

The impact of the DREAMS partnership on HIV incidence among young women who sell sex in two Zimbabwean cities: results of a non-randomised study

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ABSTRACT

Introduction Young women who sell sex (YWSS) in Zimbabwe remain at high risk of HIV infection. Effective HIV prevention strategies are needed. Through support to access a combination of evidence-based interventions, including oral pre-exposure prophylaxis (PrEP), the Determined, Resilient, Empowered, AIDS-free, Mentored and Safe (DREAMS) partnership aimed to reduce new HIV infections among adolescent girls and young women by 40% over 24 months. **Methods** Non-randomised ‘plausibility’ evaluation, powered to detect a 40% HIV incidence difference between DREAMS and non-DREAMS sites. Two large cities with DREAMS funding were included, and four smaller non-DREAMS towns for comparison. In all sites, YWSS were enrolled to a cohort through peer-referral. Women were followed up for 24 months. HIV seroconversion was the primary outcome, with secondary outcomes identified through a theory of change. Outcomes were compared between YWSS recruited in DREAMS cities and non-DREAMS towns, adjusting for individual-level confounders and HIV prevalence at enrolment.

Results From April to July 2017, 2431 women were enrolled, 1859 of whom were HIV negative at enrolment; 1019 of these women (54.8%) were followed up from March to May 2019 and included in endline analysis. Access to clinical services increased, but access to socioeconomic interventions promoted by DREAMS was limited. A total of 79 YWSS HIV seroconverted, with HIV incidence among YWSS in DREAMS cities lower (3.1/100 person-years) than in non-DREAMS towns (5.3/100 person-years). In prespecified adjusted analysis, HIV incidence was lower in DREAMS cities but with weak statistical evidence (adjusted rate ratio (RR)=0.68; 95% CI 0.40 to 1.19; p=0.18). Women in DREAMS cities were more likely to report ever and ongoing PrEP use, consistent condom use, fewer sexual partners and less intimate partner violence.

Conclusion It is plausible that DREAMS lowered HIV incidence among YWSS in two Zimbabwean cities, but our evaluation provides weak statistical evidence for impact and suggests any reduction in incidence was lower than the anticipated 40% decline. We identified changes to some important ‘pathways to impact’ variables, including condom use.

INTRODUCTION

In Eastern and Southern Africa, adolescent girls and young women (AGYW) aged 15–24 accounted for 26% of all new HIV infections in 2018.¹ Young women who sell sex (YWSS), including young female sex workers (FSW) and women who sell sex but do not identify as FSW, are at especially high risk because of their high numbers of sexual partners, constrained ability to negotiate condom use and high prevalence of other sexually transmitted infections.^{2–3} Poverty, poor access to healthcare, stigma and discrimination, and physical and sexual violence further compound this risk.^{2–4} Reducing HIV infections among YWSS requires interventions that address these multiple determinants of risk.

In 2015, the DREAMS (Determined, Resilient, Empowered, AIDS-free, Mentored and Safe) partnership was launched in ten sub-Saharan African countries, including Zimbabwe. Through financial and technical support for a combination of evidence-based interventions, DREAMS aimed to reduce new HIV infections among AGYW by 40% over 24 months.^{5–6} In Zimbabwe, interventions included HIV testing, contraception and condom provision as well as the offer of oral pre-exposure prophylaxis (PrEP), with linkage to the broader package of DREAMS services.

We evaluated whether offering HIV testing services and increasing the availability of PrEP to YWSS aged 18–24, combined with community mobilisation and social protection interventions supported by DREAMS, reduced the number of new HIV infections by 40% over 24 months, compared with HIV

Key questions

What is already known?

- ▶ Young women who sell sex (YWSS) in Eastern and Southern Africa are at high risk of HIV.
- ▶ Available evidence shows that these women are less engaged with HIV prevention services.
- ▶ There are few evaluations of interventions for the broader population of YWSS.

What are the new findings?

- ▶ We found higher engagement with clinical services among women in the places where DREAMS investments were made and differences in pre-exposure prophylaxis (PrEP) use between women recruited in the Determined, Resilient, Empowered, AIDS-free, Mentored and Safe (DREAMS) cities and non-DREAMS towns, at 24-month follow-up.
- ▶ After 24 months of follow-up, HIV incidence was high in both groups, and lower in DREAMS cities but with weak statistical evidence of a difference between the two groups.
- ▶ We found evidence for an impact on some secondary outcomes, including condom use, violence and number of partners, and some lessons for implementation.
- ▶ Overall, YWSS reported little uptake of social protection services.
- ▶ Implementation challenges, including limited experience of implementing partners working with general populations in working with YWSS and barriers faced by YWSS in accessing these general population services, need to be addressed to improve coverage of combination HIV prevention services.

What do the new findings imply?

- ▶ The available evidence indicates the continued need to implement and evaluate combination HIV prevention services for YWSS, including women who do not identify as sex workers.
- ▶ Further efforts are needed to identify approaches that enhance access to social protection services among YWSS combined with delivery of biomedical interventions, including PrEP.

incidence among YWSS residing in areas where DREAMS investments were not available.

METHODS

Study design and participants

We conducted a non-randomised ‘plausibility’ evaluation of the impact of DREAMS on HIV incidence and other secondary outcomes.⁷ Our ‘plausibility’ evaluation reflects that financial and practical issues limited the study size alongside other limitations such as the lack of randomisation.^{5,7} Our prespecified approach was to build the strength of the evidence base related to an impact of DREAMS on HIV incidence through combined analysis of outcome and qualitative process data.

The study was conducted with YWSS in two large cities and four smaller towns in Zimbabwe. The cities were selected purposively as locations where DREAMS funding was being provided. The four smaller towns were selected for comparison based on their similarity with the DREAMS cities according to data from the ‘Sisters with a Voice’ (Sisters) programme,⁵ a national HIV programme for sex workers. Sisters provides free, comprehensive HIV

prevention and care services to FSW through a network of peer educators and clinics in line with WHO guidance, including: provision of free condoms and contraceptives, HIV testing, syndromic management of sexually transmitted infections (STIs), community empowerment and legal advice supported by outreach workers and peer educators. In the DREAMS cities and one non-DREAMS town, Sisters was delivered through static sites open 5 days a week; in three of the four non-DREAMS towns, Sisters was delivered through mobile clinics in which service provision was only available 1 day per week.

The DREAMS interventions

In DREAMS cities, in addition to Sisters, a package of social and clinical interventions was available to YWSS. The DREAMS package was delivered through several implementing partners in the two cities; services available included social protection, life skills, education and vocational training, gender-based violence prevention and care, and HIV prevention, including condom promotion and distribution, an offer of PrEP combined with community empowerment and adherence support for those at highest risk of HIV (figure 1). Community-based activities aimed to increase demand for and uptake of PrEP and the DREAMS package more generally, and to support PrEP adherence. Entry into DREAMS could be through any implementing partner. In the non-DREAMS comparison towns YWSS could access usual care from the Sisters programme and the public health sector.

Cohort recruitment and follow-up

Within each city/town we recruited individuals into the study cohort through peer-referral using the same approach to respondent-driven sampling (RDS) we have used in previous surveys.^{2,5} YWSS were eligible to participate if they were aged 18–24, had exchanged sex for money and/or material support in the past month, with it explicitly stated that sex acts with men would not have happened in the absence of an exchange, and if they were not planning to move from the site within the next 6 months.

We conducted community mapping to identify hotspots where young women sell sex to select ‘seed’ participants.⁸ Six seed participants were selected in each non-DREAMS town and 10 in each DREAMS city. Seed participants were given two coupons to recruit their peers. This process continued until the desired sample size was attained across both study groups. We previously described the participants enrolled at baseline, including details of the peer referral process.² A summary of these and some additional analyses are reported in online supplemental appendix 5.

In both groups, YWSS were interviewed and offered HIV testing using a rapid HIV test at enrolment into the study in 2017. Budgetary constraints meant that women recruited in DREAMS cities were followed up at 12 months and 24 months after the initial enrolment survey, with women in non-DREAMS towns followed up at 24 months

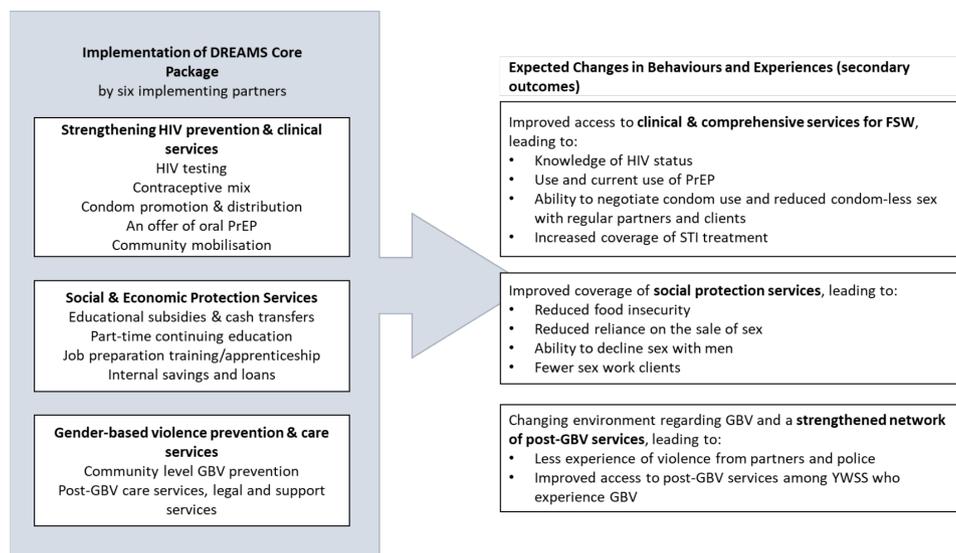


Figure 1 DREAMS core package of interventions and the expected changes in behaviours and experiences (secondary outcomes). DREAMS, Determined, Resilient, Empowered, AIDS-free, Mentored and Safe; FSW, female sex workers; GBV, gender-based violence; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infection; YWSS, young women who sell sex.

only. In 2019, at 24-month follow-up, study participants were re-interviewed and offered HIV testing as before. Complementary strategies were implemented to retain women in the study in the DREAMS and non-DREAMS groups, including WhatsApp messaging, outreach activities and engaging YWSS who recruited women to the study to inform women about the study follow-up.

HIV testing procedures

At enrolment and follow-up, women were offered counselling and HIV testing services using a serial HIV testing algorithm adapted from Zimbabwe's national testing and counselling guidelines. Determine HIV-1/2 or First Response HIV-1-2 kit antibody testing was used as the first screening test. Where the result was HIV positive, this was confirmed using First Response HIV-1-2 kit or Determine HIV-1/2. Where the two test results were discordant, repeat testing was advised within 2 weeks. All women were given the results of their HIV test.

Primary and secondary outcomes

The primary outcome was incident HIV infection over the 24-month study period. The outcome was calculated as the number of new HIV infections divided by the total person-years of follow-up during the 24-month study period, among YWSS who tested HIV-negative at enrolment. Selection of secondary outcomes reflected the hypothesised causal pathway for how DREAMS would reduce HIV incidence (figure 1).⁵ We assessed thirteen prespecified, self-reported, secondary outcomes including condom-less sex with regular partners and clients, knowledge of HIV status of themselves and their partners, whether selling sex was the primary means by which women support themselves, number of recent clients and food insecurity.

As part of a broader process evaluation, we collected qualitative data at three time points during the trial

from implementing partner staff and participants with varying levels of engagement in different DREAMS interventions. We conducted semi-structured interviews with 14 implementing partner staff and 23 participants that explored perceptions and experiences of delivering or receiving DREAMS activities. We interviewed a further 17 participants 2–3 times to identify barriers and facilitators to engaging with the programme over time.

Statistical analysis

In line with DREAMS targets, the study was powered to detect a 40% or greater reduction in HIV incidence after 24 months, assuming that HIV incidence in the comparison group would be 5.0%–8.0% per annum, as suggested by previous studies in Zimbabwe.⁵ Our analysis followed a prespecified analysis plan (online supplemental appendix 1).

We compared sociodemographic characteristics of enrolled YWSS by site and study group, including HIV status. We presented a flow diagram to illustrate enrolment and retention in the study at 24-month follow-up, and examined patterns of retention by age, marital status, highest level of education attained and whether women self-identified as FSW, all measured at enrolment. Using data at 24-month follow-up, we described self-reported uptake of DREAMS-related services in all sites and used logistic regression adjusted for age and site to compare uptake between groups.

Reflecting the non-randomised study design, we identified potential confounding factors to adjust for to obtain the fairest comparisons between the two study groups at endline. Critically, HIV prevalence at enrolment differed between the two study groups. Using factors considered a priori as associated with HIV prevalence at enrolment or likely to be associated with HIV incidence,²⁵ including age, educational attainment, marital status, self-identification

as a FSW, STI symptoms and number of sexual partners in the past month, we used logistic regression to model predictors of HIV prevalence at enrolment. We found that these factors, which differed between the two study groups, were associated with HIV prevalence. Adjusting for these factors reduced the difference in HIV prevalence at enrolment across both study groups. We therefore decided a priori to adjust for these individual-level factors in our primary analysis and to add a linear term for community-level HIV prevalence.

Primary analysis was based on the intention-to-treat principle, comparing cohorts recruited in the two DREAMS cities and four non-DREAMS towns regardless of participants' individual-level engagement with services. We calculated HIV incidence and the prevalence of secondary outcome measures for each study site. We pooled the data across study sites and used Poisson regression with follow-up time estimated as the time between interview dates, or half of this for women who seroconverted. We first conducted an age-adjusted analysis comparing HIV incidence between the DREAMS cities and non-DREAMS towns, and subsequently conducted a fully adjusted analysis including the confounders listed above.

For secondary outcomes, we used logistic regression adjusted for confounders listed above and for each respective secondary outcome measured at enrolment. In these analyses, where <5 women reported the outcome in a site, we used Fisher's exact test.

Our primary analysis excluded data collected from women followed up at 12 months post-enrolment in the DREAMS cities. In sensitivity analysis, we included this data. If a woman seroconverted by the 12-month follow-up survey, we placed the seroconversion date at the mid-point between enrolment and 12 months. If a woman seroconverted between the 12-month and 24-month follow-up surveys, we placed the seroconversion date at the mid-point between these surveys.

In a second sensitivity analysis, we applied the principles of the RDS-II method, dropping seed participants from the analysis and weighting responses for each woman by the inverse of her self-reported network size at baseline (ie, the number of other YWSS she could have recruited to the study).⁹ In our protocol paper, we described that a full statistical analysis plan would be developed before unblinding the data, but also suggested that our analysis would apply RDS weighting.⁵ During the development of the plan, but before looking at the data, we decided against the use of weighting in the primary analysis for the following reasons: the aim of our approach was to recruit balanced cohorts of YWSS in DREAMS and non-DREAMS sites and pool these for analysis, not to generate statistics representative of the cities or towns; the primary analysis was to be conducted only among the subset of women who were HIV-negative at enrolment and followed up successfully and therefore weighting may not be appropriate; and an unweighted analysis is simpler and more transparent, and is recommended in Poisson regression analyses of RDS data.¹⁰

Thirdly, assuming a uniform distribution and using 50 imputations, we randomly imputed the seroconversion date as a fraction of the interval between enrolment and 24-month survey dates, among women who seroconverted by the 24-month follow-up survey.^{11 12}

Patient and public involvement

FSW work closely with the research team at the Centre for Sexual Health and HIV/AIDS Research, Zimbabwe, however, were not directly involved in the development of the research questions and design of the study. FSW helped design and implement social mapping to identify YWSS hotspots to guide survey processes and to support RDS. YWSS were integrally involved in running all aspects of the DREAMS implementation for YWSS.

Role of funding source

The Bill & Melinda Gates Foundation staff reviewed and provided non-binding comments on the protocol and study analysis plan, but had no role in data collection, data analysis, data interpretation or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

RESULTS

Study participants

Between April and July 2017, we enrolled 2431 women (1204 in DREAMS cities and 1227 in non-DREAMS towns). Nineteen women had missing HIV test data. Among the remaining women, 76% (n=1859) tested HIV negative at enrolment (963, 80.0%, in DREAMS cities and 896, 73.0%, in non-DREAMS towns; [figure 2](#)). HIV prevalence was higher in the four non-DREAMS towns compared with the two DREAMS cities (26.3%, n=320 vs 19.5%, n=234; [table 1](#) & online supplemental appendix 2 table 1).

Among women testing HIV negative at enrolment, women recruited in the DREAMS cities reported higher levels of educational attainment, were less likely to be separated/divorced and a higher proportion reported selling sex for ≥ 3 years compared with women in the non-DREAMS towns ([table 1](#)). Women in non-DREAMS towns reported lower levels of condom-less sex with clients and condom use with regular partners at last sex (online supplemental appendix 2 tables 1 and 2).

Participant retention and follow-up

At 24-month follow-up, 1019 (54.8%) women testing HIV negative at enrolment were retained in the study (55.9%, n=538 in DREAMS cities; 53.7%, n=481 in non-DREAMS towns; [figure 2](#)). The mean follow-up time across all sites was 1.86 person-years (range in DREAMS cities: 1.76–1.90 person-years; non-DREAMS towns range: 1.83–1.97 person-years).

Enrolment characteristics and behaviours across the two groups were similar among women retained at 24-month follow-up (online supplemental appendix 2

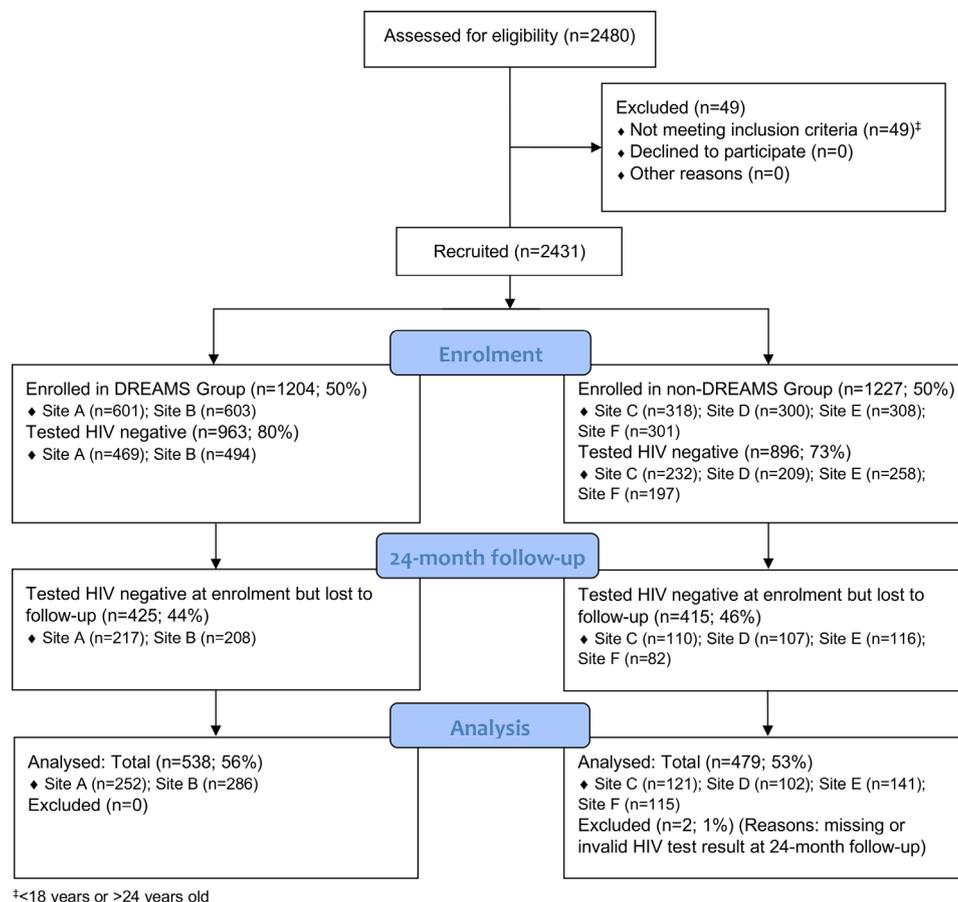


Figure 2 Consolidated Standards of Reporting Trials flow diagram of young women who sell sex recruited to the study and followed up at 24 months post-enrolment. DREAMS, Determined, Resilient, Empowered, AIDS-free, Mentored and Safe.

table 3). Retained women were similar to women lost to follow-up in terms of marital status, educational attainment and whether they self-identified as FSW or not at enrolment (online supplemental appendix 3 table 4). In non-DREAMS towns, a lower proportion of YWSS aged 18–19 were retained (49.7%, n=185) compared with DREAMS cities (57.6%, n=208; p=0.046).

Uptake of services available through the DREAMS partnership

Uptake of and access to clinical services were higher in DREAMS cities than non-DREAMS towns (table 2). In DREAMS cities, women were more likely to report accessing clinics targeting FSW (58.9%, n=317/538 vs 28.3%, n=136/480), seeing condom promotion activities (67.4%, n=361/536 vs 53.0%, n=254/479) and attending community mobilisation activities (13.6%, n=73/537 vs 5.6%, n=27/480).

Participation in savings and loans groups and cash transfers was low, with little difference between women in DREAMS cities and non-DREAMS towns (table 2). In qualitative data, we found that this partly reflected delays in establishing the YWSS component of the programme. In the early stages, service providers struggled to understand the specific needs of YWSS and felt uncomfortable integrating them with other youth. Many social programmes were fully enrolled prior to YWSS seeking to join, as implementing partners reached targets quickly

from the broader population of young women. Over time, additional places were made available and prioritised for YWSS, although those delivering the services did not always have experience of working with this vulnerable group:

I think that was one of the issues that really made it difficult for us in terms of layering services because you see that there was much demand within our cohort of clients that would have wanted that service, but then that service was not available. ... and issues to do with adolescents and young women selling sex are on the sensitive side. If you don't have the skills, you will not be able to identify a large group of them [to recruit into the programme]. (Implementing Partner, Site A)

When YWSS did engage in opportunities, they sometimes felt stigmatised. We received reports of returning school pupils being publicly identified as 'sex workers,' denied access to the library, or made to sit outside classrooms and observe teaching through open windows:

Some [other children] will be saying, 'why have you come to school? Why did you leave your work of selling sex?' to make a scene in front of other people. ... at times I felt so ashamed and I would feel it's better not to go there. (18 years, Site B)

Other barriers stemmed from YWSS' entrenched poverty, which meant they could not easily devote time to

Table 1 Key demographic and behavioural characteristics at enrolment of young women who sell sex testing HIV negative by group, 2017

	DREAMS cities (N=963)	Non-DREAMS towns (N=896)	Comparison p value
	n/N (%)	n/N (%)	
Age at recruitment			0.076
18–19	361/963 (37.5)	372/896 (41.5)	
20–24	602/963 (62.5)	524/896 (58.5)	
Highest level of education			<0.001
None/incomplete primary	28/963 (2.9)	77/896 (8.6)	
Complete primary	61/963 (6.3)	92/896 (10.3)	
Incomplete secondary	817/963 (84.8)	707/896 (78.9)	
Complete secondary or higher	57/963 (5.9)	20/896 (2.2)	
Marital status			<0.001
Single/never married	668/963 (69.4)	497/896 (55.5)	
Married/living together as if married	21/963 (2.2)	16/896 (1.8)	
Divorced/separated	270/963 (28.0)	379/896 (42.3)	
Widowed	4/963 (0.4)	4/896 (0.4)	
Years selling sex			0.001
0–2	508/962 (52.8)	538/893 (60.2)	
3+	454/962 (47.2)	355/893 (39.8)	
Self-identification as sex worker			0.847
No	319/952 (33.5)	302/890 (33.9)	
Yes	633/952 (66.5)	588/890 (66.1)	
Condom use at last with regular partner			0.002
No	252/739 (34.1)	294/696 (42.2)	
Yes	487/739 (65.9)	402/696 (57.8)	
Condom-less sex with regular partner in the past month			0.478
No	415/740 (56.1)	379/699 (54.2)	
Yes	325/740 (43.9)	320/699 (45.8)	
Condom use at last with client			0.477
No	86/743 (11.6)	65/627 (10.4)	
Yes	657/743 (88.4)	562/627 (89.6)	
Condom-less sex with client in the past month			0.001
No	611/745 (82.0)	555/628 (88.4)	
Yes	134/745 (18.0)	73/628 (11.6)	
STI symptoms in the last 12 months			0.067
No	775/963 (80.5)	690/896 (77.0)	
Yes	188/963 (19.5)	206/896 (23.0)	
Risk of common mental disorder			<0.001
No	595/963 (61.8)	624/896 (69.6)	
Yes	368/963 (38.2)	272/896 (30.4)	

DREAMS, Determined, Resilient, Empowered, AIDS-free, Mentored and Safe; STI, sexually transmitted infection.

their studies, needing to earn money or look after family members. There were also additional costs such as bus fares and purchasing supplies for vocational training that YWSS could not afford. Other barriers to uptake included

competing demands on YWSS' time, that is, caring for siblings, and their inability to pay for costs associated with participation, such as transport to classes or uniforms and equipment required for vocational training. These

Table 2 Uptake of services available through the DREAMS partnership, by study group

	DREAMS cities (N=538)	Non-DREAMS towns (N=481)	DREAMS vs non-DREAMS	
	n/N (%)	n/N (%)	OR (95% CI)	P value
Direct HIV prevention and clinical services				
Recently HIV tested (within 6 months prior to the survey)				
No	181/537 (33.7)	152/478 (31.8)		
Yes	356/537 (66.3)	326/478 (68.2)	1.32 (0.83 to 2.10)	0.237*
Ever been offered PrEP				
No	285/538 (53.0)	476/481 (99.0)		
Yes	253/538 (47.0)	5/481 (0.9)	–	<0.001†
Current use of contraceptive methods (including condom)				
No	61/495 (12.3)	101/432 (23.4)		
Yes	434/495 (87.7)	331/432 (76.6)	1.37 (0.71 to 2.63)	0.343*
Attendance to Sisters with a Voice clinic in past 12 months				
No	221/538 (41.1)	344/480 (71.7)		
Yes	317/538 (58.9)	136/480 (28.3)	12.51 (6.90 to 22.69)	<0.001*
Saw condom promotion activities in the past 12 months				
No	175/536 (32.6)	225/479 (47.0)		
Yes	361/536 (67.4)	254/479 (53.0)	1.91 (1.22 to 3.00)	0.005*
Attendance to Sisters with a Voice community mobilisation meeting in past 12 months				
No	464/537 (86.4)	453/480 (94.4)		
Yes	73/537 (13.6)	27/480 (5.6)	22.76 (3.09 to 167.71)	0.002*
Social and economic protection services				
Receipt of cash transfer or educational subsidy in past 12 months				
No	516/538 (95.9)	480/480 (100.0)		
Yes	22/538 (4.1)	0/480 (0.0)	–	<0.001†
Participation in continuing education programme in past 12 months				
No	528/538 (98.1)	480/480 (100.0)		
Yes	10/538 (1.9)	0/480 (0.0)	–	0.002†
Participation in job preparation training in past 12 months				
No	529/538 (98.3)	480/480 (100.0)		
Yes	9/538 (1.7)	0/480 (0.0)	–	0.004†
Participation in apprenticeship in past 12 months‡				
No	538/538 (100.0)	480/480 (100.0)		
Yes	0/538 (0.0)	0/480 (0.0)	–	–
Participation in internal savings and loan group in past 12 months				
No	514/537 (95.7)	479/479 (100.0)		
Yes	23/537 (4.3)	0/479 (0.0)	–	<0.001†
Gender-based violence care and support services				
Accessed healthcare services after experiencing GBV in past 12 months§				
No	49/63 (77.8)	40/48 (83.3)		
Yes	14/63 (22.2)	8/48 (16.7)	1.38 (0.15 to 10.05)	0.832*
Provided with shelter in past 12 months (among women experiencing GBV)				
No	188/189 (99.5)	181/183 (98.9)		
Yes	1/189 (0.5)	2/183 (1.1)	–	0.549†

*Age and site adjusted Wald test p value.

†Fisher's exact p value—OR and 95% CI could not be estimated using logistic regression due to sparse data.

‡Fisher's exact p value or OR and 95% CI could not be estimated due to sparse data.

§Among YWSS who experienced sexual violence.

DREAMS, Determined, Resilient, Empowered, AIDS-free, Mentored and Safe; GBV, gender-based violence; PrEP, pre-exposure prophylaxis.

Table 3 HIV incidence among young women who sell sex testing HIV negative at enrolment, by arm (A) and site (B) (N=1017)

	Number of seroconversions/ person-years of follow-up	Rate per 100 person-years (95% CI)	Age-adjusted rate ratio (95% CI) p value	Fully adjusted rate ratio (95% CI)* p value
(A) Comparison of HIV incidence among YWSS testing HIV negative at enrolment, by arm				
Non-DREAMS (N=479)	48/907.62	5.29 (3.99 to 7.02)	1.0	1.0
DREAMS (N=538)	31/988.14	3.14 (2.21 to 4.46)	0.59 (0.38 to 0.93) p=0.022	0.68 (0.40 to 1.19) p=0.176
(B) Comparison of HIV incidence among YWSS testing HIV negative at enrolment, by site				
DREAMS Site A (n=252)	16/444.74	3.60 (2.20 to 5.87)	1.0	
DREAMS Site B (n=286)	15/543.40	2.76 (1.66 to 4.58)	0.75 (0.37 to 1.52) p=0.420	0.68 (0.33 to 1.43) p=0.313
Non-DREAMS Site C (n=121)	16/226.24	7.07 (4.33 to 11.54)	1.93 (0.96 to 3.88) p=0.063	1.56 (0.74 to 3.29) p=0.243
Non-DREAMS Site D (n=102)	11/192.90	5.70 (3.16 to 10.30)	1.57 (0.73 to 3.38) p=0.252	1.33 (0.58 to 3.03) p=0.503
Non-DREAMS Site E (n=141)	12/278.41	4.31 (2.45 to 7.59)	1.21 (0.57 to 2.56) p=0.617	1.04 (0.46 to 2.38) p=0.923
Non-DREAMS Site F (n=115)	9/210.07	4.28 (2.23 to 8.23)	1.16 (0.51 to 2.63) p=0.723	1.00 (0.43 to 2.34) p=0.996

*Adjusted for age, highest level of education attained, marital status, self-identification as female sex workers, STI symptoms, number of sexual partners in the past month, HIV prevalence (measured at enrolment). DREAMS, Determined, Resilient, Empowered, AIDS-free, Mentored and Safe; STI, sexually transmitted infection; YWSS, young women who sell sex.

challenges meant that YWSS had limited ability to access 'layered' services as intended.

HIV incidence rate by study group and site

Overall, 79 YWSS HIV seroconverted after 24 months. HIV incidence was 3.60/100 person-years in DREAMS Site A and 2.76/100 person-years in DREAMS Site B. In non-DREAMS towns, the rate of new infections ranged from 4.28/100 person-years to 7.07/100 person-years (table 3).

HIV incidence among YWSS in DREAMS cities was 3.1/100 person-years compared with 5.3/100 person-years among YWSS in non-DREAMS towns (RR=0.59; 95% CI 0.38 to 0.93). In our primary analysis, adjusting for confounding variables, HIV incidence was lower in DREAMS cities than in non-DREAMS towns, but with weak statistical evidence of a difference (adjusted rate ratio (RR)=0.68; 95% CI 0.40 to 1.19; p=0.18) (table 3).

In a sensitivity analysis, including data from women in DREAMS cities followed up at 12 months, we found a very similar result (adjusted RR=0.79, 95% CI 0.47 to 1.32; p=0.36; online supplemental appendix 6 table 8). When we applied the principles of RDS-II methodology, the intervention effect was larger, the point estimate exceeded the 40% incidence reduction hypothesised by DREAMS, and the result was of borderline statistical significance (adjusted RR=0.55, 95% CI 0.28 to 1.08; p=0.08; online supplemental appendix 6 table 9). Randomly imputing the seroconversion date gave results

identical to using the mid-point as seroconversion date (online supplemental appendix 6 table 10).

Secondary outcomes by study group and site

Compared with women in the non-DREAMS towns, YWSS in the DREAMS cities were more likely to report ever having used PrEP (28.1%, n=151/538 vs 0.6%, n=2/481; table 4). In DREAMS cities, 11.5% (62/538) of YWSS reported current use of PrEP at 24 months, with no YWSS in non-DREAMS towns reporting current PrEP use. Despite higher self-reported use of PrEP in DREAMS cities, we found that within those cities there were a similar percentage of HIV infections between YWSS who did and did not report having ever used PrEP (4.6%, n=7/151 vs 6.2%, n=24/387) and current use of PrEP was low. Additionally, PrEP use among YWSS who reported condom-less sex with a client or regular partner in the past month was very low (11.4%, n=31/273).

More women in the DREAMS cities reported the ability to negotiate condom use (92.6%; n=498/538 vs 81.0%, n=389/480; adjusted OR=3.39 95% CI 2.24 to 5.14; table 4). Women in DREAMS cities were less likely to report condom-less sex with clients (11.2%, n=60/535 vs 17.2%, n=82/478; adjusted OR=0.58 95% CI 0.38 to 0.89) and having had more than three clients in the past month (47.3%, n=254/537 vs 56.6%, n=265/468; adjusted OR=0.66 95% CI 0.50 to 0.87). Fewer women in DREAMS cities reported experiencing violence from partners in the past 12 months (19.3%, n=104/538 vs 28.3%,

Table 4 Comparison of DREAMS secondary outcomes between the two DREAMS cities and the four non-DREAMS comparison towns, 2019

	DREAMS cities	Non-DREAMS towns	DREAMS vs non-DREAMS			
	(N=538)	(N=481)	Age-adjusted		Fully adjusted*	
	n/N (%)	n/N (%)	OR (95% CI)	P value	OR (95% CI)	P value
Improved access to clinical services and HIV prevention services						
Knowledge of HIV status						
No	119/538 (22.1)	118/481 (24.5)				
Yes	419/538 (77.9)	363/481 (75.5)	1.15 (0.86 to 1.54)	0.358	1.22 (0.90 to 1.66)	0.197
Ever taken PrEP						
No	378/538 (71.9)	478/481 (99.4)				
Yes	151/538 (28.1)	3/481 (0.6)	62.22 (19.69 to 196.62)	<0.001	63.82 (19.78 to 205.90)	<0.001
Ability to negotiate condom use with any partner						
No	40/538 (7.4)	91/480 (19.0)				
Yes	498/538 (92.6)	389/480 (81.0)	2.92 (1.97 to 4.34)	<0.001	3.39 (2.24 to 5.14)	<0.001
Knowledge of the HIV status of at least one of their three most recent partners						
No	179/528 (33.9)	210/474 (44.3)				
Yes	349/528 (66.1)	264/474 (55.7)	1.55 (1.20 to 2.00)	0.001	1.38 (1.06 to 1.81)	0.018
Condom-less sex with regular partner in the past month						
No	275/536 (51.3)	199/478 (41.6)				
Yes	261/536 (48.7)	294/478 (58.4)	0.68 (0.53 to 0.87)	0.002	0.72 (0.53 to 0.98)	0.034
Condom-less sex with client in the past month						
No	475/535 (88.8)	396/478 (82.8)				
Yes	60/535 (11.2)	82/478 (17.2)	0.61 (0.43 to 0.87)	0.007	0.58 (0.38 to 0.89)	0.013
Accessed STI treatment services in the past 12 months†						
No	7/74 (9.5)	18/93 (19.4)				
Yes	67/74 (90.5)	75/93 (80.6)	2.36 (0.92 to 6.03)	0.073	–	–
Improved coverage of social and economic protection service						
Food insecurity						
No	367/538 (68.2)	295/479 (61.6)				
Yes	171/538 (31.8)	184/479 (38.4)	0.75 (0.58 to 0.97)	0.027	0.81 (0.61 to 1.07)	0.130
Selling sex is the main way to support myself						
No	196/538 (36.4)	159/479 (33.2)				
Yes	342/538 (63.6)	320/479 (66.8)	0.87 (0.67 to 1.13)	0.284	0.93 (0.71 to 1.22)	0.585
Ever been unable to decline sex in the past month						
Never/not in the past month	257/534 (48.1)	236/474 (49.8)				
At least once in the past month	277/534 (51.9)	238/474 (50.2)	1.07 (0.83 to 1.37)	0.595	1.05 (0.81 to 1.36)	0.689
Number of sex work clients in the past month						
≤3	283/537 (52.7)	203/468 (43.4)				
>3	254/537 (47.3)	265/468 (56.6)	0.68 (0.53 to 0.88)	0.003	0.66 (0.50 to 0.87)	0.003
Gender-based violence prevention, and care and support services						
Experience of violence from partners in the past 12 months						
No	434/538 (80.7)	345/481 (71.7)				
Yes	104/538 (19.3)	136/481 (28.3)	0.61 (0.45 to 0.81)	0.001	0.64 (0.47 to 0.87)	0.005
Experience of violence from police in the past 12 months						
No	531/538 (98.7)	473/479 (98.7)				
Yes	7/538 (1.3)	6/479 (1.3)	1.04 (0.35 to 3.11)	0.070	1.01 (0.32 to 3.16)	0.982

Bold values highlight significant results.

*Adjusted for age, highest level of education attained, marital status, self-identification as female sex workers (measured at baseline), and for each respective secondary outcome measured at enrolment.

†Adjusted OR and 95% CI could not be estimated using logistic regression due to sparse data.

DREAMS, Determined, Resilient, Empowered, AIDS-free, Mentored and Safe; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infection.

n=136/481; adjusted OR=0.64 95% CI 0.47 to 0.87). We found little evidence for differences in other secondary outcomes, including whether the YWSS' primary means of support was sex work, and their ability to decline sex.

Secondary outcomes varied across sites and, for some outcomes, were not always in the direction expected (online supplemental appendix 4 table 5). For example, condom-less sex with client in the past month in two non-DREAMS towns (8.0%, n=8/100 and 10.7%, n=13/122) was lower or similar to levels reported by women in DREAMS cities. Similarly, the ability to negotiate condom use in these two non-DREAMS towns (92.6% n=113/122 and 85.3% n=87/102) was higher than or similar to levels reported in each DREAMS city.

DISCUSSION

After 24 months of follow-up, we found that HIV incidence was lower among YWSS recruited in two Zimbabwean cities implementing the DREAMS programme than in four towns where DREAMS was not implemented. After adjustment for baseline imbalance in HIV prevalence and predictors of HIV incidence, this potential effect of DREAMS on HIV incidence was not statistically significant. We identified some changes in outcomes on important 'pathways to impact': YWSS recruited in DREAMS cities reported fewer clients in the past month, less condom-less sex in the last month and higher levels of PrEP use at 24-month follow-up; yet we found little difference in women's engagement with social protection services. Despite our null finding, it remains plausible that DREAMS investments may have contributed to reduced HIV incidence among YWSS through increased access to clinical HIV prevention services, including PrEP and condoms.

Our study had limitations, most of which we were aware of from the start.⁵ We considered this study a plausibility evaluation since it was only powered to detect a large difference in HIV incidence and because of the lack of randomisation. A 40% reduction in HIV incidence over 24 months was an ambitious target and full implementation was not achieved until early 2019. Our sample size calculation estimated 70% retention of recruited women, but in practice this was lower, likely affecting the study's power to detect any difference in HIV incidence as well as potentially introducing bias.⁵ Mobility is high among FSW in Zimbabwe, including YWSS, and during efforts to maintain contact with enrolled women we often heard that they had left the area to seek employment opportunities.

We used data collected by the national FSW programme to identify comparison sites similar to the DREAMS cities based on, among other factors, attendance to the programme and the proportion of attendees aged 18–24.⁵ With the DREAMS cities among the largest and most populous in Zimbabwe, identifying comparison sites was challenging, as evidenced by the higher HIV prevalence in these towns at enrolment. Also, service delivery was

less intense and delivered through mobile clinics in all but one non-DREAMS towns, compared with DREAMS cities. The confounding factors, for which we adjusted for in our primary analysis, reduced but did not eliminate differences in HIV prevalence at enrolment. There may, therefore, be other factors that we did not account for that could explain the variation in HIV incidence. Furthermore, although incidence was lower in the two DREAMS cities than in all four non-DREAMS towns, it varied across the few sites included in our study, limiting our ability to draw firm conclusions about any effect of DREAMS on HIV incidence.

Finally, our secondary outcomes were self-reported via face-to-face-interviews and thus potentially prone to social desirability bias and the potential for an 'intervention' effect of more frequent contact and follow-ups among the YWSS in DREAMS cities over time.

Intriguingly, in a sensitivity analysis where we dropped seed participants and applied RDS-II weighting, we found a borderline significant impact of the programme aligned with the 40% reduction hypothesised. We decided a priori not to use this weighting in the primary analysis, and consider interpretation of these findings complex, but report them for transparency. At enrolment, RDS diagnostics suggested that women recruited were representative of the network of YWSS in the majority of sites, but convergence was not realised in one of the smaller non-DREAMS towns suggesting that YWSS may not have been representative of the broader network of YWSS in this site.² Furthermore, documenting refusal rates is difficult in RDS design.¹³

Despite these limitations, our study provides invaluable and important evidence in relation to HIV prevention efforts for a critical population. Despite their vulnerability, YWSS are often underrepresented in research.^{2 14} We show that, although challenging, cohort studies with YWSS are feasible. Retention was affected by women's mobility and likely affected by some women transitioning out of sex work, and therefore no longer interested in participation. Nonetheless, we retained over half the ~2400 women across six sites over the course of the study. Although retention was low compared with a cohort study of young FSW in Burkina Faso, which retained 86% of 321 women recruited over a median of 16.8 months of follow-up,¹⁵ and a study in Tanzania, which retained 78% of 293 HIV-negative FSW through monthly contacts over 18 months,¹⁶ there was little evidence of differential follow-up between arms in our study. To retain women, future cohort studies with YWSS should similarly employ a combination of complementary strategies, including use of mobile phone messaging and outreach.

Our findings of a plausible effect of DREAMS, adds an important new finding to a small overall evidence base. In Burkina Faso, a cohort study combined with modelling found a significant effect of integrated prevention and care services combined with peer-led education sessions on HIV incidence among young FSW.¹⁵ In Benin, a time-series analysis of community-based activities to promote

condom use and empower FSW, combined with clinical services and strategies to reduce violence, found a significant impact on HIV prevalence.¹⁷ In Tanzania, Project Shikamana found that community-led peer education, peer navigation, sensitivity training for HIV care providers and a community-led drop-in centre for activities to promote social cohesion significantly reduced HIV incidence among FSW.¹⁶ Similar to our study, Project Shikamana included a small number of sites (N=2), limiting their ability to draw inferences of impact at scale.¹⁶ Unlike most of these studies, our target population included all YWSS in the DREAMS cities, including those who did not identify as FSW, and the intervention included components delivered outside of health facility settings by numerous implementing partners.

Although HIV incidence was lower among YWSS in DREAMS cities, HIV incidence was high in all sites. Our study reiterates that more needs to be done to strengthen implementation of evidence-based HIV prevention interventions for YWSS. YWSS, both those who do and do not self-identify as FSW, are often missed by research and programmes.^{2 14 18} Engaging younger peer outreach workers and specifically targeting younger FSW can increase engagement,¹⁸ but uptake of programmes tailored to meet the needs of YWSS is often minimal.¹⁹ Failure to strengthen prevention programming for YWSS, including young FSW, has implications for the health outcomes of women themselves and for broader HIV prevention efforts.

PrEP formed a component of the DREAMS core package. Current use of PrEP among women participating in our study was low at 24 months, consistent with findings reported by PrEP efficacy and implementation studies with AGYW, including FSW, in sub-Saharan Africa,^{20 21} and a number of women in DREAMS cities who initiated PrEP seroconverted. PrEP is an important prevention option for AGYW, providing an opportunity for greater autonomy and control over sexual health.²² Recent PrEP studies and our findings underscore the need for approaches to support PrEP initiation and adherence to PrEP during periods of use,²³ particularly among the many women in our study who reported condom-less sex. Stigma, norms and sexual partners have been shown to influence PrEP use and adherence.^{24 25} Recognising that PrEP and condom use are influenced by women's broader social environment, HIV prevention programmes need to be holistic in their approach, understanding the reasons underlying poor adherence and providing social support and evidence-based adherence support during periods of PrEP use. Lessons learnt from effective antiretroviral therapy (ART) adherence strategies could inform PrEP adherence support. Wrap-around peer-supported community-based treatment improved viral suppression among adolescents aged 13–19 in Zimbabwe,²⁶ and long-term virological suppression was achieved among adults attending treatment adherence clubs in South Africa.²⁷ With evidence that long-acting PrEP is effective at reducing HIV risk among

men who have sex with men and transgender women, ongoing development of alternative formulations of long-acting PrEP holds promise for addressing barriers to oral PrEP for AGYW.²⁸ In addition to support for PrEP use, continued condom supply and strengthened distribution alongside strategies to promote condom use, where feasible and when PrEP adherence is low, need continued support and scale-up.²⁹

To reduce HIV incidence by 40% over 24 months, DREAMS endeavoured to provide AGYW with a combination of evidence-based HIV prevention interventions to address the multiple factors influencing HIV risk.^{30–32} Termed 'layering', the intention was to provide AGYW multiple interventions from the DREAMS core package simultaneously.³⁰ Studies show that 'layering' was achieved in other DREAMS-supported countries,³¹ yet we found that evidence of successful 'layering' of social services alongside comprehensive clinical services for FSW among this particular group of women in Zimbabwe was complex. At follow-up, coverage of clinical services and condoms was generally higher in the DREAMS cities than the four towns. However, coverage of social protection services was low among all women participating in the study. In DREAMS cities, low coverage was driven in part by implementation challenges, including the limited experience of other implementing partners in working with YWSS, and by barriers faced by YWSS in accessing these services. Lessons learnt through the early implementation and delivery of DREAMS to YWSS have been used to streamline service delivery for this group of women. There remains, therefore, scope to evaluate the influence of an adapted form of DREAMS, aimed at being more responsive to the needs of YWSS, on HIV risk among YWSS and learn how best to deliver wrap-around social protection services to YWSS.

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Supplement to: The impact of the DREAMS partnership on HIV incidence among young women who sell sex in two Zimbabwean cities: results of a non-randomised study

APPENDICES

1. Analysis plan
2. Additional descriptive statistics
3. Patterns of retention at 24-month follow-up
4. Comparison of dreams secondary outcomes by site
5. RDS diagnostics and results
6. Sensitivity analysis

APPENDIX 1: ANALYSIS PLAN

A non-randomised evaluation of the impact of the combined DREAMS package of HIV prevention interventions on HIV incidence among young women who sell sex in Zimbabwe

Statistical Analysis Plan

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Contents

1. INTRODUCTION	2
2. AIM	2
3. STUDY DESIGN	2
4. SAMPLING	2
5. PRIMARY AND SECONDARY OUTCOMES	3
6. STATISTICAL ANALYSIS: OVERALL APPROACH	6
7. STAGES OF ANALYSIS	9
i. COHORT RECRUITMENT AND RETENTION	9
ii. PARTICIPANT CHARACTERISTICS AT ENROLMENT	10
iii. UPTAKE OF SERVICES	10
iv. PARTICIPANT CHARACTERISTICS AT 24-MONTH FOLLOW UP	10
v. HIV INCIDENCE RATE BY DISTRICT AND STUDY ARM	10
vi. UNADJUSTED ANALYSIS	10
vii. ADJUSTED ANALYSIS	10
viii. PRE-PLANNED SUB-GROUP ANALYSES	10
ix. SENSITIVITY ANALYSIS	11
8. STRENGTHS AND LIMITATIONS	11

INTRODUCTION

Worldwide, especially in sub-Saharan Africa, young women are at high risk of HIV due to increased biological, economic and social vulnerability. In Zimbabwe, where the HIV burden is one of the highest in the world and HIV prevalence was 13.3% among adults aged 15-49 years in 2017,¹ adolescent girls and young women (AGYW) aged 15-24 years are at particularly high risk of HIV.

Recognising the vulnerability of AGYW and the social, economic and biological factors that shape women's risk, the DREAMS Partnership was developed to deliver a combined package of interventions targeted at AGYW, their partners, families and communities, to address the interacting factors that shape HIV risk among this particularly vulnerable population. One particular target population for the DREAMS Partnership was young women who sell sex (YWSS). In Zimbabwe, among this group, DREAMS included an offer of oral pre-exposure prophylaxis (PrEP), and condom promotion and provision.

We conducted an impact evaluation of DREAMS among YWSS in Zimbabwe.

AIM

The aim of this study was to estimate the impact of the DREAMS combined package of HIV prevention interventions on HIV incidence among YWSS aged 18-24 years. We also sought to evaluate the impact of DREAMS on a number of secondary outcomes.

STUDY DESIGN

This study was a non-randomised plausibility design to estimate the effect of DREAMS on HIV incidence and other secondary outcomes, highlighted in **section 5**.

We will compare HIV incidence among a cohort of YWSS recruited in two districts where DREAMS was being implemented and followed up over 2 years, to HIV incidence among a cohort of YWSS recruited in four districts where DREAMS was not being implemented and also followed up over 2 years. A similar approach will be used for comparison of secondary outcomes.

SAMPLING

In the two DREAMS sites, a network-based recruitment strategy (respondent-driven sampling (RDS)) was used to identify YWSS in the study communities, offer them HIV testing services and then inform and refer these YWSS to treatment and prevention services, including PrEP and the DREAMS package of HIV prevention interventions through the national programme for sex workers 'Sisters with a Voice' and then onward to the full range of DREAMS services. This process was also used to recruit these women into the evaluation cohort. More specific details of the recruitment process are provided in the protocol (e.g. seed selection, wave recruitment procedures, remuneration).

In two DREAMS sites, eligible YWSS were asked for written informed consent to be interviewed at enrolment into the study in 2017, and then followed-up at 12 and 24 months after the initial enrolment survey. At each time point, rapid HIV testing and counselling was offered to YWSS to ascertain the HIV status of the study participants. A detailed working definition of YWSS is provided in the protocol, but we note here that we included both young women who did and did not self-identify as sex workers, anticipating that the outcome profile might differ among these two groups of young women.

The same network-based recruitment strategy was used to identify and recruit a cohort of YWSS in the four non-DREAMS districts. YWSS recruited in these four districts were also offered HIV counselling and testing services and were referred to the existing national HIV programme for sex

workers, run by the Centre for Sexual Health and HIV/AIDS Research (CeSHHAR). Through this programme they could access HIV prevention services, including condoms, STI treatment and health education, but did not have access to PrEP or other initiatives offered under the DREAMS Partnership. These YWSS were recruited during the same time frame as women in the two DREAMS districts, and were interviewed at enrolment and followed up at 24-months post-enrolment. Although planned, no follow up was done at 12 months among this group due to budgetary constraints.

The difference, therefore, between DREAMS and non-DREAMS sites was that, in DREAMS sites, YWSS had access to comprehensive SRH and HIV services through the Sisters programme PLUS access to PrEP and other DREAMS services, such as social protection interventions. In the non-DREAMS sites, YWSS had access to comprehensive SRH and HIV services through the 'Sisters' programme but were not referred for PrEP / other DREAMS services.

PRIMARY AND SECONDARY OUTCOMES

The primary outcome is incident HIV infection over the 24-month study period, defined as:

$$\frac{\text{Number of new HIV infections among YWSS who tested HIV-negative at enrolment}}{\text{Total person-years of follow-up accumulated during the 24-month study period.}}$$

Measurement of the primary outcome was restricted to women testing HIV negative at enrolment and followed-up 24-months post-enrolment. HIV status at each round was ascertained through the rapid HIV tests delivered during the counselling and testing process with results returned to participants. No confirmatory testing procedures were conducted for the purpose of the impact evaluation.

Person-years of follow-up was defined as the total follow-up time between the enrolment survey in 2017 and the follow-up survey 24 months after enrolment (2019). For women who seroconverted during the study, the time of seroconversion was set as the mid-point between the enrolment survey and follow-up at 24 months.

The secondary objective of the impact evaluation is to explore whether the DREAMS package of interventions had an impact on the on the secondary outcomes listed in Table 1 and in line with the hypothesised causal pathway through which the DREAMS package of interventions would reduce HIV incidence (Figure 1).

Table 1. Definition of secondary outcomes

Secondary outcome	Definition	Denominator	Numerator
Biological protection			
Knowledge of HIV status	[Composite outcome] Proportion of YWSS who have EITHER (i) ever tested HIV-positive OR (ii) had an HIV test during the past 6 months and report their HIV-negative result	All YWSS participating in the survey at 24-month follow-up	YWSS reporting HIV testing in previous 6 months or self-reporting their HIV positive status
Coverage of PrEP	Proportion of HIV negative YWSS who are currently taking PrEP	YWSS not testing HIV-positive at 24-month follow up	Number of YWSS self-reporting their HIV-negative status who self-report currently taking PrEP
Uptake of PrEP	Proportion of HIV negative women who were offered PrEP who accepted the offer	YWSS self-reporting ever being offered PrEP	Number of YWSS self-reporting that they were ever offered PrEP AND that they accepted the offer of PrEP
Knowledge of partner's status	Proportion of YWSS who report knowing the HIV status of at least one of their three most recent partners	All YWSS participating in the 24-month follow up survey	Number of YWSS who report knowing the HIV status of at least one of their three most recent partners
	Proportion of YWSS who report feeling confident in discussing HIV testing with any partner	All YWSS participating in the 24-month follow up survey	Number of YWSS who agree/strongly agree that they can discuss HIV testing with any partners
Condom-less sex with regular partner	Proportion of YWSS who report condom-less sex with regular partner in the past month	All YWSS participating in the 24-month follow up survey	Number of YWSS reporting any condom less sex with regular partner in the past month
Condom-less sex with client	Proportion of YWSS who report condom-less sex with client in the past month	All YWSS participating in the 24-month follow up survey	Number of YWSS reporting any condom less sex with client in the past month
Increased ability to negotiate condom use with any partner	Proportion of women agreeing that they feel confident in negotiating condom use with any partner	All YWSS participating in the 24-month follow up survey	Number reporting that they agree/strongly agree that they are confident in negotiating condom use with any sexual partner
Number of sex work clients	Number of partners with whom women had sex with in exchange for money/material support (i.e. clients) in the past month	All YWSS participating in the 24-month follow up survey	Categorical variable of <3; 4-9; 9+ clients reported in the past month
Access to STI treatment services	Proportion of YWSS who self-reported having STI symptoms and seeking of treatment services or advice in the last 12 months	YWSS reporting having STI symptoms in the past 12 months among YWSS participating in the follow-up survey	Number of YWSS reporting accessing treatment services or advice after having STI symptoms
Social Protection			
Food insecurity	[Composite outcome] Proportion of YWSS who IN THE PAST 4 WEEKS have EITHER (i) had no food to eat because of lack of resources to get food OR (ii) had a household member who went to bed hungry because there was not enough food OR (iii) had a household member who had a whole day and night without food	All YWSS participating in the 24-month follow up survey	Number of YWSS responding 'Yes' to either of the three questions on inadequate quantity of food

Reliance on sex work for economic reasons	Proportion of YWSS who report that they were unable to decline sex with a man because of support offered in the past month	All YWSS participating in the 24-month follow up survey	Number of YWSS reporting ever unable to decline sex in past month
	Proportion of YWSS who report that selling sex is the main way they support themselves	All YWSS participating in the 24-month follow up survey	Number of YWSS reporting that selling sex is the main way they obtain money/support themselves
Experience of violence			
Experience of violence from partners	Proportion of YWSS reporting having had a partner who hit, slapped, kicked, pushed, shoved or otherwise physically hurt her in the previous 12 months	All YWSS participating in the 24-month follow up survey	Number of YWSS responding that they have been hit, kicked, slapped, shoved by a partner at least once in past 12 months
Experience of violence from police	Proportion of YWSS reporting that a member of the police hit, slapped, kicked, pushed, shoved or otherwise physically hurt her in the previous 12 months	All YWSS participating in the 24-month follow up survey	Number of YWSS responding that they have been hit, kicked, slapped, shoved by a member of police at least once in past 12 months

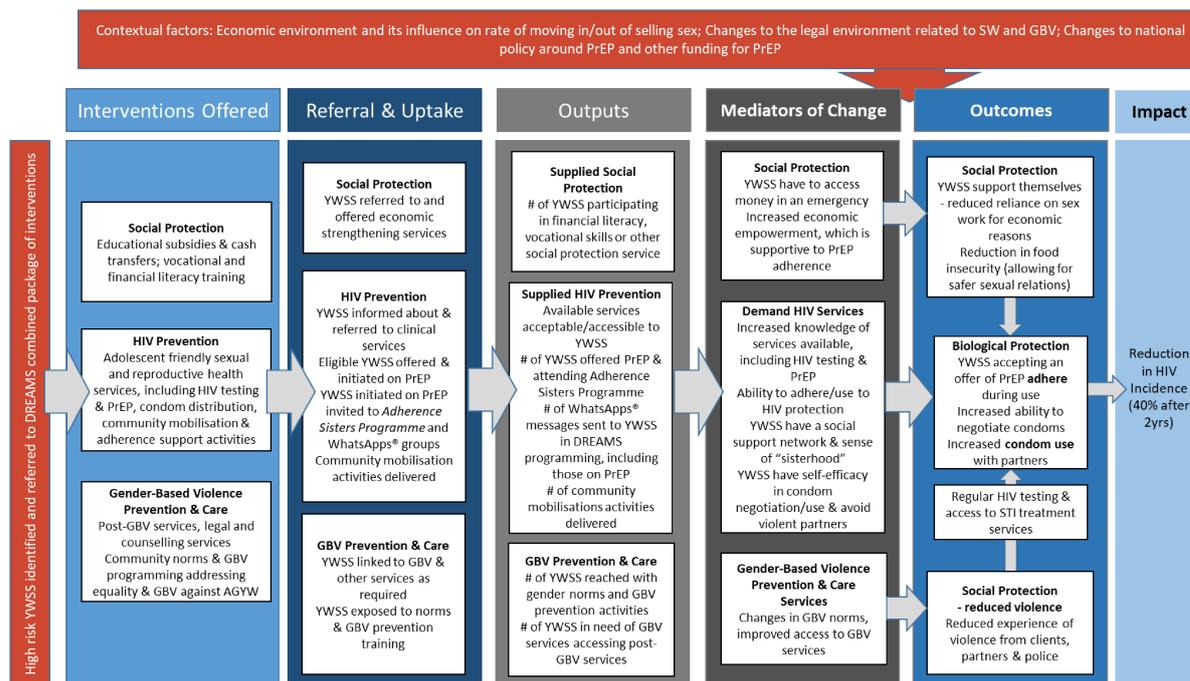


Figure 1. Hypothesised pathway through which the DREAMS combined package of interventions would have an impact on HIV incidence

STATISTICAL ANALYSIS: OVERALL APPROACH

Intention to treat: We will compare the HIV incidence rate between women recruited to the study cohort in the two DREAMS districts to the HIV incidence rate among the women recruited to the study cohort in the four non-DREAMS comparison districts, regardless of individual level of participation in the components of the DREAMS package.

In further analyses, not described here but included as part of the wider impact of evaluation of DREAMS across 4 settings, we plan to explore the relationships between individual level participation in DREAMS interventions and the primary and secondary outcomes in the two districts where DREAMS interventions were delivered.

Individual level analysis: Although the DREAMS package was allocated at district-level, we were not able to include either randomisation or a sufficient number of clusters to undertake a cluster-level randomised trial. Our analysis is therefore based on an individual level analysis comparing the cohorts recruited in the two DREAMS and four non-DREAMS clusters, in which we can evaluate whether outcomes are different across the six clusters but in which the impact of DREAMS cannot be unambiguously distinguished from the "background" differences among the clusters at baseline. Limitations of this "individual-level" analysis approach are described below.

Regression framework: For the primary outcome analysis we will use a Poisson regression framework, appropriate for the rate at which an outcome occurs per unit time. All secondary outcomes are assessed using logistic regression for binary outcomes, measured cross-sectionally after a fixed follow-up period.

Weighting and standard error adjustment for RDS: We recruited participants using RDS. Where RDS is used to make population-level estimates generalizable to the total study population of a particular geography, a variety of statistical procedures and associated assumptions are used to adjust

analyses reflecting this design. In this study the primary aim is to estimate the impact of the DREAMS interventions, by making fair comparisons across the six clusters, and so we will not weight the data to account for recruitment using RDS - on the basis that the approach to sampling was the same/standardised in each cluster. However, we plan a sensitivity analysis in which weighting will be applied; this approach adds an additional layer of complexity, but aims to provide estimates of rates/prevalences for the total study population.

Adjustment for confounding strategy: In the absence of randomisation, and also because the number of study clusters is low, it is appropriate to adjust the analysis for potential confounding variables. If we find evidence for a difference in HIV incidence between the two study arms, caution is needed when considering whether this difference is attributable/partly attributable to DREAMS. We investigated *a priori* what confounding factors to adjust for in order to obtain the fairest comparisons among study clusters. To do this, we used HIV prevalence at baseline as a “proxy” for the background level of HIV incidence.

We found that HIV prevalence was different between the two study arms at baseline. We then identified a set of variables that we *a priori* thought might be associated with HIV prevalence as explored elsewhere,² including age at enrolment, highest level of education attained, marital status, self-identification as a sex worker, STI symptoms and number of sexual partners in the past month. We included each variable in a univariable logistic regression model to confirm that they were associated with HIV prevalence and then modelled HIV prevalence against DREAMS arm adjusting for all six variables. Adjusting for these variables attenuated the difference in HIV prevalence between the two arms substantially (see Table 2).

Table 2. Factors associated with HIV prevalence at enrolment

Characteristic	N (%)	# of YWSS tested HIV positive at enrolment N=543 n (%)	Crude OR (95% CI)	P-value	Adjusted OR [†] (95% CI)	P-value
DREAMS				0.001		0.103
Non-DREAMS sites	1192 (50.2)	312 (25.8)	1		1	
DREAMS sites	1177 (49.8)	231 (19.0)	0.67 (0.53-0.85)		0.81 (0.63-1.04)	
Age at enrolment				<0.001		
18-19	814 (36.4)	93 (11.2)	1			
20-24	1555 (63.6)	450 (28.9)	3.20 (2.41-4.26)			
Highest level of education				<0.001		
Primary or less	388 (17.0)	135 (34.0)	1			
Incomplete secondary	1050 (44.2)	268 (24.8)	0.64 (0.47-0.86)			
Complete secondary or higher	931 (38.8)	140 (14.7)	0.33 (0.24-0.46)			
Marital status				<0.001		
Single/ never married	1385 (60.0)	242 (17.6)	1			
Married/ cohabiting	48 (2.4)	12 (27.2)	1.75 (0.81-3.81)			
Previously married	936 (37.6)	289 (29.9)	2.01 (1.59-2.53)			
Self-identification as a sex worker				<0.001		
No	724 (33.1)	113 (15.3)	1			
Yes	1627 (66.9)	429 (26.2)	1.96 (1.50-2.57)			
STI symptoms				<0.001		

No	1750 (74.0)	308 (16.9)	1
Yes	619 (26.0)	235 (38.2)	3.04 (2.39-3.88)
Number of sexual partners in the past month			<0.001
≤1	213 (10.1)	37 (17.8)	1
2-5	1047 (46.1)	168 (15.7)	0.86 (0.54-1.35)
6-9	301 (12.3)	66 (20.2)	1.17 (0.70-1.97)
≥10	808 (31.5)	272 (34.7)	2.46 (1.57-3.86)

*Adjusted for DREAMS, age at enrolment, highest level of education attained, marital status, self-identification as FSW, STI symptoms, number of sexual partners in the past month

We will therefore adjust our primary analysis for these six variables, measured at baseline among the cohort, so as to make fairer comparisons between the two DREAMS and four non-DREAMS study clusters, and a fairer attribution of any difference we see to DREAMS intervention. The number of sero-conversions over the two-year study period may be small relative to the number of parameters if all six variables are included in a model. We will, therefore, need to consider the “rule-of-thumb” that the number of sero-conversions should be approximately ten-times higher than the number of parameters included in our model. If the number of sero-conversions is smaller than the number of parameters if all six variables are included, we will prioritise adjusting for the variables that were the strongest confounders of the association between prevalent HIV and DREAMS, including age and educational attainment if there is evidence that the model becomes unstable with the addition of more parameters.

We will not be able to formally adjust our analysis for cluster level factors that may differ between the DREAMS and non-DREAMS districts, for example background HIV prevalence, because we have “only” included six clusters in the study. This is a limitation of our study described in further detail below

At baseline, we also analysed how HIV prevalence increased with age among the YWSS recruited in DREAMS and non-DREAMS districts (see Figure 2). We fitted a simple linear regression line to HIV prevalence by age. We noted that, while there was a difference in the HIV prevalence at each age, as described above, the rate of increase of HIV prevalence with age was almost identical at approximately an average of 6% per single year of age increase in both groups. Among young women, HIV prevalence increasing with age can be cautiously interpreted as reflecting the underlying HIV incidence.

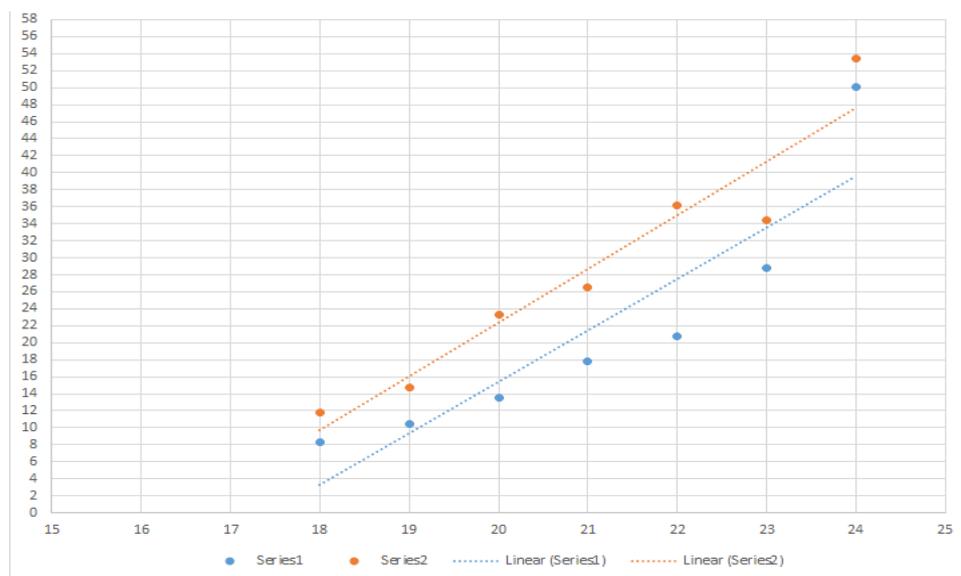


Figure 2: HIV prevalence by age and arm (blue = DREAMS sites and orange = Non-DREAMS sites)

The combination of our data suggesting an

- i) HIV prevalence that differed between the arms at baseline, but that could be largely adjusted away through the addition of six key covariates measured at baseline, and which we will adjust our primary outcome analyses for,

and

- ii) our finding that at baseline HIV prevalence increasing by age was near identical between the groups,

provide strength to the argument we will make post-analysis, that an adjusted difference in measured HIV incidence between the arms can be plausibly interpreted as reflecting the effect of the DREAMS intervention. The further the adjusted rate ratio is from 0.8, the more credible it is that DREAMS had an effect on HIV incidence. Our findings will be interpreted in the context of DREAMS uptake. We will explore uptake of DREAMS interventions across the two study sites (as described in section iv); where there is evidence of differential uptake across the two groups, this would add credibility to any finding that the DREAMS intervention had an effect on HIV incidence.

Reporting: Analyses will be reported in line with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement.

STAGES OF ANALYSIS

i. COHORT RECRUITMENT AND RETENTION

We will first describe recruitment into the cohort study, and present a flow chart showing the number of women recruited through the RDS in each district and by study arm (DREAMS and non-DREAMS), and retention at 24-month follow-up.

We will generate RDS recruitment trees by site, colour coding women by whether they tested HIV negative, HIV positive at enrolment, or tested HIV negative at enrolment and seroconverted at 24-month follow up. We have already done the detailed RDS diagnostics which found no evidence of

bias with respect to HIV prevalence in either DREAMS or non-DREAMS sites and reported them elsewhere.²

Using data collected on efforts to contact the women at the 24-month follow up, we will describe the reported reasons why women were lost to follow, for example they reportedly migrated and/or married, or were contacted but refused to participate.

ii. PARTICIPANT CHARACTERISTICS AT ENROLMENT

We will describe, by site and study arm, key demographic and behavioural characteristics of the women recruited to the cohort, including those that were identified to be associated with HIV prevalence at enrolment. We will repeat this analysis for YWSS who tested HIV negative at enrolment.

iii. UPTAKE OF SERVICES

The services delivered by DREAMS implementing partners may also be available to the women in non-DREAMS sites, particularly HIV testing service but also educational subsidies, and vocational skills training. Using 24-month follow-up data, we will describe the uptake of other services that may be available in and accessible to women in non-DREAMS sites, by arm and by site.

iv. PARTICIPANT CHARACTERISTICS AT 24-MONTH FOLLOW UP

We will describe the proportion of women retained in the study at the 24-month follow-up, and describe follow-up by enrolment characteristics, including: age, marital status, highest level of education attainment and whether women self-identified as a female sex worker.

We will repeat the descriptive analysis presented for enrolment for YWSS testing HIV negative at enrolment and followed up at 24 months.

v. HIV INCIDENCE RATE BY DISTRICT AND STUDY ARM

We will describe the number of new infections observed over the 24-month study period, and describe person-years of follow-up by district and study arm (Table 10). Subsequently, we will estimate the HIV incidence rate among the YWSS by district and by study arm.

vi. UNADJUSTED ANALYSIS

We will use Poisson regression to compare the HIV incidence rates across the two study arms.

We will fit three models, namely:

- 1) An unadjusted Poisson regression model

vii. ADJUSTED ANALYSIS

We will use Poisson regression models to compare the HIV incidence rates across the two study arms, adjusting for covariates. The models we will fit will be:

- 2) An age-adjusted Poisson regression model
- 3) A fully adjusted model including age and individual level potential confounders measured at baseline and found to be associated with HIV prevalence.

viii. PRE-PLANNED SUB-GROUP ANALYSES

We will conduct exploratory analysis, stratifying the analysis by age and by self-identification as a sex worker, to get a sense of difference in the effect size among these subgroups, and will report the findings of these analyses. We however recognise that these analyses will likely be underpowered and should be interpreted cautiously.

ix. SENSITIVITY ANALYSIS

We will perform 2 sets of sensitivity analyses:

- 1) Our primary analysis strategy does not weight the data. We will exclude seed participants and weight data by the inverse of women's reported YWSS-network size and normalise these weights by site.
- 2) Our primary analysis excludes data collected from women followed up at 12-months post-enrolment in the DREAMS districts. In our second sensitivity analysis, we will add data from the 12-month survey in the DREAMS districts to obtain information on women not followed up at 24 months. In these DREAMS districts, if someone seroconverted by the time of the 12-month follow-up, we will place the seroconversion date at the mid-point of enrolment and 12 months, and if someone tested HIV-negative at 12 months but HIV-positive at 24 months, we will place the seroconversion at the mid-point 12 months and 24 months. We will then use this information to compare HIV incidence between the two arms.

STRENGTHS AND LIMITATIONS

Our primary analysis is relatively simple, providing descriptions of HIV incidence in each site and unadjusted and adjusted statistical comparisons between the DREAMS and non-DREAMS study arms.

Our adjustment strategy includes a step-wise adjustment process, with few *a priori* variables adjusted for if they were associated with HIV prevalence at enrolment. We therefore consider the analysis to be transparent, and to build an evidence base for whether it is plausible that DREAMS had an impact on HIV incidence.

A limitation of our analysis is that we may not have collected data on important covariates that are associated with HIV and important risk factors for the outcome (HIV incidence), and that differ among study clusters / by arm. As such, if we find evidence for an effect of DREAMS on HIV incidence after adjustment, we cannot be entirely sure that this effect is attributable to DREAMS.

We are unable to conduct cluster level analysis or adjust for cluster level covariates, despite the fact that the intervention was allocated at cluster level. This means we will be unable to adjust for important potential confounders at cluster level; for example, the background HIV prevalence in the DREAMS clusters may differ from that in the non-DREAMS clusters owing to both the lack of randomisation and because of chance variability. Our interpretation will thus need to be cautious, commenting on any differences in cluster level factors that are observed at baseline.

Our intention to treat approach will compare women eligible to receive DREAMS interventions in districts where DREAMS was operating with women in districts where it was not. If DREAMS delivery was weak, or did not reach the specific target populations of women who are the focus for our impact evaluation (YWSS), then we may conclude that DREAMS did not have an impact but this may reflect limited delivery rather than the maximum potential effect. We will describe the delivery and uptake of DREAMS interventions in order to support our interpretation.

APPENDIX 2: ADDITIONAL DESCRIPTIVE STATISTICS

Supplemental Table 1. Key demographic and behavioural characteristics of all YWSS at enrolment by study group, 2017

	DREAMS cities (N=1204)	Non-DREAMS towns (N=1227)	Comparison P-value
	n/N (%)	n/N (%)	
HIV prevalence	234/1197 (19.5)	320/1216 (26.3)	<0.001
Age at recruitment			0.518
18-19	405/1204 (33.6)	428/1227 (34.9)	
20-24	799/1204 (66.4)	799/1227 (65.1)	
Highest level of education			<0.001
None/ incomplete primary	41/1204 (3.4)	133/1227 (10.8)	
Complete primary	84/1204 (7.0)	138/1227 (11.3)	
Incomplete secondary	1018/1204 (84.5)	936/1227 (76.3)	
Complete secondary or higher	61/1204 (5.1)	20/1227 (1.6)	
Marital status			<0.001
Single/ never married	801/1204 (66.5)	625/1227 (50.9)	
Married / living together as if married	31/1204 (2.6)	19/1227 (1.6)	
Divorced/ separated	365/1204 (30.3)	567/1227 (46.2)	
Widowed	7/1204 (0.6)	16/1227 (1.3)	
Years selling sex			0.026
0-2	614/1203 (51.0)	680/1224 (55.6)	
3+	589/1203 (49.0)	544/1224 (44.4)	
Self-identification as sex worker			0.031
No	390/1191 (32.7)	350/1220 (28.7)	
Yes	801/1191 (67.3)	870/1220 (71.3)	
Condom use at last with regular partner			0.004
No	320/907 (35.3)	384/919 (41.8)	
Yes	587/907 (64.7)	535/919 (58.2)	
Condom-less sex with regular partner in the past month			0.479
No	498/908 (54.8)	491/923 (53.2)	
Yes	410/908 (45.2)	432/923 (46.8)	
Condom use at last with client			0.302
No	105/946 (11.1)	89/923 (9.6)	
Yes	841/946 (88.9)	834/923 (90.4)	
Condom-less sex with client in the past month			0.001
No	786/949 (82.8)	815/924 (88.2)	
Yes	163/949 (17.2)	109/924 (11.8)	
STI symptoms in the last 12 months			0.003
No	919/1204 (76.3)	871/1227 (71.0)	
Yes	285/1204 (23.7)	356/1227 (29.0)	
Risk of common mental disorder			<0.001
No	733/1204 (60.9)	840/1227 (68.5)	
Yes	471/1204 (39.1)	387/1227 (31.5)	

Supplemental Table 2. Key demographic and behavioural characteristics of all YWSS at enrolment by study site, 2017

	DREAMS Site A (N=601)	DREAMS Site B (N=603)	Non-DREAMS Site C (N=318)	Non-DREAMS Site D (N=300)	Non-DREAMS Site E (N=308)	Non-DREAMS Site F (N=301)
	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)	n/N (%)
HIV prevalence	128/597 (21.4)	106/600 (17.7)	84/316 (26.6)	90/299 (30.1)	42/300 (14.0)	104/301 (34.6)
Age at recruitment						
18-19	222/601 (36.9)	183/603 (30.3)	103/318 (32.4)	101/300 (33.7)	142/308 (46.1)	82/301 (27.2)
20-24	379/601 (63.1)	420/603 (69.7)	215/318 (67.6)	199/300 (66.3)	166/308 (53.9)	219/301 (72.8)
Highest level of education						
None/ incomplete primary	12/601 (2.0)	29/603 (4.8)	56/318 (17.6)	34/300 (11.3)	13/308 (4.2)	30/301 (10.0)
Complete primary	49/601 (8.2)	35/603 (5.8)	40/318 (12.6)	37/300 (12.3)	21/308 (6.8)	40/301 (13.3)
Incomplete secondary	512/601 (85.2)	506/603 (83.9)	219/318 (68.9)	227/300 (75.7)	271/308 (88.0)	219/301 (72.8)
Complete secondary or higher	28/601 (4.7)	33/603 (5.5)	3/318 (0.9)	2/300 (0.7)	3/308 (1.0)	12/301 (4.0)
Marital status						
Single/ never married	501/601 (83.4)	300/603 (49.8)	135/318 (42.5)	130/300 (43.3)	197/308 (64.0)	163/301 (54.2)
Married / living together as if married	22/601 (3.7)	9/603 (1.5)	2/318 (0.6)	3/300 (1.0)	12/308 (3.9)	2/301 (0.7)
Divorced/ separated	75/601 (12.5)	290/603 (48.1)	172/318 (54.1)	164/300 (54.7)	99/308 (32.1)	132/301 (43.9)
Widowed	3/601 (0.5)	4/603 (0.7)	9/318 (2.8)	3/300 (1.0)	0/308 (0.0)	4/301 (1.3)
Years selling sex						
0-2	291/600 (48.5)	323/603 (53.6)	180/318 (56.6)	173/298 (58.1)	167/307 (54.4)	160/301 (53.2)
3+	309/600 (51.5)	280/603 (46.4)	138/318 (43.4)	125/298 (41.9)	140/307 (45.6)	141/301 (46.8)
Self-identification as sex worker						
No	223/590 (37.8)	167/601 (27.8)	65/313 (20.8)	69/300 (23.0)	151/306 (49.3)	65/301 (21.6)
Yes	367/590 (62.2)	434/601 (72.2)	248/313 (79.2)	231/300 (77.0)	155/306 (50.7)	236/301 (78.4)
Condom use at last with regular partner						
No	201/476 (42.2)	119/431 (27.6)	84/227 (37.0)	93/235 (39.6)	127/278 (45.7)	80/179 (44.7)
Yes	275/476 (57.8)	312/431 (72.4)	143/227 (63.0)	142/235 (60.4)	151/278 (54.3)	99/179 (55.3)
Condom-less sex with regular partner in the past month						
No	231/477 (48.4)	267/431 (61.9)	126/228 (55.3)	116/238 (48.7)	144/278 (51.8)	105/179 (58.7)
Yes	246/477 (51.6)	164/431 (38.1)	102/228 (44.7)	122/238 (51.3)	134/278 (48.2)	74/179 (41.3)
Condom use at last with client						
No	71/490 (14.5)	34/456 (7.5)	16/255 (6.3)	19/234 (8.1)	30/191 (15.7)	24/243 (9.9)
Yes	419/490 (85.5)	422/456 (92.5)	239/255 (93.7)	215/234 (91.9)	161/191 (84.3)	219/243 (90.1)
Condom-less sex with client in the past month						
No	393/491 (80.0)	393/458 (85.8)	236/255 (92.5)	216/234 (92.3)	151/192 (78.6)	212/243 (87.2)
Yes	98/491 (20.0)	65/458 (14.2)	19/255 (7.5)	18/234 (7.7)	41/192 (21.4)	31/243 (12.8)
STI symptoms in the last 12 months						

No	470/601 (78.2)	449/603 (74.5)	235/318 (73.9)	185/300 (61.7)	248/308 (80.5)	203/301 (67.4)
Yes	131/601 (21.8)	154/603 (25.5)	83/318 (26.1)	115/300 (38.3)	60/308 (19.5)	98/301 (32.6)
<hr/>						
Risk of common mental disorder						
No	366/601 (60.9)	367/603 (60.9)	205/318 (64.5)	189/300 (63.0)	218/308 (70.8)	228/301 (75.7)
Yes	235/601 (39.1)	236/603 (39.1)	113/318 (35.5)	111/300 (37.0)	90/308 (29.2)	73/301 (24.3)

Supplemental Table 3. Key demographic and behavioural characteristics at enrolment of YWSS testing HIV negative and followed up at 24 months by group, 2019

	DREAMS cities (N=538)	Non-DREAMS towns (N=481)	Comparison P-value
	n/N (%)	n/N (%)	
Age at enrolment			0.948
18-19	208/538 (38.7)	185/481 (38.5)	
20-24	330/538 (61.3)	296/481 (61.5)	
Highest level of education			<0.001
None/ incomplete primary	11/538 (2.0)	24/480 (5.0)	
Complete primary	27/538 (5.0)	61/480 (12.7)	
Incomplete secondary	449/538 (83.5)	380/480 (79.2)	
Complete secondary or higher	51/538 (9.5)	15/480 (3.1)	
Marital status			<0.001
Single/ never married	308/538 (57.2)	182/480 (37.9)	
Married / living together as if married	78/538 (14.5)	58/480 (12.1)	
Divorced/ separated	152/538 (28.3)	234/480 (48.8)	
Widowed	0/538 (0.0)	6/480 (1.3)	
Years selling sex			<0.001
0-2	67/537 (12.5)	99/468 (21.2)	
3+	470/537 (87.5)	369/468 (78.8)	
Self-identification as sex worker			0.005
No	217/536 (40.5)	154/480 (32.1)	
Yes	319/536 (59.5)	326/480 (67.9)	
Condom use at last with regular partner			0.009
No	170/421 (40.4)	182/367 (49.6)	
Yes	251/421 (59.6)	185/367 (50.4)	
Condom-less sex with regular partner in the past month			0.004
No	173/445 (38.9)	124/418 (29.7)	
Yes	272/445 (61.1)	294/418 (70.3)	
Condom use at last with client			0.153
No	38/394 (9.6)	44/339 (13.0)	
Yes	356/394 (90.4)	295/339 (87.0)	
Condom-less sex with client in the past month			0.029
No	321/398 (80.7)	262/354 (74.0)	
Yes	77/398 (19.3)	92/354 (26.0)	
STI symptoms in the last 12 months			0.015
No	464/538 (86.2)	386/479 (80.6)	
Yes	74/538 (13.8)	93/479 (19.4)	
Risk of common mental disorder			0.450
No	388/538 (72.1)	357/481 (74.2)	
Yes	150/538 (27.9)	124/481 (25.8)	

APPENDIX 3: PATTERNS OF RETENTION AT 24-MONTH FOLLOW-UP

Supplemental Table 4. Age, marital status, whether women self-identified as a female sex worker and educational attainment at enrolment among women testing HIV negative at enrolment and retained or not retained at 24-month follow-up in 2019

	DREAMS cities (N=963)			Non-DREAMS towns (N=896)		
Follow-up rate	538/963 (55.9%)			481/896 (53.7%)		
	YWSS retained (N=538)	YWSS not retained (N=425)	P-value [‡]	YWSS retained (N=481)	YWSS not retained (N=415)	P-value [‡]
	n/N (%)	n/N (%)		n/N (%)	n/N (%)	
Age at enrolment			0.397			0.046
18-19	208/538 (38.7)	153/425 (36.0)		185/481 (38.5)	187/415 (45.1)	
20-24	330/538 (61.3)	272/425 (64.0)		296/481 (61.5)	228/415 (54.9)	
Marital status			0.221			0.302
Single/never married	361/538 (67.1)	307/425 (72.2)		256/481 (53.2)	241/415 (58.1)	
Married/cohabiting	12/538 (2.2)	9/425 (2.1)		8/481 (1.7)	8/415 (1.9)	
Previously married	165/538 (30.7)	109/425 (25.6)		217/481 (45.1)	166/415 (40.0)	
Whether self-identifies as FSW			0.119			0.582
No	167/532 (31.4)	152/420 (36.2)		159/480 (33.1)	143/410 (34.9)	
Yes	365/532 (68.6)	268/420 (63.8)		321/480 (66.9)	267/410 (65.1)	
Educational attainment			0.927			0.163
None/ incomplete primary	15/538 (2.8)	13/425 (3.1)		34/481 (7.1)	43/415 (10.4)	
Complete primary	32/538 (5.9)	29/425 (6.8)		53/481 (11.0)	39/415 (9.4)	
Incomplete secondary	460/538 (85.5)	357/425 (84.0)		386/481 (80.2)	321/415 (77.3)	
Complete secondary or higher	31/538 (5.8)	26/425 (6.1)		8/481 (1.7)	12/415 (2.9)	

[‡]Chi-square P value for the association of each characteristic with retention at 24-month follow-up

APPENDIX 4: COMPARISON OF DREAMS SECONDARY OUTCOMES BY SITE

Supplemental Table 5. Comparison of DREAMS secondary outcomes by site

	DREAMS Site A (N=252) n/N (%)	DREAMS Site B (N=286) n/N (%)	Non-DREAMS Site C (N=122) n/N (%)	Non-DREAMS Site D (N=102) n/N (%)	Non-DREAMS Site E (N=141) n/N (%)	Non-DREAMS Site F (N=115) n/N (%)
Improved access to clinical services and HIV prevention services						
Knowledge of HIV status						
No	71/252 (28.2)	48/286 (16.8)	27/122 (22.1)	19/102 (18.6)	37/141 (26.3)	34/115 (29.6)
Yes	181/252 (71.8)	238/286 (83.2)	95/122 (77.9)	83/102 (81.4)	104/141 (73.7)	81/115 (70.4)
Unadjusted	1	1.94 (1.28-2.94), p=0.002	1.38 (0.83-2.29), p=0.214	1.71 (0.97-3.03), p=0.064	1.07 (0.68-1.70), p=0.763	0.93 (0.58-1.52), p=0.785
Fully-adjusted [‡]	1	1.77 (1.14-2.74), p=0.012	1.25 (0.72-2.15), p=0.432	1.50 (0.82-2.76), p=0.186	1.03 (0.64-1.68), p=0.893	0.83 (0.50-1.38), p=0.473
Ever taken PrEP						
No	200/252 (79.4)	187/286 (65.4)	121/122 (99.2)	102/102 (100.0)	141/142 (99.3)	114/115 (99.1)
Yes	52/252 (20.6)	99/286 (34.6)	1/122 (0.8)	0/102 (0.0)	1/142 (0.7)	1/115 (0.9)
Unadjusted	1	2.04 (1.38-3.01), p<0.001	–	–	–	–
Fully-adjusted [‡]	1	1.83 (1.16-2.91), p=0.010	–	–	–	–
Ability to negotiate condom use with any partner						
No	26/252 (10.3)	14/286 (4.9)	5/122 (4.1)	6/102 (5.9)	55/141 (39.0)	25/115 (21.7)
Yes	226/252 (89.7)	272/286 (95.1)	117/122 (95.9)	96/102 (94.1)	86/141 (61.0)	90/115 (78.3)
Unadjusted	1	2.24 (1.14-4.38), p=0.019	2.69 (1.01-7.19), p=0.048	1.84 (0.73-4.62), p=0.193	0.18 (0.11-0.31), p<0.001	0.41 (0.23-0.76), p=0.004
Fully-adjusted [‡]	1	2.06 (1.02-4.18), p=0.044	2.19 (0.79-6.04), p=0.132	1.47 (0.57-3.83), p=0.428	0.16 (0.09-0.28), p<0.001	0.39 (0.21-0.73), p=0.003
Knowledge of the HIV status of at least one of their three most recent partners						
No	68/250 (27.2)	111/278 (39.9)	45/121 (37.2)	32/100 (32.0)	65/139 (46.8)	68/114 (59.6)
Yes	182/250 (72.8)	167/278 (60.1)	76/121 (62.8)	68/100 (68.0)	74/139 (53.2)	46/114 (40.4)
Unadjusted	1	0.56 (0.39-0.81), p=0.002	0.63 (0.40-1.01), p=0.051	0.79 (0.48-1.31), p=0.370	0.43 (0.28-0.66), p<0.001	0.25 (0.16-0.40), p<0.001
Fully-adjusted [‡]	1	0.64 (0.43-0.96), p=0.030	0.85 (0.52-1.41), p=0.541	1.02 (0.59-1.74), p=0.953	0.44 (0.28-0.70), p<0.001	0.32 (0.19-0.52), p<0.001
Condom-less sex with regular partner in the past month						

	No	122/251 (48.6)	153/285 (53.7)	58/122 (47.5)	41/100 (41.0)	52/141 (36.9)	48/115 (41.7)
	Yes	129/251 (51.4)	132/285 (46.3)	64/122 (52.5)	59/100 (59.0)	89/141 (63.1)	67/115 (58.3)
	Unadjusted	1	0.82 (0.58-1.15), p=0.241	1.04 (0.68-1.61), p=0.847	1.36 (0.85-2.18), p=0.198	1.62 (1.06-2.47), p=0.025	1.32 (0.85-2.06), p=0.222
	Fully-adjusted [‡]	1	1.12 (0.73-1.71), p=0.606	1.37 (0.79-2.39), p=0.263	1.31 (0.74-2.31), p=0.358	1.58 (0.98-2.55), p=0.059	1.58 (0.89-2.81), p=0.119
Condom-less sex with client in the past month							
	No	214/250 (85.6)	261/285 (91.6)	109/122 (89.3)	92/100 (92.0)	106/141 (75.2)	89/115 (77.4)
	Yes	36/250 (14.4)	24/285 (8.4)	13/122 (10.7)	8/100 (8.0)	35/141 (24.8)	26/115 (22.6)
	Unadjusted	1	0.55 (0.32-0.94), p=0.031	0.71 (0.36-1.39), p=0.318	0.52 (0.23-1.16), p=0.108	1.96 (1.17-3.30), p=0.011	1.74 (0.99-3.05), p=0.054
	Fully-adjusted [‡]	1	0.61 (0.32-1.18), p=0.144	0.60 (0.26-1.42), p=0.247	0.62 (0.25-1.57), p=0.317	2.30 (1.21-4.37), p=0.011	1.98 (1.01-3.86), p=0.045
Accessed STI treatment services in the past 12 months							
	No	2/32 (6.3)	5/42 (11.9)	3/20 (15.0)	2/32 (6.3)	8/21 (38.1)	5/20 (25.0)
	Yes	30/32 (93.8)	37/42 (88.1)	17/20 (85.0)	30/32 (93.8)	13/21 (61.9)	15/20 (75.0)
	Unadjusted	1	0.49 (0.09-2.72), p=0.418	0.38 (0.06-2.49), p=0.312	–	0.11 (0.02-0.58), p=0.010	0.20 (0.03-1.15), p=0.072
	Fully-adjusted [‡]	1	–	0.22 (0.01-12.18), p=0.463	–	0.25 (0.01-5.52), p=0.383	–
Improved coverage of Social and Economic Protection service							
Food insecurity							
	No	191/252 (75.8)	176/286 (61.5)	35/122 (28.7)	54/102 (52.9)	118/140 (84.3)	88/115 (76.5)
	Yes	61/252 (24.2)	110/286 (38.5)	87/122 (71.3)	48/102 (47.1)	22/140 (15.7)	27/115 (23.5)
	Unadjusted	1	1.96 (1.35-2.84), p<0.001	7.78 (4.78-12.66), p<0.001	2.78 (1.72-4.52), p<0.001	0.58 (0.34-1.01), p=0.050	0.96 (0.57-1.61), p=0.880
	Fully-adjusted [‡]	1	1.56 (1.04-2.35), p=0.034	5.66 (3.34-9.61), p<0.001	2.52 (1.48-4.29), p=0.001	0.54 (0.31-0.95), p=0.033	0.87 (0.51-1.51), p=0.626
Selling sex is the main way to support myself							
	No	105/252 (41.7)	91/286 (31.8)	37/122 (30.3)	34/102 (33.3)	60/140 (42.9)	28/115 (24.3)
	Yes	147/252 (58.3)	195/286 (68.2)	85/122 (69.7)	68/102 (66.7)	80/140 (57.1)	87/115 (75.7)
	Unadjusted	1	1.53 (1.08-2.18), p=0.018	1.64 (1.04-2.60), p=0.035	1.43 (0.88-2.31), p=0.147	0.95 (0.63-1.45), p=0.819	2.22 (1.35-3.64), p=0.002
	Fully-adjusted [‡]	1	1.32 (0.90-1.94), p=0.150	1.18 (0.72-1.94), p=0.507	1.13 (0.67-1.89), p=0.655	0.97 (0.63-1.51), p=0.906	2.09 (1.25-3.49), p=0.005
Ever been unable to decline sex in the past month							
	Never/not in the past month	129/252 (51.2)	128/282 (45.4)	64/119 (53.8)	53/99 (53.5)	76/141 (53.9)	43/115 (37.4)
	At least once in the past month	123/252 (48.8)	154/282 (54.6)	55/119 (46.2)	46/99 (46.5)	65/141 (46.1)	72/115 (62.6)

	Unadjusted	1	1.26 (0.90-1.77), p=0.181	0.90 (0.58-1.40), p=0.641	0.91 (0.57-1.45), p=0.692	0.90 (0.59-1.36), p=0.606	1.76 (1.12-2.76), p=0.014
	Fully-adjusted [‡]	1	1.25 (0.87-1.80), p=0.235	0.89 (0.55-1.44), p=0.633	0.89 (0.54-1.47), p=0.649	0.95 (0.62-1.45), p=0.805	1.72 (1.08-2.74), p=0.023
Number of sex work clients in the past month							
	≤3	138/252 (54.8)	145/285 (50.9)	39/116 (33.6)	38/96 (39.6)	86/141 (61.0)	40/115 (34.8)
	>3	114/252 (45.2)	140/285 (49.1)	77/116 (66.4)	58/96 (60.4)	55/141 (39.0)	75/115 (65.2)
	Unadjusted	1	1.17 (0.83-1.64), p=0.368	2.39 (1.51-3.78), p<0.001	1.85 (1.15-2.98), p=0.012	0.77 (0.51-1.18), p=0.232	0.27 (1.44-3.58), p<0.001
	Fully-adjusted [‡]	1	1.12 (0.76-1.63), p=0.574	1.87 (1.13-3.10), p=0.015	1.56 (0.92-2.64), p=0.100	1.10 (0.70-1.74), p=0.671	2.28 (1.38-3.75), p=0.001
Gender-based violence prevention, and care and support services							
Experience of violence from partners in the past 12 months							
	No	210/252 (83.3)	224/286 (78.3)	76/122 (62.3)	73/102 (71.6)	108/142 (76.1)	88/115 (76.5)
	Yes	42/252 (16.7)	62/286 (21.7)	46/122 (37.7)	29/102 (28.4)	34/142 (23.9)	27/115 (23.5)
	Unadjusted	1	1.38 (0.90-2.14), p=0.143	3.03 (1.85-4.96), p<0.001	1.99 (1.15-3.42), p=0.013	1.57 (0.95-2.62), p=0.080	1.53 (0.89-2.64), p=0.123
	Fully-adjusted [‡]	1	1.14 (0.71-1.83), p=0.583	2.30 (1.34-3.96), p=0.003	1.39 (0.77-2.49), p=0.275	1.56 (0.91-2.66), p=0.104	1.56 (0.88-2.76), p=0.129
Experience of violence from police in the past 12 months							
	No	249/252 (98.8)	282/286 (98.6)	122/122 (100.0)	102/102 (100.0)	137/140 (97.9)	112/115 (97.4)
	Yes	3/252 (1.2)	4/286 (1.4)	0/122 (0.0)	0/102 (0.0)	3/140 (2.1)	3/115 (2.6)
	Unadjusted	1	1.18 (0.26-5.31), p=0.832	–	–	1.82 (0.36-9.13), p=0.468	2.22 (0.44-11.19), p=0.332
	Fully-adjusted [‡]	1	0.87 (0.17-4.44), p=0.869	–	–	1.81 (0.33-9.74), p=0.492	1.62 (0.29-8.95), p=0.581

[‡]Adjusted for age, highest level of education attained, marital status, self-identification as FSW (measured at baseline), and for each respective secondary outcome measured at baseline

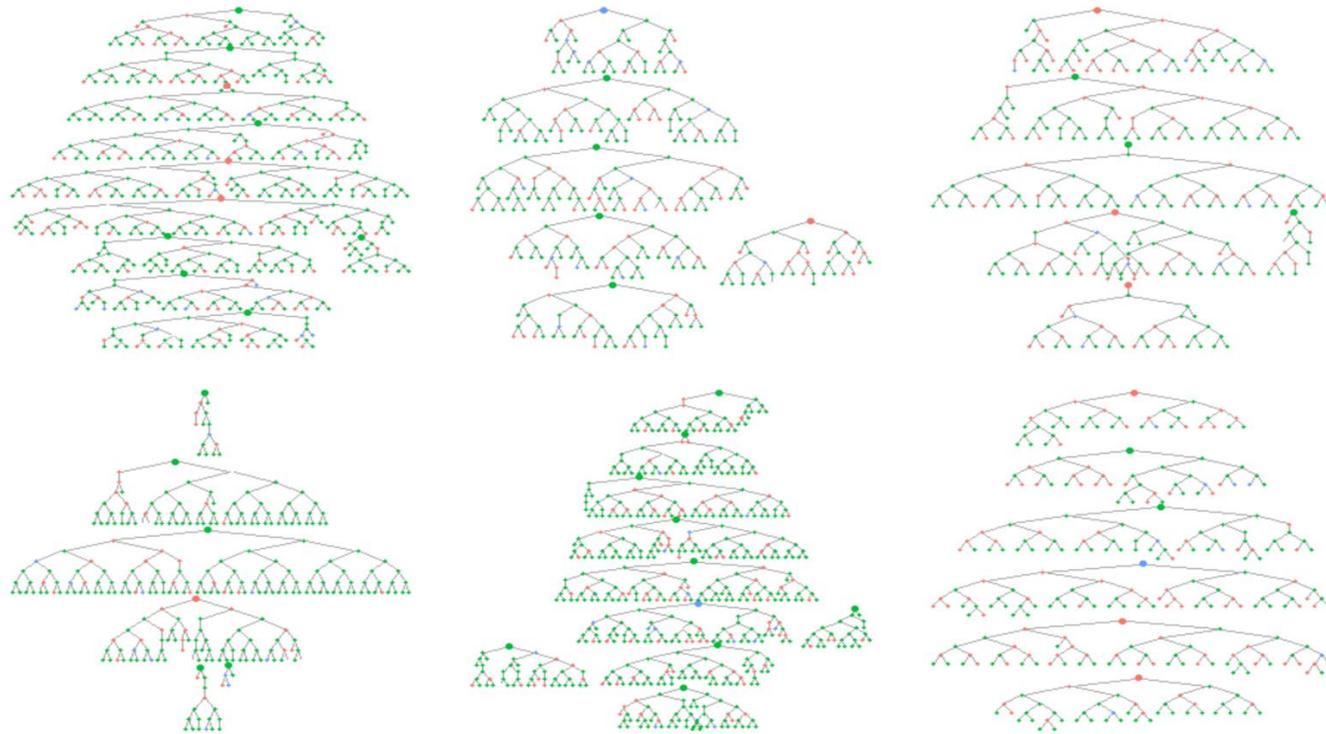
APPENDIX 5: RDS DIAGNOSTICS AND RESULTS

RDS diagnostics were based on enrolment (2017) data. Combined convergence and bottleneck plots (reported elsewhere),² suggested that key characteristics and outcomes, including age, whether women self-identified as FSW and HIV prevalence, stabilised with increasing sample sizes in five of the six sites. There was also little evidence of disconnected networks of YWSS in each site. In this study, we report the proportion of women who said that they were recruited into the study by strangers, to have an understanding of reciprocity, and assessed recruitment homophily with respect to HIV status, to understand if HIV positive recruiters preferentially recruited HIV positive peers from amongst their personal networks.

We generated RDS recruitment trees by site, colour coding women by whether they tested HIV negative at enrolment, HIV positive at enrolment, or tested HIV negative at enrolment and seroconverted at 24-month follow up. Detailed RDS diagnostics for these data are presented elsewhere.²

Supplemental Table 6. Proportion recruited by strangers, and recruitment homophily for HIV status

Site	Proportion recruited by strangers	Homophily for HIV status
DREAMS Site A	7.1	1.0
DREAMS Site B	21.1	1.0
Non-DREAMS Site C	5.7	1.0
Non-DREAMS Site D	20.6	0.9
Non-DREAMS Site E	21.8	1.0
Non-DREAMS Site F	27.8	1.0



Supplemental Figure 1. Recruitment trees. Red circles represent women who tested HIV positive at enrolment, green circles represent women who tested HIV negative at enrolment, and blue circles represent women who tested HIV negative at enrolment who seroconverted at 24-month follow-up. The larger circles denote speed participants.

Supplemental Table 7. Follow-up interview questions to assess whether respondent-driven sampling strategy worked well in 2017

	DREAMS Site A [†] (N=137) n/N (%)	DREAMS Site B (N=270) n/N (%)	Non-DREAMS Site C (N=120) n/N (%)	Non-DREAMS Site D (N=96) n/N (%)	Non-DREAMS Site E (N=153) n/N (%)	Non-DREAMS Site F (N=120) n/N (%)
Apart from the woman who did recruit you to the study, has anyone else approached you to give you a coupon?						
No	38/45 (84.4)	248/270 (91.9)	88/120 (73.3)	70/96 (72.9)	151/153 (98.7)	119/120 (99.2)
Yes	7/45 (15.6)	22/270 (8.1)	32/120 (26.7)	26/96 (27.1)	2/153 (1.3)	1/120 (0.8)
If yes, how many times has this happened?						
Once	1/5 (20.0)	16/22 (72.7)	11/32 (34.4)	16/24 (66.7)	–	–
Twice	3/5 (60.0)	5/22 (22.7)	12/32 (37.5)	6/24 (25.0)	–	–
Three or more times	1/5 (20.0)	1/22 (4.5)	9/32 (28.1)	2/24 (8.3)	–	–
How many YWSS (aged over 18) do you know personally who live in this site, where you know their name and they know yours						
median (p25-p75)	6 (5-10)	5 (4-10)	10 (5-15)	6 (4-10)	6 (5-15)	6 (4-10)
Of these YWSS whom you know personally, how many have you seen in the last month?						
median (p25-p75)	5 (4-9)	4 (3-7)	8 (5-10)	6 (4-10)	5 (3-10)	5 (4-10)
Of the YWSS whom you know personally, how many would you have considered asking to take part in the study?						
median (p25-p75)	5 (4-8)	4 (2-7)	4 (2-7)	4 (2-7)	5 (2-10)	4 (2-7)
How many women did you give a coupon to who accepted it?						
0	0/44 (0.0)	2/270 (0.7)	1/117 (0.9)	0/95 (0.0)	0/153 (0.0)	0/120 (0.0)
1	2/44 (4.5)	5/270 (1.9)	11/117 (9.4)	7/95 (7.4)	19/153 (12.4)	12/120 (10.0)
2	42/44 (95.5)	263/270 (97.4)	105/117 (89.7)	88/95 (92.6)	134/153 (87.6)	108/120 (90.0)
How many women did you try to recruit to the survey but who refused?						
0	37/44 (84.1)	226/256 (88.3)	88/118 (74.6)	68/94 (72.3)	133/153 (86.9)	106/117 (90.6)
1	2/44 (4.5)	12/256 (4.7)	16/118 (13.6)	11/94 (11.7)	14/153 (9.2)	9/117 (7.7)
2	3/44 (6.8)	10/256 (3.9)	8/118 (6.8)	11/94 (11.7)	2/153 (1.3)	0/117 (0.0)
≥3	2/44 (4.5)	8/256 (3.1)	6/118 (5.1)	4/94 (4.3)	4/153 (2.6)	2/117 (1.7)

⁴Lot of missing data in site A due to errors in questionnaire skip patterns

Across all the study sites, some women were approached more than once to participate in the study (Supplemental Table 7), and very few women refused the coupon they were offered.

APPENDIX 6: SENSITIVITY ANALYSES

We conducted sensitivity analyses in which we (i) included data collected from women followed up at 12-months post-enrolment in the DREAMS sites, and (ii) RDS-II weighted our data, where the 24-month data was weighted using RDS weights that were generated using enrolment. For (i), we only present the primary outcome results which are very similar to that of the primary analysis results, and we do not present the results of uptake of DREAMS and secondary outcomes results because they are also very similar to that of primary analysis.

Supplemental Table 8. HIV incidence among YWSS testing HIV negative at enrolment, by arm (A) and site (B) (N=1138) (including 12-month follow-up data)

A. Comparison of HIV incidence among YWSS testing HIV negative at enrolment, by group				
	Number of seroconversions/person-years of follow-up	Rate per 100 person-years (95% CI)	Age-adjusted rate ratio (95%CI) p-value	Fully adjusted rate ratio (95%CI)[‡] p-value
Non-DREAMS (N=479)	48/907.62	5.29 (3.99-7.02)	1.0	1.0
DREAMS (N=659)	42/1098.31	3.82 (2.83-5.17)	0.72 (0.47-1.09) p=0.118	0.79 (0.47-1.32) p=0.364
B. Comparison of HIV incidence among YWSS testing HIV negative at enrolment, by site				
DREAMS Site A (n=309)	24/493.94	4.86 (3.26-7.25)	1.0	
DREAMS Site B (n=350)	18/604.38	2.98 (1.88-4.73)	0.60 (0.32-1.11) p=0.101	0.61 (0.32-1.17) p=0.139
Non-DREAMS Site C (n=121)	16/226.24	7.07 (4.33-11.54)	1.44 (0.76-2.71) p=0.263	1.29 (0.64-2.59) p=0.471
Non-DREAMS Site D (n=102)	11/192.90	5.70 (3.16-10.30)	1.16 (0.57-2.38) p=0.678	1.12 (0.51-2.42) p=0.783
Non-DREAMS Site E (n=141)	12/278.41	4.31 (2.45-7.59)	0.90 (0.45-1.80) p=0.761	0.88 (0.41-1.90) p=0.743
Non-DREAMS Site F (n=115)	9/210.07	4.28 (2.23-8.23)	0.86 (0.40-1.86) p=0.705	0.81 (0.36-1.80) p=0.604

[‡]Adjusted for age, highest level of education attained, marital status, self-identification as FSW, STI symptoms, number of sexual partners in the past month, HIV prevalence (measured at enrolment)

Supplemental Table 9. HIV incidence among YWSS testing HIV negative at enrolment, by group (A) and site (B) (N=1017) (RDS weighted)

A. Comparison of HIV incidence among YWSS testing HIV negative at enrolment, by group				
	Number of seroconversions/person-years of follow-up	Rate per 100 person-years (95% CI)	Age-adjusted rate ratio (95%CI) p-value	Fully adjusted rate ratio (95%CI)[‡] p-value
Non-DREAMS (N=479)	48/907.62	5.61 (3.77-7.46)	1.0	1.0
DREAMS (N=538)	31/988.14	2.93 (1.68-4.18)	0.52 (0.31-0.90) p=0.019	0.55 (0.28-1.08) p=0.082
B. Comparison of HIV incidence among YWSS testing HIV negative at enrolment, by site				
DREAMS Site A (n=252)	16/444.74	3.49 (1.44-5.53)	1.0	
DREAMS Site B (n=286)	15/543.40	2.46 (0.92-4.01)	0.69 (0.28-1.66) p=0.401	0.67 (0.28-1.58) p=0.357
Non-DREAMS Site C (n=121)	16/226.24	6.63 (2.60-10.66)	1.85 (0.79-4.28) p=0.154	1.47 (0.61-3.55) p=0.395
Non-DREAMS Site D (n=102)	11/192.90	6.65 (2.21-11.10)	1.85 (0.76-4.51) p=0.174	1.55 (0.58-4.12) p=0.383
Non-DREAMS Site E (n=141)	12/278.41	5.36 (1.94-8.77)	1.54 (0.65-3.66) p=0.328	1.51 (0.60-3.77) p=0.379
Non-DREAMS Site F (n=115)	9/210.07	3.88 (1.13-6.63)	1.07 (0.42-2.71) p=0.885	1.10 (0.42-2.85) p=0.849

[‡]Adjusted for age, highest level of education attained, marital status, self-identification as FSW, STI symptoms, number of sexual partners in the past month, HIV prevalence (measured at enrolment)

Supplemental Table 10. HIV incidence among young women who sell sex testing HIV negative at enrolment, by arm (A) and site (B) (N=1017) (Imputed seroconversion date)

A. Comparison of HIV incidence among YWSS testing HIV negative at enrolment, by arm				
	Number of seroconversions/person-years of follow-up	Rate per 100 person-years (95% CI)	Age-adjusted rate ratio (95%CI) p-value	Fully adjusted rate ratio (95%CI)[‡] p-value
Non-DREAMS (N=479)	48/907.60	5.29 (3.99-7.02)	1.0	1.0
DREAMS (N=538)	31/983.77	3.15 (2.22-4.48)	0.59 (0.38-0.93) p=0.023	0.69 (0.40-1.19) p=0.180
B. Comparison of HIV incidence among YWSS testing HIV negative at enrolment, by site				
DREAMS Site A (n=252)	16/444.06	3.60 (2.21-5.88)	1.0	
DREAMS Site B (n=286)	15/539.70	2.78 (1.68-4.61)	0.75 (0.37-1.53) p=0.431	0.69 (0.33-1.45) p=0.325
Non-DREAMS Site C (n=121)	16/227.78	7.02 (4.30-11.47)	1.92 (0.96-3.85) p=0.067	1.55 (0.73-3.27) p=0.252
Non-DREAMS Site D (n=102)	11/192.12	5.73 (3.17-10.34)	1.57 (0.73-3.39) p=0.249	1.34 (0.59-3.06) p=0.488
Non-DREAMS Site E (n=141)	12/277.64	4.32 (2.45-7.61)	1.21 (0.57-2.56) p=0.615	1.05 (0.46-2.39) p=0.913
Non-DREAMS Site F (n=115)	9/210.07	4.28 (2.23-8.23)	1.16 (0.51-2.63) p=0.722	1.01 (0.43-2.35) p=0.984

Supplemental Table 11. Uptake of services available through the DREAMS Partnership, by group (RDS weighted)

	DREAMS cities (N=538) n/N (%)	Non-DREAMS towns (N=481) n/N (%)	DREAMS vs non-DREAMS	
			OR (95% CI)	P-value
Direct HIV Prevention and Clinical services				
Recently HIV tested (within 6mths prior to the survey)				
No	181/537 (36.6)	152/478 (33.8)		
Yes	356/537 (63.4)	326/478 (66.2)	1.39 (0.81-2.37)	0.234 [‡]
Ever been offered PrEP				
No	285/538 (55.5)	476/481 (99.0)		
Yes	253/538 (44.5)	5/481 (1.0)	–	<0.001 [§]
Current use of contraceptive methods (including condom)				
No	61/495 (11.8)	101/432 (27.3)		
Yes	434/495 (88.2)	331/432 (72.7)	1.79 (0.81-3.93)	0.148 [‡]
Attendance to Sisters with a Voice Clinic in past 12 months				
No	221/538 (43.4)	344/480 (73.0)		
Yes	317/538 (56.6)	136/480 (27.0)	14.54 (7.36-28.75)	<0.001 [‡]
Saw condom promotion activities in the past 12 months				
No	175/536 (34.0)	225/479 (48.2)		
Yes	361/536 (66.0)	254/479 (51.8)	1.86 (1.10-3.16)	0.022 [‡]
Attendance to Sisters with a Voice community mobilisation meeting in past 12 months				
No	464/537 (86.8)	453/480 (94.3)		
Yes	73/537 (13.2)	27/480 (5.7)	17.24 (2.32-128.20)	0.005 [‡]
Social and Economic Protection Services				
Receipt of cash transfer or educational subsidy in past 12 months				
No	516/538 (96.1)	480/480 (100.0)		
Yes	22/538 (3.9)	0/480 (0.0)	–	<0.001 [§]
Participation in continuing education programme in past 12 months				
No	528/538 (98.2)	480/480 (100.0)		
Yes	10/538 (1.8)	0/480 (0.0)	–	0.018 [§]

Participation in job preparation training in past 12 months				
No	529/538 (98.1)	480/480 (100.0)		
Yes	9/538 (1.9)	0/480 (0.0)	–	0.024 [§]
Participation in apprenticeship in past 12 months[†]				
No	538/538 (100.0)	480/480 (100.0)		
Yes	0/538 (0.0)	0/480 (0.0)	–	–
Participation in internal savings & loan group in past 12 months				
No	514/537 (96.1)	479/479 (100.0)		
Yes	23/537 (3.9)	0/479 (0.0)	–	<0.001 [§]
Gender-based Violence Care and Support Services				
Accessed healthcare services after experiencing GBV in past 12 months[†]				
No	49/63 (77.4)	40/48 (84.9)		
Yes	14/63 (22.6)	8/48 (15.1)	1.48 (0.20-11.00)	0.701 [‡]
Provided with shelter in past 12 months (among women experiencing GBV)				
No	188/189 (99.3)	181/183 (99.3)		
Yes	1/189 (0.7)	2/183 (0.7)	–	0.922 [§]

[†]Among YWSS who experienced sexual violence

[‡]Age and site adjusted Wald test p-value

[§]Fisher's exact p-value – OR and 95% CI could not be estimated using logistic regression due to sparse data

[¶]Fisher's exact p-value or OR and 95% CI could not be estimated due to sparse data

Supplemental Table 12. Comparison of DREAMS secondary outcomes between the two DREAMS cities and the four non-DREAMS comparison towns, 2019 (RDS weighted)

		DREAMS cities	Non-DREAMS towns	DREAMS vs non-DREAMS			
		(N=538)	(N=481)	Age-adjusted		Fully-adjusted [‡]	
		n/N (%)	n/N (%)	OR (95% CI)	P-value	OR (95% CI)	P-value
Improved access to clinical services and HIV prevention services							
Knowledge of HIV status							
	No	119/538 (24.8)	118/481 (25.7)				
	Yes	419/538 (75.2)	363/481 (74.3)	1.07 (0.76-1.51)	0.694	1.12 (0.78-1.60)	0.533
Ever taken PrEP							
	No	387/538 (74.4)	478/481 (99.3)				
	Yes	151/538 (25.6)	3/481 (0.7)	47.94 (14.61-157.38)	<0.001	49.52 (14.62-167.78)	<0.001
Ability to negotiate condom use with any partner							
	No	40/538 (7.9)	91/480 (20.7)				
	Yes	498/538 (92.1)	389/480 (79.3)	3.11 (1.95-4.98)	<0.001	3.68 (2.24-6.04)	<0.001
Knowledge of the HIV status of at least one of their three most recent partners							
	No	179/528 (35.8)	210/474 (43.8)				
	Yes	349/528 (64.2)	264/474 (56.2)	1.39 (1.03-1.87)	0.032	1.30 (0.94-1.78)	0.108
Condom-less sex with regular partner in the past month							
	No	275/536 (53.0)	199/478 (41.2)				
	Yes	261/536 (47.0)	279/478 (58.8)	0.62 (0.46-0.83)	0.001	0.65 (0.45-0.93)	0.017
Condom-less sex with client in the past month							
	No	475/535 (89.8)	396/478 (83.4)				
	Yes	60/535 (10.2)	82/478 (16.6)	0.57 (0.37-0.85)	0.007	0.57 (0.35-0.93)	0.024
Accessed STI treatment services in the past 12 months[§]							
	No	7/74 (10.0)	18/93 (20.9)				

	Yes	67/74 (90.0)	75/93 (79.1)	2.49 (0.85-7.28)	0.096	–	–
Improved coverage of Social and Economic Protection service							
Food insecurity							
	No	367/538 (70.6)	295/479 (60.7)				
	Yes	171/538 (29.4)	184/479 (39.3)	0.65 (0.48-0.88)	0.005	0.66 (0.48-0.92)	0.014
Selling sex is the main way to support myself							
	No	196/538 (38.5)	159/479 (36.3)				
	Yes	342/538 (61.5)	320/479 (63.7)	0.93 (0.68-1.27)	0.650	0.97 (0.70-1.34)	0.845
Ever been unable to decline sex in the past month							
	Never/not in the past month	257/534 (50.3)	236/474 (52.6)				
	At least once in the past month	277/534 (49.7)	238/474 (47.4)	1.10 (0.82-1.47)	0.513	1.09 (0.80-1.48)	0.586
Number of sex work clients in the past month							
	≤3	283/537 (56.3)	203/468 (47.0)				
	>3	254/537 (43.7)	265/468 (53.0)	0.69 (0.52-0.93)	0.014	0.63 (0.46-0.87)	0.005
Gender-based violence prevention, and care and support services							
Experience of violence from partners in the past 12 months							
	No	434/538 (83.0)	345/481 (72.6)				
	Yes	104/538 (17.0)	136/481 (27.4)	0.55 (0.39-0.77)	0.001	0.53 (0.36-0.76)	0.001
Experience of violence from police in the past 12 months							
	No	531/538 (99.1)	473/479 (98.8)				
	Yes	7/538 (0.9)	6/479 (1.2)	0.74 (0.20-2.72)	0.652	0.68 (0.18-2.54)	0.565

[†]Adjusted for age, highest level of education attained, marital status, self-identification as FSW (measured at baseline), and for each respective secondary outcome measured at enrolment

[‡]OR and 95% CI could not be estimated using logistic regression due to sparse data

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