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# Cohort analysis of programme data to estimate HIV incidence and uptake of HIV-related services among female sex workers in Zimbabwe, 2009-14

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

**Tables: 3**

**Figures: 2**

# *Abstract*

## **Background**

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

## **Methods**

Analysis of data from FSW consultations with Zimbabwe's National Sex Work programme, 2009-14. At each visit, data were collected on socio-demographic characteristics, HIV testing history, HIV tests conducted by the programme and antiretroviral (ARV) history. Characteristics at first visit and longitudinal data on programme engagement, repeat HIV testing and HIV sero-conversion were analysed using a cohort approach.

## **Results**

Data were available for 13360 women, 31389 visits, 14579 reported HIV tests, 2750 tests undertaken by the programme 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 programme 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 two or more HIV tests, the HIV sero-conversion rate was 9.8 / 100 person years of follow-up (95% confidence interval 7.1-15.9).

## **Conclusions**

Individual-level outreach programme 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 programme improvement. Further methodological validation is required.

## *Contributions*

JH conceptualised the paper, contributed to the analysis and led the drafting of the paper

SM is the director of the Sister programme and oversaw all aspects of data collection activities in the field

JD developed the data management and cleaning systems and contributed to the analysis

SC was involved in implementation, conducted regular external monitoring of programme and data and commented on the manuscript

CD led the analysis of the data

CB was involved in setting up the programme and commented on the manuscript

SNM contributed to the analysis

RW-G was involved in external monitoring of the programme at three sites and commented on the manuscript

VM was involved in programme design and implementation on behalf of National AIDS Council and commented on the manuscript

DH was involved in implementation of the programme and data and commented on the manuscript

OM was involved in programme design and implementation on behalf of Ministry of Health and Child Care and commented on the manuscript

FC oversaw all aspects of design, implementation and evaluation of the Sisters for Life programme and contributed to all aspects of the manuscript

All authors contributed to the writing of the paper and agreed on the final draft to be submitted

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We would like to thank all the staff and stakeholders involved in running the programme, the many 'sisters' who help implement and attend the programme. In addition we would particularly like to acknowledge the contribution of the late Hellen Zitsenga, who was the senior nurse manager for the programme since its inception and who oversaw the day to day collection of all the data included here. She will be greatly missed.

## *Key Messages*

- While there are a range approaches to HIV surveillance among high-risk, marginalised 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 programmes 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 programme contacts with 13,000 women in 26 sites covering all provinces in Zimbabwe, 2009-14.
- The data suggest very high incidence (10-12% per year) among female sex workers in Zimbabwe and suggest programme retention, repeat HIV testing and linkage to treatment can all be improved. The analysis approach could be used to track whether improvements are being realised over time.
- The approach has many potential biases, but these are worthy of better characterisation through further study characterisation since 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 <sup>1</sup>. Sex work-related behaviours are illegal and/or stigmatised in many countries, including Zimbabwe <sup>2,3</sup>. 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, while 65-73% report consistent condom use with transactional partners <sup>4</sup>.

General population surveys that ask about these behaviours suffer from social desirability bias, and anyway tend to recruit few individuals in these risk categories. The major issue for surveys of this hidden populations is that no sampling frame for the target population is available. Location-based <sup>5</sup> or respondent-driven sampling (RDS) surveys<sup>6,7</sup> that target FSW improve significantly upon convenience samples and are theoretically-based and feasible, but remain complex to analyse and interpret. Structural factors, including high mobility, further complicate matters <sup>8</sup>. 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 <sup>10</sup>. Another review identified only seven African studies in five countries on anti-retroviral (ARV) uptake, attrition, adherence and outcomes among FSW <sup>11</sup>.

Data from outreach programmes are a potential resource. We compiled individual-level programmatic data collected from consultations with the Zimbabwean national HIV prevention programme for FSW from 2009-14. 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 programme; 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<sup>12</sup>. Since then the 'Sisters' programme has expanded across the country, and provides free access to HIV testing, STI treatment, family planning, HIV prevention education, condoms and legal services<sup>13</sup>. There are six 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 programme is supported by trained peer educators and community mobilisation 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 as well as building social cohesion and empowerment. In the case of outreach sites, peer educators are responsible for maintaining programme activities in between weekly programme visits. Women attending the programme who are HIV-negative are encouraged to re-test every six months, but there is no active follow up of women who default. From 2009-2013, access to antiretroviral (ARV) medication increased rapidly across Zimbabwe<sup>14</sup>. Over this period the programme 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 350cells/ml<sup>15</sup>.

## Data collection

At first visit to the programme at any site, women were assigned a unique identifier. At each visit to the programme they were asked if they had been to the programme 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 programme were entered into a separate data file. Socio-demographic 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 analysed information from visits to all 26 sites collected between 11 September 2009, the date of the first visit to the Harare clinic, and 14 March 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 following a positive test. Some events, such as HIV tests, could be reported at more than one consultation or might have appeared both as a self-reported test and in the programme testing database. For example, if a FSW made several visits to the programme, 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 prior to first visits to the programme 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 1<sup>st</sup> of the month where month and year were present and 1<sup>st</sup> 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 programme we required that full date information (dd/mm/yyyy) were 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 programme had been initiated.

## **Data analysis**

Women were assigned to one of five categories that described them on the date of their first visit to the programme: (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 analysed data on dates of visits to the programme, 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 programme. Within the data a personal timeline was constructed for each FSW. The “revisit rate” was the proportion of individuals coming for more than one visit to the programme. 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 programme 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 programme) 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 two HIV tests after first attending the programme. We identified individuals who had a positive test result as well as a prior negative test since their first visit to the programme, and imputed the date of infection as the mid-point between the negative and positive test result. These individuals contributed time at risk from their first visit until this imputed date of sero-conversion. 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 programme. Figure 2 shows graphically how the timeline for women was constructed.

We compared “baseline” status and longitudinal indicators across several categories: time periods (pre- and post-31<sup>st</sup> July 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 programme 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). Since the data were collected from women as part of routine clinical care, individual informed consent was not obtained. Data were extracted in anonymised form from the clinical database for analysis.

## Results

We recorded 31,389 consultations with 13,360 women (median age at first visit 29 yrs). Most FSW attending the programme had secondary education (6,889/9,316, 74.0%) and a high proportion were divorced or separated (8,101/13,257 61.1%) (Table 1). Some 28.0% (3,735/13,360) had never previously tested for HIV when they first attended the programme, though after July 2011 this proportion was smaller (1,898/8,794, 21.6%). Among those who had tested for HIV before their first visit, 50.4% (4,847/9,625) reported having tested positive. Among those who had tested HIV-positive, 41.0% (1,986/4,847) reported previously initiating ARV treatment. Younger FSW (12-25 years old) 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). 7,445 visits were by FSW who only attended the programme once (55.7% of individuals), the remainder were follow-up visits by 5,915 individuals who attended more than once, with a mean of 4 and median of 3 visits, with 2,448 (18.3%) coming twice. The median time between first and second visit was 53 days (Lower-quartile 19, upper-quartile 126), among the 5,915 women who attended twice or more. Individuals whose first visit was before July 2011 were more likely to come back (see Table 2). Individuals who reported being HIV-positive at baseline were more likely to re-attend (see Table 2). Among those individuals who had an HIV-positive test conducted by the programme (N=1,263), and would have therefore been referred to government services, 54.1% were not seen again, while 16.0% (93/580) of those who were seen again later reported having started ARVs.

HIV-negative FSW engaged with the programme had had a negative test within the last 6 months 26.5% of the total follow-up time (95% CI: 23.4 - 29.5) (Table 3). Those who had never previously tested at their first visit to the programme were the least likely, during their engagement with the programme, to know their status (19.9% of the total follow-up time, 95% CI 17.1 – 22.8). After July 2011 a greater proportion of women were aware of their status: among those who first came to the programme after 1 July 2011, FSW knew their status 30.4% of time. The programme conducted 2,750 HIV tests, 1,263 (45.9%) of which were positive. 760/14,579 (5.2%) of the HIV tests took place within three 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 1,539 person years of follow up (rate 23.0 initiations / 100 person years of follow up), calculated from the first time that the programme 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 six months.

Some 67 women sero-converted following their first visit, among the 605 women who had at least two tests at or after their first visit including at least one 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 – 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 prior to the first visit (7.3 cases per 100 person years). The incidence rate calculated using only HIV tests administered by the programme was 12.5 (95% CI 6.9 – 21.2) per 100 person years of follow-up (24 cases in 193 person years follow-up).

## Discussion

We used individual-level, anonymised data drawn from an outreach programme database to calculate indicators of HIV-intervention uptake among women accessing an outreach HIV prevention programme for FSW in 26 sites across Zimbabwe, and estimated the rate of HIV sero-conversion among women reporting two 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 programme data could be better harnessed to characterise the epidemiology of HIV among FSW and to inform public health action.

Establishing population-based measures of HIV-related phenomena among FSW is difficult since it is not possible to enumerate and conduct random-sampling-based surveillance<sup>5</sup>. Our approach uses outreach programme 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 programme attendees are likely to be more representative of the underlying population than the research-cohorts of FSW among whom many studies are conducted<sup>11</sup>. 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 programme. However rates of repeat testing were not optimal. Just over half of FSW seen by the programme 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, while HIV-positive FSW started treatment at a rate of 23/100 person years of engagement with the programme each year. While 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<sup>16</sup>.

However, caution is warranted: the methods we describe may suffer from potential biases requiring further characterisation. The most obvious limitation of data collected through outreach programmes is that they only offer information on FSW accessing the programme. 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 non-access of the programme 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, while 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 programme were likely accessing the same services through other channels. Indeed, over 70% of the FSW attending the programme had previously had an HIV test prior to their first engagement with our programme and among those presenting with a prior HIV positive test 41% had already initiated ARV. Further, the characteristics of FSW who access the programme 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.

Another potential limitation is that while we issued each woman with a unique identifier code that could be used to identify her at future visits to the programme at any site, this system involved no biometrics or validation and it is likely that some individual women appear as duplicates in the dataset. FSW working in Zimbabwe are highly mobile and may access the programme 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 programme. Although much less precise, our incidence estimate using only tests actually conducted by the programme 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%)<sup>4</sup> and in 14 sites in 2013 (mean 56%)<sup>17</sup>. Global estimates of FSW HIV prevalence suggest this is much higher than in the general population<sup>1</sup>; in Zimbabwe general population HIV prevalence for women aged 15-49 is 15%<sup>18</sup>. There are little comparable data for FSW HIV incidence from any setting in sub-Saharan Africa<sup>19-22</sup>, while general population HIV incidence in Zimbabwe is estimated at about 1% per annum<sup>23</sup>. We estimate a figure 10-12 times higher than this among FSW accessing a dedicated HIV prevention programme and reporting multiple HIV tests. Approximately 70% of our sample had ever tested for HIV at their first visit to the programme, 60% prior to 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 programme attendees were aged below 20)<sup>24</sup>. Data from 2008-2010 suggest that 60% of FSW in sub-Saharan Africa had tested in the last 12 months<sup>25</sup>. HIV testing is available to FSW, even in the absence of targeted services, though there are significant barriers to service access in our setting<sup>26</sup> and in others<sup>27</sup>. Our estimate that at first visit to the programme 41% of HIV-positive FSW were on ARV is similar to the 38% figure reported in a recent systematic review<sup>11</sup>. Overall, data obtained from this programme platform appear compatible with other information currently available on FSW.

Many programmes 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 programme 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 programmes to consider this possibility. In 2014 we established an electronic data capture platform which 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 programme 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 programme 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-randomised trial: the 'Sisters Antiretroviral therapy programme 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 programme 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.

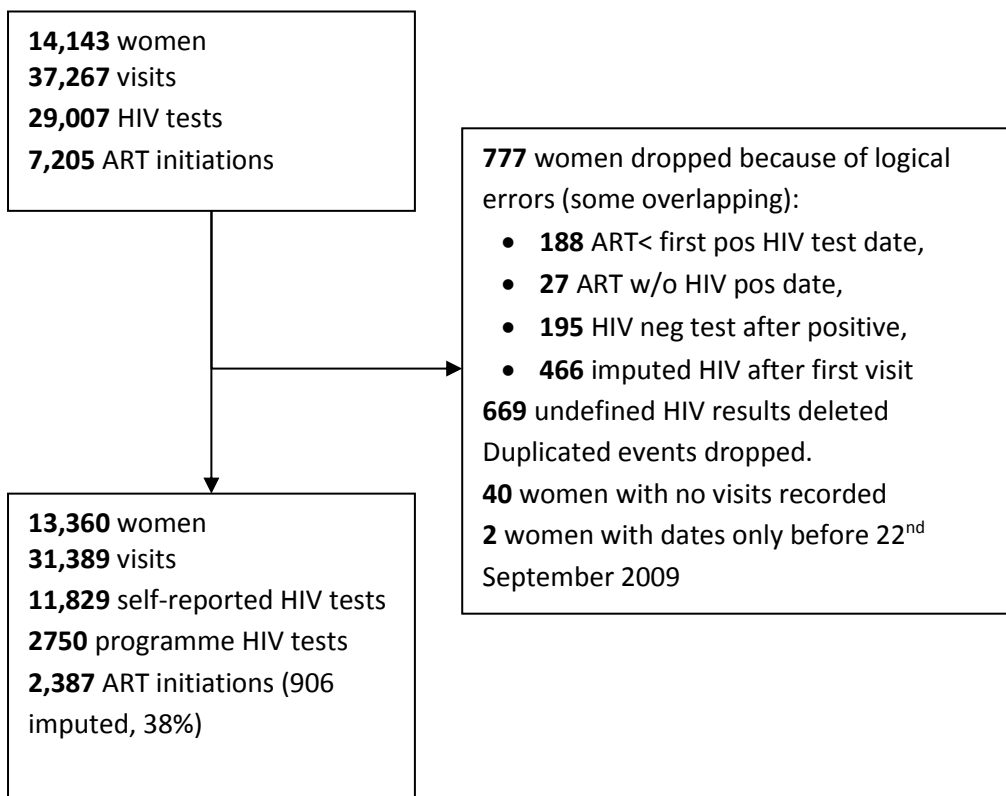
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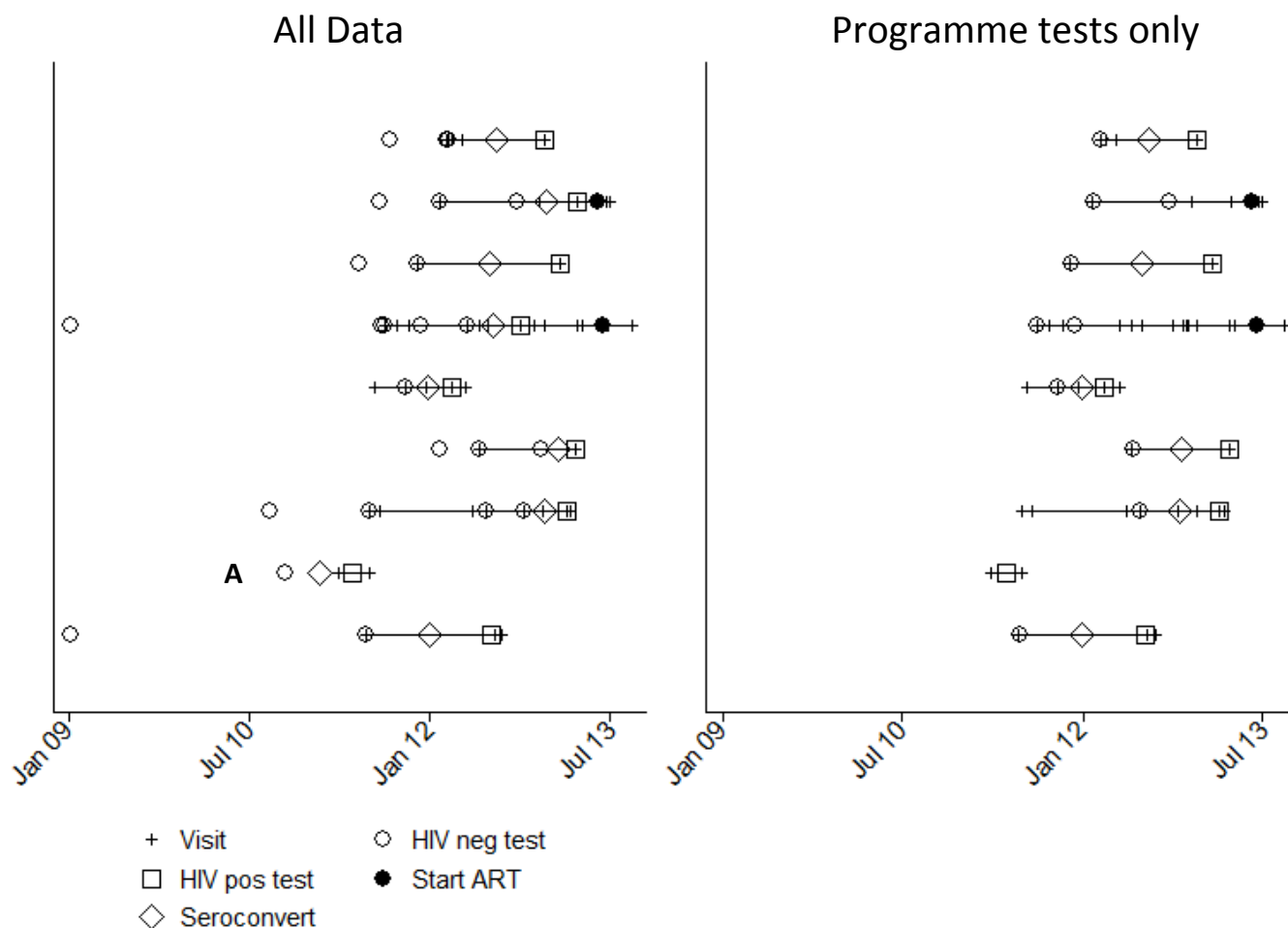
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## Tables and Figures

**Figure 1: Flow chart of exclusions**



**Figure 2: Examples of timelines of female sex-worker event histories**



**Figure 2:** This graph shows the timelines of nine women who first attended the clinics after January 2011. These timelines show HIV tests (negative and positive), visits, dates of starting ART, and approximate sero-conversion 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, while on the right only programme tests are used. As a result, the estimated time of sero-conversion – or the estimation of sero-conversion at all – is often different in the two data handling approaches. In the timeline labelled ‘A’ the sero-conversion date is calculated using a negative test prior to the first visit, which would not be permitted in our primary incidence estimation procedure, and also estimates the sero-conversion date to be prior to the start of follow-up, thus being excluded from all analysis.



**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 months ago		HIV-negative test < 6 months ago		Previous positive test, not on treatment		Previous positive test, & on treatment	
	n	Col%	n	Row %s	n	Row %s	n	Row %s	N	Row %s	n	Row %s
<b>Total</b>	13,360	100	3,735	28.0	2,348	17.6	2,430	18.2	2,861	21.4	1,986	14.9
<b>Period of first visit</b>												
Before 1st July 2011	4,566	34.2	1,837	40.2	683	15.0	497	10.9	1,015	22.2	534	11.7
After 1st July 2011	8,794	65.8	1,898	21.6	1,665	18.9	1,933	22.0	1,846	21.0	1,452	16.5
<b>Age</b>				Col. %		Col. %		Col. %		Col. %		Col. %
12-25*	3,815	29.1	1,158	31.5	856	37.1	1,075	45.3	577	20.6	149	7.7
26-35	5,941	45.3	1,661	45.1	1,026	44.5	945	39.8	1,473	52.6	836	43.0
36+	3,350	25.6	863	23.4	424	18.4	355	15.0	748	26.8	960	49.4
<b>Education</b>												
None / Primary	2,427	26.1	571	27.4	378	21.5	409	20.5	574	29.1	495	33.0
Secondary	6,889	74.0	1,517	72.7	1,377	78.5	1,589	79.5	1,402	71.0	1,004	67.0
<b>Marital Status</b>												
Cohabiting/Married	351	2.7	82	2.2	86	3.7	76	3.2	61	2.2	46	2.3
Divorced/Separated	8,101	61.1	2,290	61.8	1,477	63.4	1,603	66.4	1,730	61.0	1,001	50.8
Never married	2,172	16.4	681	18.4	472	20.3	475	19.7	344	12.1	200	10.2
Widowed	2,633	19.9	655	17.7	296	12.7	260	10.8	699	24.7	723	36.7

**Table 1:** 4,044 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 = 3,773, missing in period 2 = 271). The proportion HIV positive at first visit, by age group, was 19.0% (726/3,815) for 12-25 years; 38.9% (2,309/5,941) for 26-35 years; and 51.0% (1,708/3,350) for 36+ years. The proportion who had started ART at first visit, by age group, was 3.9% (149/3,815) for 12-25 years; 14.1% (836/5,941) for 26-35 years; and 28.7% (960/3,350) for 36+ years. Note that over the period of the analysis HIV+ women with a CD4 count of <350cells/ were eligible for ART.

\* While 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.

**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-Value (LRT)	Adjusted Odds Ratio (95% CI)	P-Value (LRT)
<b>Total</b>	9,540	4,622	48.5				
<b>Period of first visit</b>							
Before 1st July 2011	4,566 (47.9)	2,432	53.3	Baseline		Baseline	
After 1st July 2011	4,974 (52.1)	2,190	44.0	0.69 (0.57 - 0.84)	<0.001	0.81 (0.69 - 0.95)	0.010
<b>Age</b>							
12-25	2,688 (28.4)	1,174	43.7	Baseline			
26-35	4,318 (45.6)	2,161	50.1	1.29 (1.20 - 1.39)			
36+	2,472 (26.1)	1,273	51.5	1.37 (1.21 - 1.55)	<0.001		
<b>Education</b>							
None / Primary	1,442 (25.7)	637	44.2	Baseline		Baseline	
Secondary	4,166 (74.3)	1,861	44.7	1.02 (0.88 - 1.18)	0.79	1.05 (0.93 - 1.20)	0.41
<b>Marital Status</b>							
Cohabiting/Married	161 (1.7)	77	47.8	0.97 (0.77 - 1.22)		0.90 (0.72 - 1.12)	
Divorced/Separated	5,808 (61.1)	2,767	47.6	0.96 (0.89 - 1.03)		0.88 (0.80 - 0.97)	
Never married	1,519 (16.0)	739	48.7	Baseline		Baseline	
Widowed	2,017 (21.2)	1,020	50.6	1.08 (0.93 - 1.25)	0.13	0.91 (0.77 - 1.08)	0.013
<b>Baseline status</b>							
Never tested	3,147 (33.0)	1,277	40.6	Baseline		Baseline	
Previous HIV- > 6 months ago	1,584 (16.6)	727	45.9	1.24 (1.05 - 1.47)		1.40 (1.23 - 1.59)	
HIV - within 6 months	1,497 (15.7)	767	51.2	1.54 (1.39 - 1.70)		1.87 (1.70 - 2.06)	
HIV+ & not on treatment	2,076 (21.8)	1,130	54.4	1.75 (1.58 - 1.93)		1.64 (1.37 - 1.98)	
HIV + & on treatment	1,236 (13.0)	721	58.3	2.05 (1.86 - 2.25)	<0.001	2.06 (1.76 - 2.41)	<0.001

**Table 2:** 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.

**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				HIV incidence (Sero-conversion date estimated with tests after first visit only)			
	N (col %)	PY / Total PY	Mean proportion % (95% CI)	N (col %)	n/ 100PY	Rate / 100 PY	Rate ratio (95% CI)	N (col %)	n/100 PY	Rate per 100 PY	Rate ratio (95% CI)
<b>Total</b>	2,882	649/1,935	26.5 (23.4 - 29.5)	2,145	354/15.4	23.0 (19.3 - 26.9)		605	67/6.9	9.8 (7.1 - 15.9)	
<b>Period of first visit</b>											
Before 1st July 2011	1,233 (42.8)	326/1,077	21.2 (19.2 - 23.1)	1,145 (53.4)	237/10.6	22.4 (19.8 - 27.0)	Baseline	293 (48.4)	45/4.3	10.5 (8.0 - 16.0)	Baseline
After 1st July 2011	1,649 (57.2)	323/858	30.4 (25.6 - 35.2)	1,000 (46.6)	117/4.8	24.3 (14.3 - 42.7)	1.08 (0.70 - 1.71)	312 (51.6)	22/2.6	8.6 (4.9 - 18.5)	0.82 (0.51 - 1.32)
<b>Age</b>											
12-25	1,029 (36.0)	230/656	28.6 (25.2 - 32.1)	461 (21.6)	41/3.3	12.3 (9.2 - 16.2)	Baseline	223 (37.0)	27/2.5	10.8 (8.1 - 16.1)	Baseline
26-35	1,233 (43.1)	281/869	24.8 (22.3 - 27.3)	1,138 (53.3)	196/8.2	23.9 (17.9 - 30.1)	1.94 (1.47 - 2.55)	262 (43.5)	32/3.0	10.7 (6.8 - 22.1)	0.99 (0.76 - 1.29)
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)	118 (19.6)	8/1.3	6.0 (3.6 - 10.1)	0.56 (0.36 - 0.87)
<b>Education</b>											
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	77 (21.5)	4/0.7	5.7 (2.3 - 14.8)	Baseline
Secondary	1,394 (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)	282 (78.6)	28/2.5	11.3 (7.5 - 18.4)	1.97 (0.85 - 4.57)
<b>Marital Status</b>											
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)	14 (2.3)	1/0.1	7.3 (N/A - N/A)	0.79 (0.09 - 7.04)
Divorced/Separated	1,802 (62.9)	412/1,219	27.2 (23.5 - 31.0)	1,298 (61.0)	218/9.6	22.7 (18.1 - 28.1)	1.28 (0.84 - 1.94)	394 (65.7)	50/4.4	11.3 (8.3 - 17.4)	1.22 (0.63 - 2.36)
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	108 (18.0)	11/1.2	9.2 (4.8 - 24.2)	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)	84 (14.0)	5/1.0	4.8 (2.9 - 10.3)	0.52 (0.26 - 1.04)
<b>Baseline status</b>											
Never tested	1,022 (35.5)	170/664	19.9 (17.1 - 22.8)	509 (23.7)	89/3.3	26.8 (20.0 - 45.7)	Baseline	159 (26.3)	23/1.9	11.9 (8.7 - 17.9)	Baseline
HIV > 6 months 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)	195 (32.2)	24/2.2	11.0 (6.9 - 20.8)	0.93 (0.57 - 1.50)
HIV - within 6 months	1,025 (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)	251 (41.5)	20/2.8	7.3 (4.9 - 13.4)	0.61 (0.43 - 0.87)
HIV+ & not on treatment		N/A		1,451 (67.7)	238/11.1	21.5 (16.4 - 26.7)	0.80 (0.58 - 1.11)	N/A		N/A	

Table 3: 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 (i.e. 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 programme tests only was 12.5 (robust 95% CI 6.9 – 21.2), resulting from 24 cases and 193 person years.