experience violence in their work, whereas 65%–73% report consistent condom use with transactional partners.[4]

General population surveys that ask about these behaviors suffer from social desirability bias and anyway tend to recruit few individuals in these risk categories. The major issue for surveys of this hidden population is that no sampling frame for the target population is available. Location-based[5] or respondent-driven sampling (RDS) surveys[6,7] that target FSW improve significantly upon convenience samples and are theoretically based and feasible, but remain complex to analyze and interpret. Structural factors, including high mobility, further complicate matters.[8,9] A significant information gap therefore remains, which prevents better programming for FSW in Africa. A recent systematic review of HIV epidemiology among FSW identified 30 HIV prevalence studies (16 countries; average sample size, 714 women) but no HIV incidence studies from sub-Saharan Africa since 2007.[1] Another review identified only 7 African studies in 5 countries on ARV uptake, attrition, adherence, and outcomes among FSW.[10]

Data from outreach programs are a potential resource. We compiled individual-level programmatic data collected from consultations with the Zimbabwean national HIV prevention program for FSW from 2009 to 2014. Using cohort methods, we estimated intervention uptake and, among FSW with serial HIV tests, the rate of HIV seroconversion. The aim of this paper is not to evaluate the program; rather, we describe our analysis of the data, interpret the indicators we develop, and consider strengths and limitations of our approach.

METHODS

Setting

In 2009, we established the "Sisters with a Voice" HIV prevention and sexual and reproductive health services for FSW in Harare, Zimbabwe, within the National Behaviour Change Programme.[11] Since then, the "Sisters" program has expanded across the country and provides free access to HIV testing, STI treatment, family planning, HIV prevention education, condoms, and legal services.[12] There are 6 fixed sites in larger towns or cities open on weekdays, with mobile teams providing once weekly clinical services to surrounding hotspots or smaller towns (outreach services). The program is supported by trained peer educators and community mobilization and empowerment activities. Peer educators and outreach staff run participatory group meetings with sex workers at all sites (including outreach sites) at least once a month. Materials to support group activities are aimed at creating demand for services and building social cohesion and empowerment. In the case of outreach sites, peer educators are responsible for maintaining program activities in between weekly program visits. Women attending the program who are HIV negative are encouraged to retest every 6 months, but there is no active follow-up of women who default. From 2009 to 2013, access to antiretroviral (ARV) medication increased rapidly across Zimbabwe.[13] Over this period, the program itself did not initiate women onto antiretroviral treatment (ART) but referred women to public services. HIV-positive individuals were eligible to initiate ART when their CD4 count fell below 350 cells per mL.[14]

Data Collection

At first visit to the program at any site, women were assigned a unique identifier. At each visit to the program, they were asked if they had been to the program before and if so the file was retrieved and unique ID used to link consultations. This linkage was possible both within and across sites; however, as discussed further below, it is possible that if women chose to deliberately withhold the fact that they had been previously enrolled some records may not have been linked, so some women may appear as duplicates in the data. Data were collected on structured forms by nursing staff undertaking clinical consultation and subsequently single-entered into a database in Microsoft Access. Data on HIV tests conducted by the program were entered into a separate data file. Sociodemographic information included date of birth, marital status and parity, and beginning in mid-2011, educational attainment. At all visits, information was collected on whether FSW had ever tested for HIV and the date and result of the most recent test, wherever this had been undertaken. Among women identified as HIV infected, data were collected at each visit on whether and when ARVs had been initiated and if these were currently being taken. We analyzed information from visits to all 26 sites collected between September 11, 2009, the date of the first visit to the Harare clinic, and March 14, 2014, the last visit considered for this analysis.

Data Management

Date fields were re-coded in "date" format. Dates that were not in a valid format were checked against source data. We specified logical queries for valid dates and the result of HIV tests, for example, querying when a negative test was reported after a positive test. Some events, such as HIV tests, could be reported at more than 1 consultation or might have appeared both as a self-reported test and in the program testing database. For example, if a FSW made several visits to the program, the same last HIV test may have been reported more than once, sometimes at different levels of precision. We harvested the most precise information provided across all visits and removed duplicates: for example, September 2010 would be updated by 15 September 2010. Data related to events that occurred before first visits to the program were also collected. For example, the date of the first HIV test may have been some years in the past. In these cases, where a precise date was not provided, we imputed the date as the first of the month where month and year were present and first January if only the year had been provided. We merged the visit and testing database and identified and removed duplicate HIV tests (by patient ID and date) reported in both.

Finally, we excluded women from analysis where we remained concerned about data accuracy. Our approach was conservative. For all events occurring on or subsequent to the first visit to the program, we required that full date information (dd/mm/yyyy) was present and excluded women with missing data in relation to these dates. Women were excluded if they reported taking ARVs but did not report a previous HIV-positive test; if they had an HIV-negative test after an HIV-positive test; or if they had either an HIV test date or ARV start date that did not have a reported month. Figure 1 shows the flow chart of exclusions. Overall, the original database contained records on 14,143 FSW. We excluded 808 FSW (6%) from our analysis database because of concerns about the accuracy of data. Details of missing data for other variables are provided with the tables. In particular, data collection on educational attainment only started some time after the program had been initiated.

Data Analysis

Women were assigned to 1 of 5 categories that described them on the date of their first visit to the program:

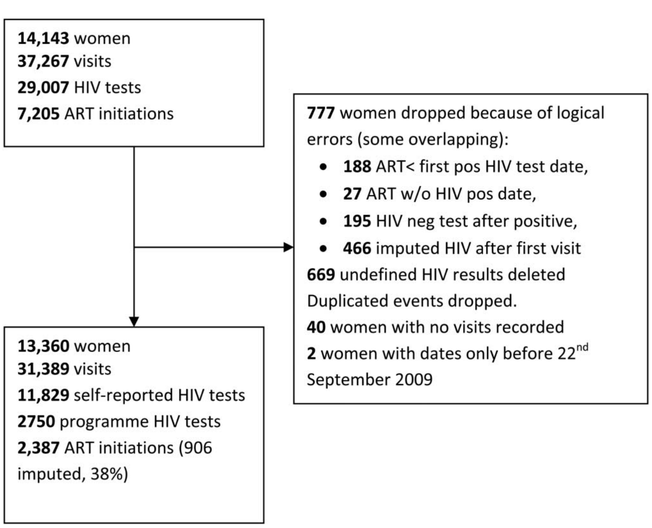

FIGURE 1. Flow chart of exclusions.

(1) never having HIV tested, (2) having previously tested HIV negative over 6 months ago, (3) having previously tested HIV negative up to 6 months ago, (4) having previously tested HIV positive but not having commenced ARV, and (5) having previously tested HIV positive and ever initiated ARV treatment.

We then analyzed data on dates of visits to the program, HIV tests, the date on which ARVs were initiated, and dates over which FSW were aware of their HIV status. Using these dates, we created a data set reflecting an open cohort of women visiting the program. Within the data, a personal timeline was constructed for each FSW. The "revisit rate" was the proportion of individuals coming for more than 1 visit to the program. We calculated the median time between first and second visits for those who attended at least twice. The level of "HIV-negative status awareness" was calculated as the proportion of time between first and last visits to the program during which individuals who had not previously had a positive HIV test "knew" their HIV status to be negative. Women were considered to "know" their HIV-negative status if they had tested HIV negative within the previous 6 months. The denominator time was censored if women became HIV positive. The "ARV initiation rate" was calculated as the rate at which women initiated ARVs among those who reported knowing that they were HIV positive but not on ARV therapy. The person time at risk was calculated as the time between the first visit where the woman reports being HIV positive (or a positive test conducted by the program) and the last HIV-negative visit, with censoring at the date where women reported initiating ARV.

We calculated HIV prevalence as the number of positive first tests divided by the number of first HIV tests reported. To estimate HIV incidence, we restricted our analysis to individuals who had or reported having at least 2 HIV tests after first attending the program. We identified individuals who had a positive test result and a prior negative test since their first visit to the program and imputed the date of infection as the midpoint between the negative and positive test result. These individuals contributed time at risk from their first visit until this imputed date of seroconversion. Women who did not seroconvert contributed time at risk between the first visit and last negative test. We also calculated the HIV incidence rate using only HIV tests conducted by the program. Figure 2 shows graphically how the timeline for women was constructed.

We compared "baseline" status and longitudinal indicators across several categories: time periods (before and after July 31, 2011, which was the approximate mid-date of the period examined here), age, marital status, and educational attainment. To describe differences between groups, we used logistic regression for binary outcome variables and Poisson regression for rates, reporting 95% confidence intervals with robust standard errors to account for inclusion of data from multiple sites.

Ethics approval for the analysis of program data was obtained from the Medical Research Council of Zimbabwe (MRCZ/A/1762) and ethics committees of University College London (4948/001) and London School of Hygiene and Tropical Medicine (6524). Because the data were collected

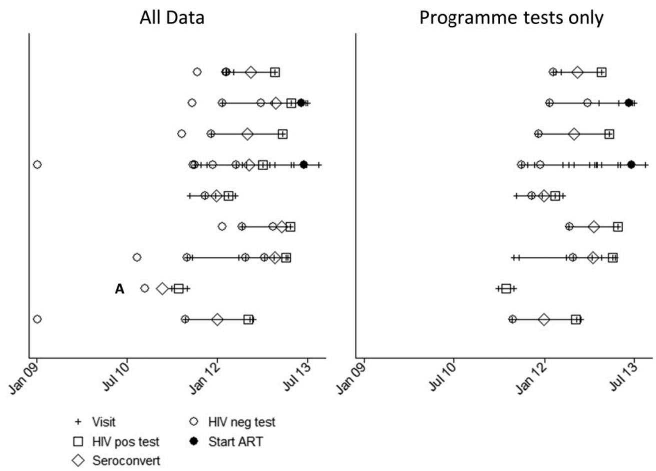

FIGURE 2. Examples of timelines of female sex-worker event histories. This graph shows the timelines of 9 women who first attended the clinics after January 2011. These timelines show HIV tests (negative and positive), visits, dates of starting ART, and approximate seroconversion dates calculated as the midpoint between a positive test and the last negative test. The lines connect the first and the last visits. The timelines on the left use all HIV test data; whereas on the right, only program tests are used. As a result, the estimated time of seroconversion—or the estimation of seroconversion at all—is often different in the 2 data-handling approaches. In the timeline labeled "A," the seroconversion date is calculated using a negative test before the first visit, which would not be permitted in our primary incidence estimation procedure, and also estimates the seroconversion date to be before the start of follow-up, thus being excluded from all analysis.

from women as part of routine clinical care, individual informed consent was not obtained. Data were extracted in anonymized form from the clinical database for analysis.

RESULTS

We recorded 31,389 consultations with 13,360 women (median age at first visit 29 years). Most FSW attending the program had secondary education (6889/9316, 74.0%) and a high proportion were divorced or separated (8101/13,257, 61.1%) (Table 1). Some 28.0% (3735/13,360) had never previously tested for HIV when they first attended the program; though after July 2011, this proportion was smaller (1898/8794, 21.6%). Among those who had tested for HIV before their first visit, 50.4% (4847/9625) reported having tested positive. Among those who had tested HIV positive, 41.0% (1986/4847) reported previously initiating ARV treatment. Younger FSW (12–25 years) were the most likely to have tested HIV negative within the previous 6 months. Older FSW were more likely to be HIV positive and on treatment. Divorced or widowed FSW were those most likely to be HIV positive and on treatment.

The highest number of visits made by any individual client was 37, and the highest number of consultations occurred at the main clinic in Harare, which was the first clinic to open (12,033 consultations, 38.3% of the total). A total of 7445 visits were by FSW who only attended the program once (55.7% of individuals), the remainder were follow-up visits by 5915 individuals who attended more than once, with a mean of 4 and median of 3 visits, with 2448 (18.3%) coming twice. The median time between first and second visit was 53 days (lower-quartile 19, upper-quartile 126) among the 5915 women who attended twice or more. Individuals whose first visit was before July 2011 were more likely to come back (Table 2). Individuals who reported being HIV positive at baseline were more likely to re-attend (Table 2). Among those individuals who had an HIV-positive test conducted by the program (N = 1263) and would have therefore been referred to government services, 54.1% were not seen again, whereas 16.0% (93/580) of those who were seen again later reported having started ARVs.

HIV-negative FSW engaged with the program had had a negative test within the last 6 months 26.5% of the total follow-up time (95% CI: 23.4 to 29.5) (Table 3). Those who had never previously tested at their first visit to the program were the least likely, during their engagement with the program, to know their status (19.9% of the total follow-up time, 95% CI: 17.1 to 22.8). After July 2011, a greater proportion of women were aware of their status: among those who first came to the program after July 1, 2011, FSW knew their status 30.4% of time. The program conducted 2750 HIV tests, 1263 (45.9%) of which were positive. 760/14,579 (5.2%) of the HIV tests took place within 3 months of a previous negative test. Of these, 733 were HIV negative and 27 were HIV positive.

In total, 355 individuals with an HIV-positive test reported starting ARV therapy during 1539 person years of follow-up (rate 23.0 initiations/100 person years of follow-up) calculated from the first time that the program was aware of their HIV-positive status until either their last visit or date of initiating ARV therapy. The ARV initiation rate increased with participant age and was highest among individuals who arrived having had an HIV-negative test within the previous 6 months.

Some 67 women seroconverted after their first visit, among the 605 women who had at least 2 tests at or after their first visit including at least 1 negative test, and over 686 person years of follow-up. Among these women, the rate of new infection was 9.8 per 100 person years of follow-up (95% CI: 7.1 to 15.9). Incidence was lower among women aged over 35 (6.0 cases per 100 person years) and in women who had tested for HIV within 6 months before the first visit (7.3 cases per 100 person years). The incidence rate calculated using only HIV tests administered by the program was 12.5 (95% CI: 6.9 to 21.2) per 100 person years of follow-up (24 cases in 193 person years follow-up).

DISCUSSION

We used individual-level, anonymized data drawn from an outreach program database to calculate indicators of HIV-intervention uptake among women accessing an outreach HIV prevention program for FSW in 26 sites across Zimbabwe and estimated the rate of HIV seroconversion among women reporting 2 or more HIV tests. Given the complexity of HIV surveillance among FSW, and the paucity of epidemiological data on this group in Africa, we suggest that program data could be better harnessed to characterize

TABLE 1. Sociodemographic Characteristics at First Visit of Women Accessing Dedicated FSW STI and HIV Prevention Services in 26 Sites in Zimbabwe, 2009–2012

	Total		Never Tested at First Visit		Previous HIV-Negative Test >6 mo Ago		HIV-Negative Test <6 mo Ago		Previous Positive Test, Not on Treatment		Previous Positive Test, and on Treatment	
	n	Col (%)	n	Row (%s)	n	Row (%s)	n	Row (%s)	N	Row (%s)	n	Row (%s)
Total	13,360	100	3735	28.0	2348	17.6	2430	18.2	2861	21.4	1986	14.9
Period of first visit												
Before July 1, 2011	4566	34.2	1837	40.2	683	15.0	497	10.9	1015	22.2	534	11.7
After July 1, 2011	8794	65.8	1898	21.6	1665	18.9	1933	22.0	1846	21.0	1452	16.5
Age				Col (%)		Col (%)		Col (%)		Col (%)		Col (%)
12–25*	3815	29.1	1158	31.5	856	37.1	1075	45.3	577	20.6	149	7.7
26–35	5941	45.3	1661	45.1	1026	44.5	945	39.8	1473	52.6	836	43.0
36+	3350	25.6	863	23.4	424	18.4	355	15.0	748	26.8	960	49.4
Education												
None/Primary	2427	26.1	571	27.4	378	21.5	409	20.5	574	29.1	495	33.0
Secondary	6889	74.0	1517	72.7	1377	78.5	1589	79.5	1402	71.0	1004	67.0
Marital Status												
Cohabiting/Married	351	2.7	82	2.2	86	3.7	76	3.2	61	2.2	46	2.3
Divorced/Separated	8101	61.1	2290	61.8	1477	63.4	1603	66.4	1730	61.0	1001	50.8
Never married	2172	16.4	681	18.4	472	20.3	475	19.7	344	12.1	200	10.2
Widowed	2633	19.9	655	17.7	296	12.7	260	10.8	699	24.7	723	36.7

Four thousand forty-four women have missing education data, 224 have missing age data, and 103 have missing marital status. Missingness in education is largely due to education not having been collected before 2011 (missing in period 1 = 3773, missing in period 2 = 271). The proportion HIV positive at first visit, by age group, was 19.0% (726/3815) for 12–25 years; 38.9% (2309/5941) for 26–35 years; and 51.0% (1708/3350) for 36+ years. The proportion who had started ART at first visit, by age group, was 3.9% (149/3815) for 12–25 years; 14.1% (836/5941) for 26–35 years; and 28.7% (960/3350) for 36+ years. Note that over the period of the analysis, HIV+ women with a CD4 count of <350 cells/were eligible for ART.

*Although the youngest FSW age recorded in our database is 12 years, in total there were 115 FSW who reported an age under 18 years, and a further 450 aged 18–19 years.

the epidemiology of HIV among FSW and to inform public health action.

Establishing population-based measures of HIV-related phenomena among FSW is difficult because it is not possible to enumerate and conduct random-sampling-based surveillance.[5] Our approach uses outreach program data and has several limitations which we discuss below. However, our analysis also had strengths. We collected longitudinal data from a large sample of women self-identifying as FSW. As we discuss below, these women may not be representative of all FSW. However, our program attendees are likely to be more representative of the underlying population than the research cohorts of FSW among whom many studies are conducted.[10] Taken at face value, the data provide strategic information that could guide HIV resource allocation and programming in Zimbabwe. The data suggest very high HIV incidence among FSW. Most FSW had previously tested for HIV when they accessed the program. However, rates of repeat testing were not optimal. Just over half of FSW seen by the program did not return for a second visit, suggesting retention could be improved. Finally, around 41% of FSW who had previously tested positive at first visit had also started ARVs, whereas HIV-positive FSW started treatment at a rate of 23/100 person years of engagement with the program each year. Although not all FSW will be eligible at the treatment guidelines in place during this time, this reflects another area for potential strengthening: Zimbabwe's 2013 revision of National ART guidelines recommends ART for all HIV-positive SWs regardless of CD4 count.[15]

However, caution is warranted: the methods we describe may suffer from potential biases requiring further characterization. The most obvious limitation of data collected through outreach programs is that they only offer information on FSW accessing the program. There are several reasons why these women may not be representative of the wider FSW population. Those who do not access services may be more at risk of HIV infection than those who do, for example, their nonaccess of the program may be reflective of riskier, more unstable lifestyles. Conversely, those accessing services may have higher risk than the underlying population of FSW: for example, individuals may be likely to attend services if they suspect recent exposure to HIV infection or have become sick. Further, although those who attended these outreach services may be more likely to access health care and stay engaged with services, they may not be. We have limited data on the rate with which FSW accessed other clinics or private services. Some FSW who did not access the outreach program were likely accessing the same services through other channels. Indeed, over 70% of the FSW attending the program had previously had an HIV test before their first engagement with our program and among those presenting with a prior HIV-positive test 41% had already initiated ARV. Further, the characteristics of FSW who access the program may also change over time. The balance of these factors influencing who does and does not appear among the recruited sample is hard to gauge. These limitations notwithstanding uncertainties about representativeness also affect all other approaches to surveying FSW, such as RDS surveys.

TABLE 2. Proportion of Women Re-Attending Within 12 Months of First Visit (Women Who First Visit After 15/03/2013 Excluded)

	Total n (Col %)	n	Row (%)	Unadjusted Odds Ratio (95% CI)	*P* (LRT)	Adjusted Odds Ratio (95% CI)	*P* (LRT)
Total	9540	4622	48.5				
Period of first visit							
Before July 1, 2011	4566 (47.9)	2432	53.3	Baseline		Baseline	
After July 1, 2011	4974 (52.1)	2190	44.0	0.69 (0.57–0.84)	<0.001	0.81 (0.69–0.95)	0.010
Age							
12–25	2688 (28.4)	1174	43.7	Baseline			
26–35	4318 (45.6)	2161	50.1	1.29 (1.20–1.39)			
36+	2472 (26.1)	1273	51.5	1.37 (1.21–1.55)	<0.001		
Education							
None/Primary	1442 (25.7)	637	44.2	Baseline		Baseline	
Secondary	4166 (74.3)	1861	44.7	1.02 (0.88–1.18)	0.79	1.05 (0.93–1.20)	0.41
Marital Status							
Cohabiting/Married	161 (1.7)	77	47.8	0.97 (0.77–1.22)		0.90 (0.72–1.12)	
Divorced/Separated	5808 (61.1)	2767	47.6	0.96 (0.89–1.03)		0.88 (0.80–0.97)	
Never married	1519 (16.0)	739	48.7	Baseline		Baseline	
Widowed	2017 (21.2)	1020	50.6	1.08 (0.93–1.25)	0.13	0.91 (0.77–1.08)	0.013
Baseline status							
Never tested	3147 (33.0)	1277	40.6	Baseline		Baseline	
Previous HIV− >6 mo ago	1584 (16.6)	727	45.9	1.24 (1.05–1.47)		1.40 (1.23–1.59)	
HIV− within 6 mo	1497 (15.7)	767	51.2	1.54 (1.39–1.70)		1.87 (1.70–2.06)	
HIV+ and not on treatment	2076 (21.8)	1130	54.4	1.75 (1.58–1.93)		1.64 (1.37–1.98)	
HIV+ and on treatment	1236 (13.0)	721	58.3	2.05 (1.86–2.25)	<0.001	2.06 (1.76–2.41)	<0.001

Odds ratios estimated using logistic regression with robust standard errors. Association with education and marital status adjusted for age; association with baseline status adjusted for age, education, and marital status. The association between period and return visits within 6 months was adjusted for by all the other variables.

Another potential limitation is that although we issued each woman with a unique identifier code that could be used to identify her at future visits to the program at any site, this system involved no biometrics or validation and it is likely that some individual women appear as duplicates in the data set. FSW working in Zimbabwe are highly mobile and may access the program at multiple sites. A further limitation with respect to our calculation of HIV incidence is that we incorporate information on the self-reported results of HIV tests. We used a longitudinal approach, incorporating data from self-reported data on HIV tests in the context of a clinical interview, as opposed to household interviews which may be more prone to reporting bias. Many tests were confirmed through the program. Although much less precise, our incidence estimate using only tests actually conducted by the program was very similar to our estimate using all reported tests after the first visit.

There are limited data on HIV and service access among FSW in sub-Saharan Africa with which to compare our data. With respect to epidemiological parameters, our estimate that 50% of FSW who had previously tested at first visit were HIV positive is in line with our own estimates of HIV prevalence from RDS surveys in 3 sites in 2011 (50%–70%)[4] and in 14 sites in 2013 (mean 56%).[16] Global estimates of FSW HIV prevalence suggest that this is much higher than in the general population[1]; in Zimbabwe, general population HIV prevalence for women aged 15–49 is 15%.[17] There are little comparable data for FSW HIV incidence from any setting in sub-Saharan Africa,[18–21] whereas general population HIV incidence in Zimbabwe is estimated at about 1% per annum.[22] We estimate a figure of 10–12 times higher than this among FSW accessing a dedicated HIV prevention program and reporting multiple HIV tests. Approximately 70% of our sample had ever tested for HIV at their first visit to the program, 60% before July 2011 and 78% after. Among the general population in the 2010/11 Zimbabwe Demographic Health Survey, 57% of all women aged 15–49 had ever tested, up from 22% in 2005/6 and with higher rates among those aged 20–49 (<2% of the program attendees were aged below 20).[17] Data from 2008–2010 suggest that 60% of FSW in sub-Saharan Africa had tested in the last 12 months.[23] HIV testing is available to FSW, even in the absence of targeted services, though there are significant barriers to service access in our setting[24] and in others.[25] Our estimate that at first visit to the program, 41% of HIV-positive FSW were on ARV is similar to the 38% figure reported in a recent systematic review.[10] Overall, data obtained from this program platform seem compatible with other information currently available on FSW.

Many programs collect data from clients to support service delivery. In turn, aggregated data are often reported to funders or regulatory bodies. However, these statistics often do not reflect the depth of analysis that may be possible. We used standard epidemiological techniques to generate a virtual open cohort of women accessing the program and generated a range of useful statistics. The approaches we used are not complex though they require care in both data collection and analysis. We advise other programs to consider this

TABLE 3. Longitudinal Knowledge of HIV Status Among HIV-Negatives; Rate of Starting Antiretroviral Medication Among HIV-Positives; HIV Incidence

		% of Time Engaged in Care "Knowing Status" Among Those Who Arrive HIV −ve			Rate of Starting ARV		
	N (Col %)	PY/Total PY	Mean Proportion (%) (95% CI)	N (Col %)	n/100PY	Rate/100 PY	Rate Ratio (95% CI)
Total	2882	649/1935	26.5 (23.4–29.5)	2145	354/15.4	23.0 (19.3–26.9)	
Period of first visit							
Before July 1, 2011	1233 (42.8)	326/1077	21.2 (19.2–23.1)	1145 (53.4)	237/10.6	22.4 (19.8–27.0)	Baseline
After July 1, 2011	1649 (57.2)	323/858	30.4 (25.6–35.2)	1000 (46.6)	117/4.8	24.3 (14.3–42.7)	1.08 (0.70–1.71)
Age							
12–25	1029 (36.0)	230/656	28.6 (25.2–32.1)	461 (21.6)	41/3.3	12.3 (9.2–16.2)	Baseline
26–35	1233 (43.1)	281/869	24.8 (22.3–27.3)	1138 (53.3)	196/8.2	23.9 (17.9–30.1)	1.94 (1.47–2.55)
36+	598 (21.9)	135/403	26.3 (22.2–30.3)	536 (25.1)	116/3.8	30.4 (27.6–35.1)	2.47 (1.87–3.25)
Education							
None/Primary	409 (22.7)	81/208	30.0 (24.6–35.4)	321 (28.0)	44/1.6	28.1 (14.2–61.2)	Baseline
Secondary	1394 (77.3)	287/772	30.3 (25.7–34.9)	824 (72.0)	96/4.5	21.3 (14.1–32.5)	0.76 (0.51–1.12)
Marital Status							
Cohabiting/Married	82 (2.9)	16/48	24.6 (16.8–32.3)	43 (2.0)	7/0.3	24.4 (8.4–61.1)	1.38 (0.49–3.85)
Divorced/Separated	1802 (62.9)	412/1219	27.2 (23.5–31.0)	1298 (61.0)	218/9.6	22.7 (18.1–28.1)	1.28 (0.84–1.94)
Never married	568 (19.8)	120/363	27.4 (23.4–31.4)	293 (13.8)	36/2.0	17.8 (11.1–26.9)	Baseline
Widowed	414 (14.5)	95/293	22.2 (17.6–26.8)	495 (23.3)	92/3.4	26.9 (23.0–30.6)	1.52 (0.96–2.41)
Baseline status							
Never tested	1022 (35.5)	170/664	19.9 (17.1–22.8)	509 (23.7)	89/3.3	26.8 (20.0–45.7)	Baseline
HIV >6 mo ago	835 (29.0)	201/563	29.5 (26.2–32.9)	138 (6.4)	20/0.8	25.4 (16.1–40.1)	0.95 (0.62–1.44)
HIV− within 6 mo	1025 (35.6)	277/708	30.5 (26.0–34.9)	47 (2.2)	7/0.2	31.4 (17.6–55.6)	1.17 (0.64–2.14)
HIV+ and not on treatment		N/A		1451 (67.7)	238/11.1	21.5 (16.4–26.7)	0.80 (0.58–1.11)

		HIV Incidence (Seroconversion Date Estimated with Tests after First Visit Only)		
	N (Col %)	n/100 PY	Rate Per 100 PY	Rate Ratio (95% CI)
Total	605	67/6.9	9.8 (7.1–15.9)	
Period of first visit				
Before July 1, 2011	293 (48.4)	45/4.3	10.5 (8.0–16.0)	Baseline
After July 1, 2011	312 (51.6)	22/2.6	8.6 (4.9–18.5)	0.82 (0.51–1.32)
Age				
12–25	223 (37.0)	27/2.5	10.8 (8.1–16.1)	Baseline
26–35	262 (43.5)	32/3.0	10.7 (6.8–22.1)	0.99 (0.76–1.29)
36+	118 (19.6)	8/1.3	6.0 (3.6–10.1)	0.56 (0.36–0.87)
Education				
None/Primary	77 (21.5)	4/0.7	5.7 (2.3–14.8)	Baseline
Secondary	282 (78.6)	28/2.5	11.3 (7.5–18.4)	1.97 (0.85–4.57)
Marital Status				
Cohabiting/Married	14 (2.3)	1/0.1	7.3 (N/A–N/A)	0.79 (0.09–7.04)
Divorced/Separated	394 (65.7)	50/4.4	11.3 (8.3–17.4)	1.22 (0.63–2.36)
Never married	108 (18.0)	11/1.2	9.2 (4.8–24.2)	Baseline
Widowed	84 (14.0)	5/1.0	4.8 (2.9–10.3)	0.52 (0.26–1.04)
Baseline status				
Never tested	159 (26.3)	23/1.9	11.9 (8.7–17.9)	Baseline
HIV >6 mo ago	195 (32.2)	24/2.2	11.0 (6.9–20.8)	0.93 (0.57–1.50)
HIV− within 6 mo	251 (41.5)	20/2.8	7.3 (4.9–13.4)	0.61 (0.43–0.87)
HIV+ and not on treatment	N/A	N/A		

All 95% confidence intervals are robust to clustering. Extent of engagement with care, shown for women who arrive HIV-negative in terms of the amount of time knowing their HIV status (ie, having been recently tested), and as the rate of uptake of ART for HIV-positive women. Seroconversion date estimated as the midpoint between positive test and last HIV-negative test. Follow-up time from first to last HIV-negative test, or seroconversion date. The incidence of HIV calculated from program tests only was 12.5 (robust 95% CI: 6.9 to 21.2), resulting from 24 cases and 193 person years.

possibility. In 2014, we established an electronic data capture platform that has now been rolled out in all sites. Data are uploaded in real time. This system will improve data completeness, quality, and participant tracking. In future work, we plan to compare the population accessing the program with data from 14 RDS surveys in overlapping sites and plan to explore geographical and over-time variation in the indicators. These analyses will be used where possible to guide and strengthen program implementation, for example by identifying where testing activities might be strengthened, and to provide information for policy makers to inform resource allocation decisions. Finally, the data will be leveraged to provide process indicators for an ongoing cluster-randomized trial: the "Sisters antiretroviral therapy program for prevention of HIV: an Integrated response" (SAPPH-IRE) intervention trial (PACTR201312000722390). The combination intervention under study in the trial seeks to improve the accessibility of ARV for both prevention and treatment for FSW in Zimbabwe: the program data platform will provide data on whether the intervention has succeeded in improving retention, as well as rates of repeat testing and linkage to ART treatment and prevention.

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