

# DREAMS impact on HIV status knowledge and sexual risk among cohorts of young women in Kenya and South Africa

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**Objectives:** We sought evidence of DREAMS' impact on uptake of services and sexual risk among adolescent-girls-and-young-women (AGYW).

**Design:** Cohorts of AGYW aged 13–22 years were randomly selected in 2017–2018 and followed-up to 2019; 1081 in Nairobi, Kenya; 1171 in Gem, western Kenya; and 2184 in uMkhanyakude, South Africa.

**Methods:** Outcomes were knowledge of HIV status, condomless sex (past 12 months), lifetime partners, transactional sex (past 12 months), and awareness and use of condoms and pre-exposure-prophylaxis (PrEP). Using a causal inference framework, we estimated the proportions with each outcome if all vs. none were DREAMS invitees by 2018.

**Results:** Among AGYW followed up in 2019, the percentage invited to DREAMS by 2018 was 74, 57, and 53% in Nairobi, Gem, and uMkhanyakude, respectively. By 2018, the estimated percentages of AGYW who would know their HIV status, comparing the scenarios that all vs. none were DREAMS invitees, were 86 vs. 56% in Nairobi, 80 vs. 68% in Gem, and 56 vs. 49% in uMkhanyakude. By 2019, awareness of condoms and PrEP was high among DREAMS invitees, but recent participation in condom promotion activities was less than 50% and recent PrEP use was around 0–10%. In Gem, there was evidence of a reduction attributable to DREAMS in condomless sex, and among younger AGYW in the number of lifetime partners; in Nairobi evidence of a reduction in condomless sex among sexually active older AGYW; and in uMkhanyakude no evidence that DREAMS changed these outcomes.

**Conclusion:** Alongside sustaining high levels of knowledge of HIV status, more is needed to link AGYW into prevention methods such as PrEP and condoms.

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Comprehensive HIV prevention promotes safer sexual partnerships, but poverty, social norms, and inequalities limit AGYW's prevention choices.

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## Introduction

The high risk of HIV acquisition among adolescent girls and young women (AGYW), relative to male peers and older age groups, has been a consistent feature of the HIV pandemic in sub-Saharan Africa [1–4]. Rapid rises in sexually acquired HIV infection from an early age have driven high levels of adult HIV prevalence, even as antiretroviral treatment (ART) has become more widely available [4–8]. In recognition that broader HIV epidemic control relies on stronger, differentiated prevention among young people, global and national commitments to youth-centered campaigns have grown in the past decade [9]. This includes the large investment by PEPFAR and private sector partners in the DREAMS (Determined, Resilient, Empowered, AIDS-free, and Mentored lives) Partnership since 2015 [10].

In 15 of the countries most affected by HIV/AIDS, DREAMS seeks to combine evidence-based interventions in a coherent package that simultaneously addresses the multiple, complex drivers of AGYW risk. As single interventions and sectors had previously shown limited effect on HIV outcomes among AGYW, DREAMS employs a comprehensive and multisectoral approach to address the “myriad of factors” that increase young women’s sexual risk [6,11]. The DREAMS “core package” includes biomedical, social, and behavioral interventions [12].

As part of an independent evaluation of DREAMS across diverse settings in Kenya and South Africa during 2016–2019, we sought evidence of DREAMS’ impact on sexual behaviors that are associated with HIV incidence [13]. Behaviors such as condomless sex, increased number of sexual partners, and engagement in transactional sex are established predictors of HIV acquisition and other sexually transmitted infections [14–16]. In addition, uptake of HIV testing – and knowing one’s HIV status – can enable individuals to adopt safe sexual behaviors and, through treatment and prevention cascades, link with services including condoms, ART, and pre-exposure-prophylaxis (PrEP) to avoid acquisition or transmission of HIV [17,18]. By evaluating DREAMS’ effect on such behaviors, we aimed to understand whether it has a direct effect on AGYW’s individual risk factors and service uptake.

## Materials and methods

### Settings and study design

Evaluation studies were conducted in urban informal settlements in Nairobi in Kenya, rural Gem in Siaya county in western Kenya, and rural uMkhanyakude in KwaZulu Natal in South Africa. Each of the three settings had a long-established demographic surveillance system overlapping with an area selected by PEPFAR for DREAMS investments [13]. In each setting, a random sample of AGYW was selected from a population-wide sampling frame and enrolled into a closed cohort study, with a target sample size of approximately 1000 in each Kenyan setting, and approximately 2000 in uMkhanyakude. Sampling was stratified by younger and older AGYW at the time of enrolment, using categories of 13–17 and 18–22 years in Gem and uMkhanyakude, and 15–19 and 20–22 years in Nairobi. Enrolment was in 2017 in Nairobi and uMkhanyakude, and in 2018 in Gem, with annual follow-up to 2019.

At enrolment and at each follow-up, questionnaire data were collected on self-reported invitation to participate in DREAMS (yes or no), participation in interventions that were part of the DREAMS core package, individual and household characteristics that could be determinants of outcomes and/or invitation to DREAMS, and outcomes across themes of biological, social, and behavioral protection. Data were collected electronically using tablets, with questionnaires administered by trained research interviewers. Sensitive questions around sexual behavior were self-completed by participants on the tablet.

### DREAMS interventions

DREAMS interventions were conceptualized as a core package of evidence-based interventions, delivered to individual AGYW, their families, and the wider community [11]. Individual-level interventions aimed to empower AGYW and reduce their risk of HIV acquisition, and included HIV testing services, social asset building, condom promotion and provision, education on PrEP, social protection (including education subsidies), school-based HIV prevention curricula encompassing HIV, sex, and violence prevention education, post-violence care, and expanding the availability and range of contraceptives. There was targeted provision of

PrEP to AGYW identified as being at high risk of HIV acquisition, including young women who sell sex.

In the two Kenyan settings, one implementing partner was responsible for all intervention delivery and for which AGYW to enroll into DREAMS. Targeting criteria included household poverty, whether AGYW were in or out of school, had a child or were pregnant, and/or had lost one or both parents. In South Africa, uMkhanyakude was selected for DREAMS investments after a national geographic prioritization exercise. Multiple implementing partners delivered components of the intervention package in the same district, with community-based organizations identifying vulnerable AGYW from their registers of orphans and vulnerable children and households, and referral of AGYW by school staff, healthcare, and social workers.

Implementation began in 2016, with all interventions being delivered by 2017. Invitation to participate in DREAMS continued into 2018 in Kenya, and intervention delivery continued during 2019–2020. In uMkhanyakude, PEPFAR investments in DREAMS were discontinued at the end of 2018.

### Outcomes and explanatory variables, and analysis

Outcomes were self-reported and comprised knowledge of HIV status (defined as a self-report of HIV-positive status or testing HIV-negative in the previous 12 months), condomless sex in the previous 12 months (asked of those who reported a sexual partner in the past 12 months), number of lifetime partners, transactional sex (defined as sex in exchange for material support of any kind) in the previous 12 months, and awareness and use of condoms and PrEP. We analyzed these outcomes using 2019 data, to represent a time point 2–3 years after DREAMS interventions were established and when all AGYW who were invited to DREAMS would have participated in interventions for at least 1 year. We also analyzed knowledge of HIV status in 2018, due to the immediacy of the effect of uptake of HIV testing services on this outcome.

The impact of DREAMS was estimated by comparing outcomes among AGYW who were, or were not, invited to DREAMS by 2018. For each outcome, directed acyclic graphs (DAGs) were used to identify a minimal set of confounding variables that should be controlled for in analyses of the impact of DREAMS, informed by how DREAMS was targeted and which individual and household characteristics could influence the outcomes. This minimal set encompassed age group, highest educational achievement, currently in school, measures of household poverty including a wealth index and food insecurity, orphanhood status, ever had sex, and ever pregnant, all measured at cohort enrolment.

First, we used multivariable logistic regression to summarize the association between DREAMS invitation and each outcome with odds ratios, adjusting first only for age group and area of residence, and then for all confounding variables identified from the DAG. These analyses were done separately for each setting, and both overall and separately for younger and older AGYW.

Second, we conducted analysis within a causal inference framework to compare the percentage of AGYW with the outcome under the two counterfactual scenarios that all AGYW were invited to DREAMS vs. none were invited to DREAMS. For this, our primary analysis used propensity-score regression adjustment. The outcome of the propensity score model was invitation to DREAMS by 2018 (yes or no), with explanatory variables those in the minimal set of confounding variables. This model was used to estimate a “propensity to be invited to DREAMS” for each AGYW. For each of our outcome variables, we then fitted a logistic regression model to predict the probability of the outcome with restriction to AGYW who were DREAMS invitees; age group and the propensity score were explanatory variables. From this model, we predicted the probability of the outcome for *all* AGYW, irrespective of whether or not they were invited to DREAMS. The average value of these probabilities was used to estimate the percentage of AGYW with the outcome under the counterfactual scenario that all AGYW were DREAMS invitees. We repeated this approach for AGYW who were not invited to DREAMS, to estimate the percentage of AGYW with the outcome under the counterfactual scenario that no AGYW were DREAMS invitees. We present these average predictions overall, and separately for younger and older AGYW.

We used bootstrapping on 1000 samples drawn with replacement to obtain confidence intervals for our predicted percentages with the outcome, and for the difference in the percentages between the two counterfactual scenarios. We also conducted sensitivity analyses, using inverse-probability-of-treatment (IPTW) weighting (with probability of treatment equal to the propensity score), stratification on the propensity score, and also using predictions derived from a multivariable logistic regression model of the outcome variable on the minimal confounding set of explanatory variables.

### Ethics

Approvals were granted by research ethics committees at the London School of Hygiene and Tropical Medicine, the University of KwaZulu-Natal, Amref Health Africa, the Kenyan Medical Research Institute, University College London, and the Liverpool School of Tropical Medicine. Written informed consent was obtained from participants aged at least 18 years. For legal minors less than 18 years, guardian consent was taken first before a girl's assent was sought.

## Results

### Cohort enrolment and retention

In Nairobi 1081, in Gem 1171, and in uMkhanyakude 2184 AGYW were enrolled to the cohort. Cohort retention in 2019 was high, at 79% in Nairobi, 87% in Gem, and 78% in uMkhanyakude (S1 Table, <http://links.lww.com/QAD/C428>). Retention was higher among AGYW who were invited to participate in DREAMS compared with those who were not, with a larger difference among older than younger AGYW, and in Nairobi compared with Gem and uMkhanyakude.

Retention was at least 65% across most categories of participant characteristics, as measured at enrolment (S1 Table, <http://links.lww.com/QAD/C428>), with the largest differentials according to educational and sexual experience. In Nairobi and uMkhanyakude, retention was around 10–20% higher among those in vs. out of schooling at enrolment. Among older AGYW, retention was around 15–20% lower among those who had ever had sex compared with those who had not in Nairobi and

Gem, with no clear patterns in uMkhanyakude; differentials were smaller among younger AGYW, among whom around 90% reported at enrolment that they had never had sex.

### Characteristics at enrolment

Among AGYW followed up in 2019, the percentage who had been invited to DREAMS by 2018 was 74% (628/852) in Nairobi, 57% (582/1018) in Gem, and 53% (903/1712) in uMkhanyakude (Tables 1–3). The corresponding figures were higher among younger AGYW (80% (369/464) in Nairobi, 58% (361/622) in Gem, and 63% (608/972) in uMkhanyakude) and lower among older AGYW (67% (259/388) in Nairobi, 56% (221/396) in Gem, and 40% (295/740) in uMkhanyakude).

Comparing AGYW who were invited to DREAMS by 2018 with those who were not, differentials in characteristics at enrolment were relatively small and around 5–10% in absolute terms (Tables 1–3). For example, DREAMS invitees were more likely to be enrolled in school, to report household food insecurity

**Table 1. Characteristics at enrolment, Nairobi.**

	Overall		15–17 years		18–22 years	
	Invited to DREAMS		Invited to DREAMS		Invited to DREAMS	
	No n (%)	Yes n (%)	No n (%)	Yes n (%)	No n (%)	Yes n (%)
Currently in school						
No	109 (48.7)	203 (32.3)	20 (21.1)	47 (12.7)	89 (69)	156 (60.2)
Yes	115 (51.3)	425 (67.7)	75 (78.9)	322 (87.3)	40 (31)	103 (39.8)
Highest education completed						
None/incomplete primary	30 (13.4)	62 (9.9)	19 (20.0)	47 (12.7)	11 (8.5)	15 (5.8)
Complete primary	54 (24.1)	116 (18.5)	26 (27.4)	76 (20.6)	28 (21.7)	40 (15.4)
Some secondary	76 (33.9)	334 (53.2)	43 (45.3)	236 (64.0)	33 (25.6)	98 (37.8)
Complete secondary/tertiary	64 (28.6)	116 (18.5)	7 (7.4)	10 (2.7)	57 (44.2)	106 (40.9)
Food insecurity						
No	166 (74.1)	398 (63.4)	70 (73.7)	232 (62.9)	96 (74.4)	166 (64.1)
Yes	58 (25.9)	230 (36.6)	25 (26.3)	137 (37.1)	33 (25.6)	93 (35.9)
Self-assessed household poverty						
Very poor	23 (10.3)	92 (14.6)	8 (8.4)	50 (13.6)	15 (11.6)	42 (16.2)
Moderately poor	180 (80.4)	492 (78.3)	79 (83.2)	289 (78.3)	101 (78.3)	203 (78.4)
Not poor	21 (9.4)	44 (7.0)	8 (8.4)	30 (8.1)	13 (10.1)	14 (5.4)
Wealth tertile						
Third (lowest)	77 (34.4)	226 (36.0)	36 (37.9)	138 (37.4)	41 (31.8)	88 (34.0)
Second (intermediate)	79 (35.3)	198 (31.5)	38 (40.0)	118 (32.0)	41 (31.8)	80 (30.9)
First (highest)	68 (30.4)	204 (32.5)	21 (22.1)	113 (30.6)	47 (36.4)	91 (35.1)
Sexual and pregnancy history						
Never had sex	125 (55.8)	432 (68.8)	82 (86.3)	332 (90.0)	43 (33.3)	100 (38.6)
Ever had sex, never pregnant	26 (11.6)	64 (10.2)	6 (6.3)	19 (5.1)	20 (15.5)	45 (17.4)
Ever pregnant	73 (32.6)	132 (21.0)	7 (7.4)	18 (4.9)	66 (51.2)	114 (44.0)
Lifetime partners						
0	125 (55.8)	432 (68.8)	82 (86.3)	332 (90.0)	43 (33.3)	100 (38.6)
1	60 (26.8)	102 (16.2)	11 (11.6)	26 (7.0)	49 (38.0)	76 (29.3)
≥2	39 (17.4)	94 (15)	2 (2.1)	11 (3.0)	37 (28.7)	83 (32.0)
Marital status						
Never married	161 (71.9)	534 (85.0)	92 (96.8)	362 (98.1)	69 (53.5)	172 (66.4)
Currently married	54 (24.1)	79 (12.6)	2 (2.1)	7 (1.9)	52 (40.3)	72 (27.8)
Previously married	9 (4.0)	15 (2.4)	1 (1.1)	0 (0.0)	8 (6.2)	15 (5.8)
Orphanhood status						
Not an orphan	170 (75.9)	493 (78.5)	75 (78.9)	297 (80.5)	95 (73.6)	196 (75.7)
Single/double orphan	54 (24.1)	135 (21.5)	20 (21.1)	72 (19.5)	34 (26.4)	63 (24.3)

**Table 2. Characteristics at enrolment, Gem.**

	Overall		13–17 years		18–22 years	
	Invited to DREAMS		Invited to DREAMS		Invited to DREAMS	
	No <i>n</i> (%)	Yes <i>n</i> (%)	No <i>n</i> (%)	Yes <i>n</i> (%)	No <i>n</i> (%)	Yes <i>n</i> (%)
Highest education completed						
Primary/None	175 (40.1)	260 (44.7)	136 (52.1)	221 (61.2)	39 (22.3)	39 (17.6)
Secondary and above	143 (32.8)	229 (39.3)	61 (23.4)	84 (23.3)	82 (46.9)	145 (65.6)
Unknown	118 (27.1)	93 (16.0)	64 (24.5)	56 (15.5)	54 (30.9)	37 (16.7)
Food insecurity						
No	360 (82.6)	429 (73.7)	218 (83.5)	276 (76.5)	142 (81.1)	153 (69.2)
Yes	76 (17.4)	153 (26.3)	43 (16.5)	85 (23.5)	33 (18.9)	68 (30.8)
Self-assessed household poverty						
Very poor	48 (11.0)	81 (13.9)	38 (14.6)	55 (15.2)	10 (5.7)	26 (11.8)
Moderately poor	307 (70.4)	424 (72.9)	176 (67.4)	254 (70.4)	131 (74.9)	170 (76.9)
Not poor	81 (18.6)	77 (13.2)	47 (18.0)	52 (14.4)	34 (19.4)	25 (11.3)
Wealth tertile						
Third (lowest)	157 (36.0)	267 (45.9)	101 (38.7)	160 (44.3)	56 (32.0)	107 (48.4)
Second (intermediate)	83 (19.0)	112 (19.2)	52 (19.9)	69 (19.1)	31 (17.7)	43 (19.5)
First (highest)	196 (45.0)	203 (34.9)	108 (41.4)	132 (36.6)	88 (50.3)	71 (32.1)
Sexual and pregnancy history						
Never had sex	279 (64.0)	422 (72.5)	221 (84.7)	330 (91.4)	58 (33.1)	92 (41.6)
Ever had sex, never pregnant	76 (17.4)	82 (14.1)	31 (11.9)	25 (6.9)	45 (25.7)	57 (25.8)
Ever pregnant	81 (18.6)	78 (13.4)	9 (3.4)	6 (1.7)	72 (41.1)	72 (32.6)
Lifetime partners						
0	280 (64.2)	422 (72.5)	221 (84.7)	330 (91.4)	59 (33.7)	92 (41.6)
1	76 (17.4)	100 (17.2)	28 (10.7)	27 (7.5)	48 (27.4)	73 (33.0)
≥2	80 (18.3)	60 (10.3)	12 (4.6)	4 (1.1)	68 (38.9)	56 (25.3)
Orphanhood status						
Not an orphan	259 (59.4)	356 (61.2)	164 (62.8)	232 (64.3)	95 (54.3)	124 (56.1)
Maternal orphan	15 (3.4)	20 (3.4)	8 (3.1)	9 (2.5)	7 (4.0)	11 (5.0)
Paternal orphan	36 (8.3)	56 (9.6)	24 (9.2)	29 (8.0)	12 (6.9)	27 (12.2)
Double orphan	19 (4.4)	14 (2.4)	8 (3.1)	6 (1.7)	11 (6.3)	8 (3.6)
Unknown	107 (24.5)	136 (23.4)	57 (21.8)	85 (23.5)	50 (28.6)	51 (23.1)

**Table 3. Characteristics at enrolment, uMkhanyakude.**

	Overall		13–17 years		18–22 years	
	Invited to DREAMS		Invited to DREAMS		Invited to DREAMS	
	No <i>n</i> (%)	Yes <i>n</i> (%)	No <i>n</i> (%)	Yes <i>n</i> (%)	No <i>n</i> (%)	Yes <i>n</i> (%)
Currently in school						
No	248 (30.7)	111 (12.3)	5 (1.4)	5 (0.8)	243 (54.6)	106 (35.9)
Yes	561 (69.3)	792 (87.7)	359 (98.6)	603 (99.2)	202 (45.4)	189 (64.1)
Highest education completed						
None/incomplete primary	67 (8.3)	109 (12.1)	49 (13.5)	104 (17.1)	18 (4.1)	5 (1.7)
Some secondary	591 (73.1)	732 (81.1)	314 (86.3)	502 (82.6)	277 (62.4)	230 (78.0)
Complete secondary/tertiary	150 (18.6)	62 (6.9)	1 (0.3)	2 (0.3)	149 (33.6)	60 (20.3)
Food insecurity						
No	528 (65.4)	647 (71.9)	290 (79.9)	467 (77.2)	238 (53.6)	180 (61.0)
Yes	279 (34.6)	253 (28.1)	73 (20.1)	138 (22.8)	206 (46.4)	115 (39.0)
Wealth tertile						
Third (lowest)	247 (32.2)	345 (39.2)	97 (27.4)	231 (39.0)	150 (36.2)	114 (39.9)
Second (intermediate)	277 (36.1)	299 (34.0)	129 (36.4)	195 (32.9)	148 (35.7)	104 (36.4)
First (highest)	244 (31.8)	235 (26.7)	128 (36.2)	167 (28.2)	116 (28.0)	68 (23.8)
Sexual and pregnancy history						
Never had sex	424 (53.0)	636 (70.6)	321 (89.4)	542 (89.4)	103 (23.4)	94 (31.9)
Ever had sex, never pregnant	117 (14.6)	101 (11.2)	18 (5.0)	37 (6.1)	99 (22.4)	64 (21.7)
Ever pregnant	259 (32.4)	164 (18.2)	20 (5.6)	27 (4.5)	239 (54.2)	137 (46.4)
Lifetime partners						
0	426 (52.7)	637 (70.5)	321 (88.2)	542 (89.1)	105 (23.6)	95 (32.2)
1	65 (8.0)	63 (7.0)	13 (3.6)	18 (3.0)	52 (11.7)	45 (15.3)
≥2	67 (8.3)	32 (3.5)	5 (1.4)	4 (0.7)	62 (13.9)	28 (9.5)
Unknown	251 (31.0)	171 (18.9)	25 (6.9)	44 (7.2)	226 (50.8)	127 (43.1)
Ever migrated						
No	648 (80.1)	784 (86.8)	338 (92.9)	570 (93.8)	310 (69.7)	214 (72.5)
Yes	161 (19.9)	119 (13.2)	26 (7.1)	38 (6.3)	135 (30.3)	81 (27.5)

(in Kenya), and less likely to report they had ever had sex, than those not invited to DREAMS.

### Estimated impact of DREAMS on outcomes

*Knowledge of HIV status, in 2018 and 2019* In 2018, in all three settings and for both younger and older AGYW, knowledge of HIV status was higher among those invited to DREAMS compared with those not invited (Table 4). Among older AGYW, the corresponding percentages were 89 vs. 73% in Nairobi, 85 vs. 74% in Gem, and 73 vs. 71% in uMkhanyakude, with adjusted odds ratios (aORs) of 3.3, 1.8, and 1.4, respectively. Among younger AGYW, comparing DREAMS invitees with non-invitees, the percentage who knew their HIV status was 83 vs. 46% in Nairobi, 78 vs. 64% in Gem, and 43 vs. 33% in uMkhanyakude, with aORs of 8.4, 2.0, and 1.5, respectively.

We estimated that the percentages of AGYW who would know their HIV status in 2018, comparing the scenarios that all were invited to DREAMS vs. none were invited, were 86 vs. 56% in Nairobi [difference, 29.3% increase due to DREAMS with 95% confidence interval (95% CI) 21.9–37.0], 80 vs. 68% in Gem (difference, 11.8% with 95% CI 6.6–17.0), and 56 vs. 49% in uMkhanyakude (difference, 7.0% with 95% CI 2.8–11.4) (Table 5, Fig. 1). Differentials were larger among younger than older AGYW.

In 2019, the differentials in knowledge of HIV status between DREAMS invitees and non-invitees were smaller than in 2018, and in uMkhanyakude there was no longer evidence of a differential (S2, <http://links.lww.com/QAD/C428> and S3, <http://links.lww.com/QAD/C428> Tables).

### *Condomless sex at least once in the previous 12 months in 2019, among all adolescent girls and young women*

Among older AGYW, the percentage who reported condomless sex was lower among DREAMS invitees than non-invitees in the Kenyan settings (49 vs. 61% in Nairobi; 23 vs. 37% in Gem), and did not differ by DREAMS invitation in uMkhanyakude (46 vs. 48%) (Table 4). We estimated that the percentages who would report condomless sex, comparing the scenarios that all were invited to DREAMS vs. none were invited, were 50 vs. 57% in Nairobi (difference, -6.2% with 95% CI -16.3 to 4.4), 26 vs. 37% in Gem (difference, -11.5% with 95% CI -21.8 to -0.2), and 48 vs. 47% in uMkhanyakude (difference, 1.5% with 95% CI -6.4 to 9.1), with evidence for a reduction due to DREAMS only in Gem (Table 5, Fig. 1).

Among younger AGYW, the percentage who reported condomless sex was considerably lower than among older AGYW (Table 4). We estimated that the percentages who would report condomless sex, comparing the scenarios that all were invited to DREAMS vs. none were invited,

were 19 vs. 11% in Nairobi (difference, 8% with 95% CI 0.7–15.0), 4 vs. 7% in Gem (difference, -2.9% with 95% CI -6.2 to 0.6), and 12 vs. 12% in uMkhanyakude (difference, 0.2% with 95% CI -7.0 to 3.9) (Table 5, Fig. 1), with weak evidence of an increase due to DREAMS in Nairobi and of a decrease due to DREAMS in Gem.

### *Condomless sex at least once in the previous 12 months in 2019, among sexually active adolescent girls and young women*

Among older AGYW, the percentage who reported they were sexually active during the previous 12 months was lower among DREAMS invitees than non-invitees, at 59% (152/259) vs. 65% (84/129) in Nairobi, 50% (110/221) vs. 67% (117/175) in Gem, and 75% (220/295) vs. 77% (344/445) in uMkhanyakude. With analysis restricted to sexually active AGYW, the percentages of DREAMS invitees and non-invitees who reported condomless sex were 84 vs. 94% in Nairobi, 47 vs. 56% in Gem, and 61 vs. 62% in uMkhanyakude, with aORs of 0.2 (95% CI 0.1–0.8), 0.8 (95% CI 0.4–1.4), and 1.0 (0.7–1.4), respectively (Table 4).

Among younger AGYW, the percentage who reported they were sexually active during the previous 12 months was higher among DREAMS invitees than non-invitees in Nairobi, at 23% (85/369) vs. 18% (17/95), lower in Gem at 10% (37/361) vs. 14% (36/261), and the same in uMkhanyakude at 20% (122/608) vs. 20% (71/364). With analysis restricted to sexually active AGYW, the percentages of DREAMS invitees and non-invitees who reported condomless sex were 82 vs. 71% in Nairobi, 35 vs. 47% in Gem, and 62 vs. 59% in uMkhanyakude, with aORs of 3.6 (95% CI 0.8–15.9), 0.9 (95% CI 0.3–2.9), and 1.2 (95% CI 0.6–2.2), respectively (Table 4).

Combining older and younger AGYW, and comparing the scenarios that all were invited to DREAMS vs. none were invited, we estimated that the percentages of sexually active AGYW who would report condomless sex were 83 vs. 84% in Nairobi, 46 vs. 52% in Gem, and 62 vs. 61% in uMkhanyakude, with a suggestion of a reduction due to DREAMS in Gem (Table 5, Fig. 1). Restricting analysis to older AGYW, there was a suggestion of a reduction in condomless sex due to DREAMS in Nairobi.

### *Lifetime partners, in 2019*

Among older AGYW, comparing DREAMS invitees with non-invitees, the percentages who reported at least two lifetime partners were 37 vs. 42% in Nairobi, 34 vs. 45% in Gem, and 38 vs. 49% in uMkhanyakude, with aORs of 0.9 (95% CI 0.6–1.4), 0.8 (95% CI 0.5–1.3), and 0.9 (95% CI 0.6–1.2), respectively, with no evidence of a difference due to DREAMS (Table 4). We estimated that the percentages who would report at least two lifetime partners, comparing the scenarios that all were

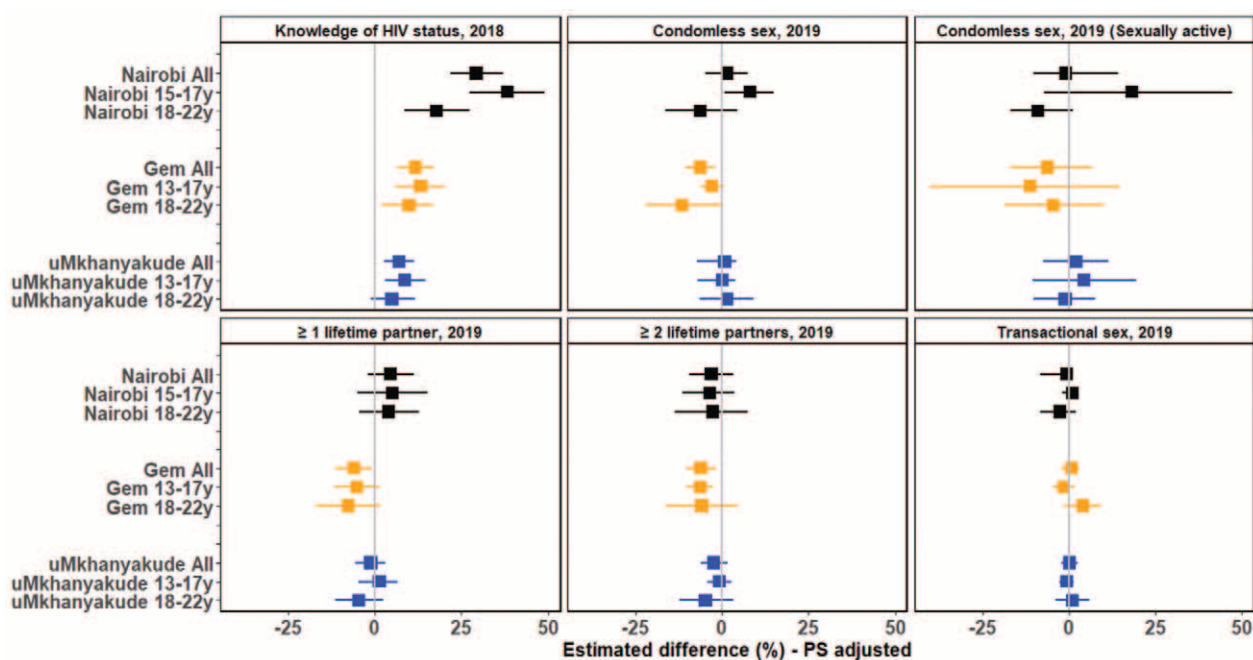
Table 4. Impact of DREAMS on outcomes, from multivariable logistic regression.

Outcome			Overall		Not invited to DREAMS by 2018v		Invited to DREAMS by 2018		Unadjusted OR, 95% CIv		Age-area adjusted OR, 95%, CI		Multivariable-adjusted OR, 95%, CI			
			n/N	%	n/N	%	n/N	%	OR	95% CI	OR	95%, CI	OR	95% CI	P	
Knowledge of HIV status, 2018	Nairobi	Overall	662/836	79.2	129/212	60.8	533/624	85.4	3.8	(2.6–5.4)	4.4	(3.0–6.4)	5.1	(3.4–7.6)	P < 0.001	
		15–17 years	352/466	75.5	43/94	45.7	309/372	83.1	5.8	(3.6–9.5)	6.0	(3.6–9.8)	8.4	(4.8–15.0)	P < 0.001	
		18–22 years	310/370	83.8	86/118	72.9	224/252	88.9	3.0	(1.7–5.2)	3.1	(1.8–5.6)	3.3	(1.8–6.2)	P < 0.001	
	Gem	Overall	880/1171	75.1	351/514	68.3	529/657	80.5	1.9	(1.5–2.5)	2.0	(1.5–2.7)	1.9	(1.5–2.5)	P < 0.001	
		13–17 years	492/684	71.9	182/285	63.9	310/399	77.7	2.0	(1.4–2.8)	2.1	(1.5–2.9)	2.0	(1.4–2.9)	P < 0.001	
		18–22 years	388/487	79.7	169/229	73.8	219/258	84.9	2.0	(1.3–3.1)	1.9	(1.2–3.0)	1.8	(1.1–2.9)	P = 0.02	
	uMkhanyakude	Overall	993/1853	53.6	480/886	54.2	513/967	53.1	1.0	(0.8–1.1)	1.4	(1.1–1.7)	1.4	(1.1–1.8)	P = 0.02	
		13–17 years	410/1041	39.4	128/389	32.9	282/652	43.3	1.6	(1.2–2.0)	1.5	(1.2–2.0)	1.5	(1.1–2.0)	P = 0.008	
		18–22 years	583/812	71.8	352/497	70.8	231/315	73.3	1.1	(0.8–1.6)	1.3	(0.9–1.7)	1.4	(1.0–2.0)	P = 0.06	
	Condomless sex, 2019	Nairobi	Overall	288/852	33.8	91/224	40.6	197/628	31.4	0.7	(0.5–0.9)	0.9	(0.6–1.3)	1.0	(0.6–1.5)	P = 0.96
			15–17 years	82/464	17.7	12/95	12.6	70/369	19.0	1.6	(0.8–3.1)	1.6	(0.8–3.0)	2.5	(1.1–5.3)	P = 0.022
			18–22 years	206/388	53.1	79/129	61.2	127/259	49.0	0.6	(0.4–0.9)	0.7	(0.4–1.0)	0.6	(0.4–1.1)	P = 0.11
Gem		Overall	147/1018	14.4	82/436	18.8	65/582	11.2	0.5	(0.4–0.8)	0.5	(0.4–0.8)	0.6	(0.4–0.8)	P = 0.006	
		13–17 years	30/622	4.8	17/261	6.5	13/361	3.6	0.5	(0.3–1.1)	0.5	(0.3–1.1)	0.5	(0.2–1.1)	P = 0.088	
		18–22 years	117/396	29.5	65/175	37.1	52/221	23.5	0.5	(0.3–0.8)	0.6	(0.4–0.9)	0.6	(0.4–1.0)	P = 0.062	
uMkhanyakude		Overall	466/1712	27.2	255/809	31.5	211/903	23.4	0.7	(0.5–0.8)	1.0	(0.8–1.2)	1.1	(0.8–1.4)	P = 0.63	
		13–17 years	118/972	12.1	42/364	11.5	76/608	12.5	1.1	(0.7–1.6)	1.1	(0.7–1.6)	1.1	(0.7–1.8)	P = 0.68	
		18–22 years	348/740	47.0	213/445	47.9	135/295	45.8	0.9	(0.7–1.2)	0.9	(0.7–1.2)	1.0	(0.8–1.4)	P = 0.79	
Condomless sex among sexually active AGYW, 2019		Nairobi	Overall	288/338	85.2	91/101	90.1	197/237	83.1	0.5	(0.3–1.1)	0.6	(0.3–1.3)	0.5	(0.2–1.3)	P = 0.18
			15–17 years	82/102	80.4	12/17	70.6	70/85	82.4	1.9	(0.6–6.3)	2.1	(0.6–7.1)	3.6	(0.8–15.9)	P = 0.092
			18–22 years	206/236	87.3	79/84	94.0	127/152	83.6	0.3	(0.1–0.9)	0.3	(0.1–0.9)	0.2	(0.07–0.8)	P = 0.023
	Gem	Overall	147/300	49.0	82/153	53.6	65/147	44.2	0.7	(0.4–1.1)	0.7	(0.4–1.1)	0.7	(0.5–1.2)	P = 0.24	
		13–17 years	30/73	41.1	17/36	47.2	13/37	35.1	0.6	(0.2–1.6)	0.6	(0.2–1.5)	0.9	(0.3–2.9)	P = 0.92	
		18–22 years	117/227	51.5	65/117	55.6	52/110	47.3	0.7	(0.4–1.2)	0.7	(0.4–1.2)	0.8	(0.4–1.4)	P = 0.43	
	uMkhanyakude	Overall	466/757	61.6	255/415	61.4	211/342	61.7	1.0	(0.7–1.4)	1.0	(0.7–1.4)	1.0	(0.7–1.4)	P = 0.86	
		13–17 years	118/193	61.1	42/71	59.2	76/122	62.3	1.1	(0.6–2.1)	1.2	(0.6–2.1)	1.2	(0.6–2.2)	P = 0.56	
		18–22 years	348/564	61.7	213/344	61.9	135/220	61.4	1.0	(0.7–1.4)	0.9	(0.7–1.4)	1.0	(0.7–1.4)	P = 0.89	
	≥1 lifetime partner, 2019	Nairobi	Overall	442/852	51.9	128/224	57.1	314/628	50.0	0.7	(0.5–1.0)	1.1	(0.7–1.5)	1.2	(0.8–1.8)	P = 0.33
			15–17 years	142/464	30.6	28/95	29.5	114/369	30.9	1.1	(0.6–1.7)	1.2	(0.7–2.1)	1.5	(0.8–2.7)	P = 0.19
			18–22 years	300/388	77.3	100/129	77.5	200/259	77.2	1.0	(0.6–1.6)	1.1	(0.6–1.6)	1.2	(0.7–2.2)	P = 0.46
Gem		Overall	372/1018	36.5	183/436	42.0	189/582	32.5	0.7	(0.5–0.9)	0.6	(0.5–0.9)	0.7	(0.5–0.9)	P = 0.018	
		13–17 years	99/622	15.9	50/261	19.2	49/361	13.6	0.7	(0.4–1.0)	0.7	(0.4–1.0)	0.7	(0.5–1.1)	P = 0.087	
		18–22 years	273/396	68.9	133/175	76.0	140/221	63.4	0.5	(0.3–0.8)	0.5	(0.4–1.0)	0.7	(0.4–1.2)	P = 0.21	
uMkhanyakude		Overall	708/1595	44.4	391/743	52.6	317/852	37.2	0.5	(0.4–0.6)	0.8	(0.6–1.1)	0.9	(0.7–1.2)	P = 0.63	
		13–17 years	190/946	20.1	70/354	19.8	120/592	20.3	1.0	(0.7–1.4)	0.9	(0.7–1.4)	0.9	(0.6–1.3)	P = 0.72	
		18–22 years	518/649	79.8	321/389	82.5	197/260	75.8	0.7	(0.4–1.0)	0.7	(0.5–1.1)	0.9	(0.6–1.5)	P = 0.81	
≥2 lifetime partners, 2019		Nairobi	Overall	198/852	23.2	67/224	29.9	131/628	20.9	0.6	(0.4–0.9)	0.8	(0.5–1.1)	0.8	(0.6–1.2)	P = 0.38
			15–17 years	49/464	10.6	13/95	13.7	36/369	9.8	0.7	(0.3–1.3)	0.7	(0.3–1.4)	0.7	(0.3–1.4)	P = 0.30
			18–22 years	149/388	38.4	54/129	41.9	95/259	36.7	0.8	(0.5–1.2)	0.8	(0.5–1.3)	0.9	(0.6–1.4)	P = 0.66
	Gem	Overall	186/1018	18.3	102/436	23.4	84/582	14.4	0.5	(0.4–0.8)	0.5	(0.4–0.8)	0.6	(0.4–0.9)	P = 0.009	
		13–17 years	32/622	5.1	23/261	8.8	9/361	2.5	0.3	(0.1–0.6)	0.3	(0.1–0.6)	0.3	(0.1–0.6)	P = 0.001	
		18–22 years	154/396	38.9	79/175	45.1	75/221	33.9	0.6	(0.4–0.9)	0.7	(0.5–1.1)	0.8	(0.5–1.3)	P = 0.36	
	uMkhanyakude	Overall	361/1595	22.6	220/743	29.6	141/852	16.5	0.5	(0.4–0.6)	0.7	(0.6–1.0)	0.8	(0.6–1.1)	P = 0.27	
		13–17 years	71/946	7.5	29/354	8.2	42/592	7.1	0.9	(0.5–1.4)	0.8	(0.5–1.3)	0.8	(0.5–1.3)	P = 0.32	
		18–22 years	290/649	44.7	191/389	49.1	99/260	38.1	0.6	(0.5–0.9)	0.7	(0.5–1.0)	0.9	(0.6–1.2)	P = 0.40	
	Transactional sex, 2019	Nairobi	Overall	30/852	3.5	11/224	4.9	19/628	3.0	0.6	(0.3–1.3)	0.7	(0.3–1.6)	0.7	(0.3–1.6)	P = 0.41
			15–17 years	8/464	1.7	1/95	1.1	7/369	1.9	1.8	(0.2–15.0)	2.0	(0.2–16.6)	1.8	(0.2–15.7)	P = 0.58
			18–22 years	22/388	5.7	10/129	7.8	12/259	4.6	0.6	(0.2–1.4)	0.6	(0.2–1.3)	0.5	(0.2–1.3)	P = 0.19
Gem		Overall	47/1018	4.6	20/436	4.6	27/582	4.6	1.0	(0.6–1.8)	1.0	(0.6–1.9)	1.2	(0.6–2.3)	P = 0.57	
		13–17 years	20/622	3.2	11/261	4.2	9/361	2.5	0.6	(0.2–1.4)	0.6	(0.2–1.4)	0.9	(0.3–2.8)	P = 0.88	
		18–22 years	27/396	6.8	9/175	5.1	18/221	8.1	1.6	(0.7–3.7)	1.6	(0.7–3.7)	1.6	(0.7–3.9)	P = 0.28	
uMkhanyakude		Overall	102/1712	6.0	57/809	7.0	45/903	5.0	0.7	(0.5–1.0)	1.0	(0.6–1.5)	1.0	(0.6–1.6)	P = 0.97	
		13–17 years	24/972	2.5	10/364	2.7	14/608	2.3	0.8	(0.4–1.9)	0.9	(0.4–2.0)	0.8	(0.3–1.9)	P = 0.66	
		18–22 years	78/740	10.5	47/445	10.6	31/295	10.5	1.0	(0.6–1.6)	1.1	(0.7–1.7)	1.1	(0.7–1.9)	P = 0.60	

Table 5. Estimated impact of DREAMS on outcomes, comparing the counterfactual scenarios that all vs. no AGYW were invited to DREAMS by 2018.

Outcome			% with outcome in total study population (observed)	Estimated % with outcome if no AGYW are invited to DREAMS, & 95% CI	Estimated % with outcome if all AGYW are invited to DREAMS, & 95% CI	Difference in estimated % with outcome; all AGYW invited to DREAMS - no AGYW invited to DREAMS, & 95% CI
Knowledge of HIV status, 2018	Nairobi	Overall	79.2	56.2 (49.1–63.4)	85.5 (82.8–88.3)	29.3 (21.9,37.0)
		15–17y	75.5	44.6 (34.3–55.1)	83.0 (79.2–87.1)	38.4 (27.4,49.1)
		18–22y	83.8	70.8 (62.1–79.5)	88.7 (84.6–92.7)	17.9 (8.4,27.5)
	Gem	Overall	75.2	68.3 (64.2–72.5)	80.1 (77.0–83.4)	11.8 (6.6,17.0)
		13–17y	71.9	64.1 (58.3–69.5)	77.3 (73.0–81.2)	13.2 (6.1,20.2)
		18–22y	79.7	74.2 (68.6–79.7)	84.1 (79.2–88.8)	9.9 (2.2,16.9)
	uMkhanyakude	Overall	53.6	49.5 (46.2–52.8)	56.5 (53.4–59.5)	7.0 (2.8,11.4)
		13–17y	39.4	33.6 (28.8–38.3)	42.3 (38.6–45.9)	8.7 (3.0,14.6)
		18–22y	71.8	69.8 (65.5–73.9)	74.8 (70.2–79.2)	4.9 (-1.3,11.6)
Condomless sex, 2019	Nairobi	Overall	33.8	31.8 (26.2–37.4)	33.4 (29.9–37.0)	1.6 (-4.6,7.6)
		15–17y	17.7	11.1 (5.5–17.6)	19.2 (15.2–23.3)	8.1 (0.7,15.0)
		18–22y	53.1	56.6 (47.0–65.3)	50.4 (44.4–56.5)	-6.2 (-16.3,4.4)
	Gem	Overall	14.4	18.4 (14.8–22.3)	12.2 (9.3–14.9)	-6.3 (-10.6,-2.0)
		13–17y	4.8	6.6 (4.1–9.7)	3.7 (1.8–5.8)	-2.9 (-6.2,0.6)
		18–22y	29.5	37.0 (28.6–46.7)	25.5 (19.4–31.2)	-11.5 (-21.8,-0.2)
	uMkhanyakude	Overall	27.2	26.9 (24.6–34.5)	27.7 (24.6–30.8)	0.8 (-7.1,4.1)
		13–17y	12.1	11.8 (9.0–19.5)	12.0 (9.7–14.7)	0.2 (-7.0,3.9)
		18–22y	47.0	46.6 (41.8–51.1)	48.1 (42.2–53.8)	1.5 (-6.4,9.1)
Condomless sex among sexually active AGYW, 2019	Nairobi	Overall	85.2	84.3 (70.2–92.2)	83.4 (78.5–88.5)	-0.9 (-10.3,14.1)
		15–17y	80.4	64.2 (35.8–88.4)	82.3 (74.2–90.3)	18.1 (-7.3,47.2)
		18–22y	87.3	92.9 (84.5–97.5)	83.9 (78.0–89.8)	-9.0 (-16.9,1.2)
	Gem	Overall	49.0	51.8 (43.6–59.9)	45.7 (37.1–53.7)	-6.1 (-17.0,6.7)
		13–17y	41.1	46.6 (28.1–62.1)	35.4 (18.0–49.5)	-11.2 (-40.2,14.7)
		18–22y	51.5	53.4 (44.7–62.7)	49.0 (37.1–58.4)	-4.5 (-18.5,9.9)
	uMkhanyakude	Overall	61.6	59.9 (52.9–66.7)	61.9 (55.9–67.9)	2.0 (-7.4,11.5)
		13–17y	61.1	58.0 (45.8–70.0)	62.3 (52.9–71.0)	4.3 (-10.4,19.5)
		18–22y	61.7	62.4 (57.0–67.5)	61.3 (54.4–68.2)	-1.1 (-10.1,7.6)
≥1 lifetime partner, 2019	Nairobi	Overall	51.9	48.0 (42.1–54.5)	52.6 (49.0–56.3)	4.6 (-2.0,11.3)
		15–17y	30.6	26.1 (17.8–35.5)	31.2 (26.9–36.3)	5.1 (-5.0,15.3)
		18–22y	77.3	74.1 (66.2–81.3)	78.1 (73.3–82.6)	4.0 (-4.4,12.6)
	Gem	Overall	36.5	40.7 (36.4–44.8)	34.6 (31.0–38.3)	-6.1 (-11.4,-1.0)
		13–17y	15.9	19.3 (14.5–24.4)	14.1 (10.5–18.0)	-5.2 (-11.7,1.2)
		18–22y	68.9	74.4 (67.0–81.7)	66.8 (61.0–72.5)	-7.6 (-17.0,1.7)
	uMkhanyakude	Overall	44.4	45.4 (42.1–49.2)	44.2 (41.0–47.4)	-1.2 (-5.7,2.9)
		13–17y	20.1	19.0 (15.0–23.3)	20.3 (17.0–23.6)	1.3 (-4.8,6.7)
		18–22y	79.8	81.0 (76.6–85.2)	76.4 (71.0–81.5)	-4.6 (-11.3,2.4)
≥2 lifetime partners, 2019	Nairobi	Overall	23.2	25.7 (20.1–31.3)	22.6 (19.3–25.9)	-3.1 (-9.4,3.3)
		15–17y	10.6	13.5 (7.2–20.5)	10.0 (6.9–13.4)	-3.5 (-11.3,3.7)
		18–22y	38.4	40.2 (31.8–49.1)	37.5 (31.8–43.6)	-2.7 (-13.6,7.6)
	Gem	Overall	18.3	22.4 (18.8–25.9)	16.3 (13.2–19.5)	-6.1 (-10.4,-1.8)
		13–17y	5.1	8.9 (5.4–12.4)	2.6 (1.2–4.4)	-6.3 (-10.3,-2.4)
		18–22y	38.9	43.6 (36.2–51.7)	37.8 (31.0–44.6)	-5.8 (-16.5,4.4)
	uMkhanyakude	Overall	22.6	24.4 (21.7–27.3)	22.0 (18.9–25.2)	-2.4 (-6.2,1.7)
		13–17y	7.5	8.0 (5.2–10.9)	7.2 (5.2–9.3)	-0.8 (-4.2,2.7)
		18–22y	44.7	46.6 (41.2–51.6)	41.9 (35.7–47.9)	-4.7 (-12.1,3.2)
Transactional sex, 2019	Nairobi	Overall	3.5	3.8 (2.4–11.1)	3.2 (1.8–4.7)	-0.6 (-8.2,1.2)
		15–17y	1.7	0.9 (0.8–3.5)	1.9 (0.6–3.4)	1.0 (-1.8,2.4)
		18–22y	5.7	7.2 (3.7–12.5)	4.7 (2.2–7.3)	-2.6 (-8.3,2.1)
	Gem	Overall	4.6	4.4 (2.5–6.4)	5.1 (0.3–7.1)	0.7 (-2.2,3.2)
		13–17y	3.2	4.1 (1.8–6.6)	2.6 (1.1–4.6)	-1.5 (-4.6,1.6)
		18–22y	6.8	4.9 (2.2–8.5)	9.0 (5.2–13.1)	4.1 (-1.4,9.3)
	uMkhanyakude	Overall	6	5.8 (4.3–7.4)	6.0 (4.2–7.9)	0.2 (-2.3,2.4)
		13–17y	2.5	2.8 (1.3–4.6)	2.3 (1.1–3.6)	-0.6 (-2.7,1.5)
		18–22y	10.5	9.9 (7.2–12.8)	11.0 (7.2–14.8)	1.1 (-3.9,5.8)





**Fig. 1.** Estimated difference in the percentage of AGYW with each outcome, comparing the scenario that all AGYW vs. no AGYW were invited to DREAMS by 2018 (difference = estimated % with outcome if all AGYW invited to DREAMS – estimated % with outcome if no AGYW invited to DREAMS).

invited to DREAMS vs. none were invited, were 37 vs. 40% in Nairobi, 38 vs. 44% in Gem, and 42 vs. 47% in uMkhanyakude (Table 5, Fig. 1).

Among younger AGYW, there was evidence that the percentage with at least two lifetime partners and at least one lifetime partner was lower among DREAMS invitees than non-invitees in Gem, at 2.5 vs. 9% (aOR 0.3, 95% CI 0.1–0.6) and 14 vs. 19% (aOR 0.7, 95% CI 0.5–1.1), respectively, while there was no evidence of a difference between DREAMS invitees and non-invitees in Nairobi or uMkhanyakude (Table 4). We estimated that the percentages who would report  $\geq 1$  lifetime partner, comparing the scenarios that all were invited to DREAMS vs. none were invited, were 31 vs. 26% in Nairobi (difference, 5% with 95% CI -5.0 to 15.3), 14 vs. 19% in Gem (difference, -5.2% with 95% CI -11.7 to 1.2), and 20 vs. 19% in uMkhanyakude (difference, 1.3% with 95% CI -4.8 to 6.7) (Table 5, Fig. 1).

#### *Transactional sex in the previous 12 months, in 2019*

Among younger AGYW, around 2–3% reported transactional sex, and among older AGYW around 5–10%, with no evidence of a difference between DREAMS invitees and non-invitees (Tables 4 and 5, Fig. 1).

#### **Sensitivity analyses, for comparing scenarios that all vs. no adolescent girls and young women were invited to DREAMS**

For all outcomes, findings were similar in sensitivity analyses (S4–S10, <http://links.lww.com/QAD/C428> tables).

#### **Prevention cascades for condom use and pre-exposure-prophylaxis in Kenya, 2019**

Among HIV-negative AGYW who were invited to DREAMS and participated in at least three primary interventions (as an indication of relatively high engagement), awareness of PrEP was high among older AGYW and among younger AGYW in Nairobi, at around 90% (Fig. 2). Among older AGYW, the percentage who had ever used PrEP was around 10% in Nairobi and around 1% reported current use, while in Gem, around 20% had ever used PrEP and around 10% reported use in the previous 12 months.

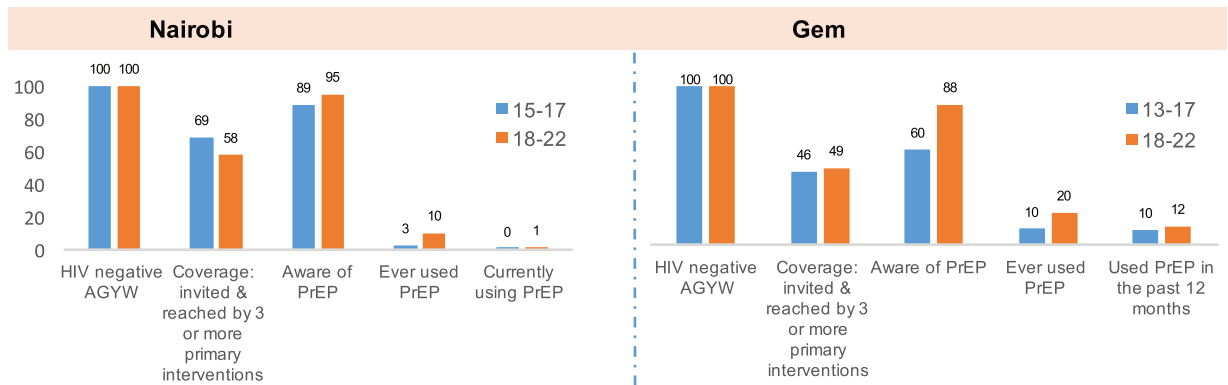
With analysis further restricted to sexually active AGYW, awareness of condoms was high at around 90–100%, while participation in condom promotion activities in the previous 12 months was around 20% in Gem and around 45% in Nairobi (Fig. 2).

## **Discussion**

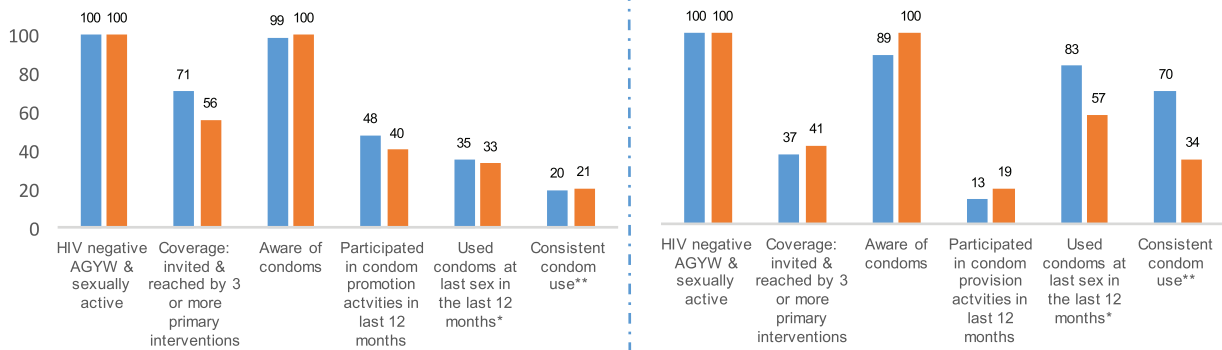
### **Key findings**

DREAMS increased knowledge of HIV status among AGYW in all three settings by 2018, to around 80–90% among DREAMS invitees in Nairobi and Gem, and to around 40 and 70%, respectively, in younger and older AGYW in uMkhanyakude. We did not find evidence that this provided an entry point to an HIV prevention cascade; although awareness of condoms and PrEP was high among DREAMS invitees, recent participation in

(a) Panel : PrEP cascade (2019)



(b) Panel : Condom use cascade (2019)



\*using the questions: (i) The last time you had sex with 'partner X' did you/your partner use a male or female condom? (ii) did you use a condom the last time you had sex in the past 12 months? \*\*using the question: How often would you say you and your partner use condoms during sex?: consistent use of condoms is defined as 'always' using condoms with all three recent partners.

Fig. 2. Condom and PrEP cascades among DREAMS invitees in Gem and Nairobi, 2019.

condom promotion activities was less than 50% and current or recent PrEP use was around 0–10%. Meanwhile, DREAMS' impact on sexual behaviors that are associated with HIV risk [19] varied by setting and age group. In Gem, there was evidence of a reduction attributable to DREAMS in condomless sex, and among younger AGYW in the number of lifetime partners; in Nairobi, there was a suggestion of a reduction attributable to DREAMS in condomless sex among sexually active older AGYW; in uMkhanyakude, there was no evidence that DREAMS changed these outcomes. There was no evidence that DREAMS changed the proportion of AGYW self-reporting transactional sex.

**Interpretation and implications of findings**

Our findings from Kenya show that the model of offering HIV testing at the “safe spaces” that were created for DREAMS invitees in the community, offering privacy and confidentiality in a convenient setting with a trusted provider, is effective in enabling a high proportion of AGYW to know their HIV status. The more modest gains in uMkhanyakude were likely because DREAMS safe spaces were not a focal point for offering HIV testing and other testing options were not coordinated across

implementing partners [20]. Continuing to offer HIV testing to AGYW in safe community spaces will make an important contribution to ensuring a high proportion know their HIV status. This approach could be extended beyond DREAMS invitees, alongside peer-led community outreach to create demand for HIV testing, increased provision of HIV self-testing [21], and renewed efforts to promote non-judgmental and adolescent-and-youth-friendly clinical services [19].

Stronger linkages from HIV testing into other prevention services could ensure that knowledge of status empowers AGYW to stay AIDS-free. We found that, by 2019, awareness of PrEP was high, but use was low. Kenya and South Africa are among countries with the largest-scale roll-out of PrEP during 2017–2019 [22,23], but in uMkhanyakude, PrEP was only provided through services for female sex workers and reached few DREAMS beneficiaries in general and none of those in our cohort study who self-reported selling sex [24]. In Gem and Nairobi, various factors – that also apply nationally and beyond [22] – limited PrEP uptake and continuation, including that PrEP was a new intervention and was initially prioritized for AGYW considered at “high-risk.” As of

2021, there are concerted efforts to increase and widen access to and uptake of PrEP in settings such as those included in our impact evaluation, not limiting it to “high-risk” individuals [25], and to facilitate HIV-status-neutral and risk-informed prevention within a broader framework of sexual and reproductive health and rights (SRHR). Lessons identified from early efforts to offer PrEP in non-trial conditions include that it is important to simplify, differentiate, decentralize, and destigmatize PrEP provision [26,27], and evidence has accumulated from a range of settings and populations on various ways to achieve this [23,28–34]. In the context of DREAMS and AGYW’s access to PrEP, it may be key to integrate PrEP provision into wider youth-friendly and accessible SRH services, and to address common misconceptions about PrEP, while peer-support interventions can help to identify and refer AGYW who are eligible for PrEP [35]. Moreover, the existing infrastructure of DREAMS could contribute to expanding PrEP delivery, through its safe spaces, social mobilization, DREAMS mentors, and PrEP ambassadors [32]. Adaptation of DREAMS safe spaces to the needs of older AGYW could also contribute to improving the prevention cascade through DREAMS [36], and in the medium-term long-acting PrEP has huge potential to increase uptake [37].

The evidence that DREAMS reduced two key elements of behavioral risk among AGYW in Gem, that is, number of lifetime partners and condomless sex, was encouraging. On the other hand, the lack of evidence for impact in Nairobi and uMkhanyakude showed how difficult it can be to change these outcomes, though in uMkhanyakude DREAMS was discontinued before it had time to embed [20] (because uMkhanyakude was not among districts identified as ‘high-priority’ in the PEPFAR country-operational-plan). In Nairobi, the social and economic context of urban informal settlement areas – high poverty levels, relatively high living costs, the relative ease with which young people can socialize with their peers – may have made it harder for young women to reduce their behavioral risk compared with rural Gem.

Condoms remain key to HIV prevention efforts, as a preferred choice for many unmarried young women for both pregnancy and HIV/STI prevention [38–40]. Alongside their provision as part of HIV prevention services, it could be important to reintegrate their promotion and provision within SRH services that are focused on prevention of pregnancy and protection from reproductive tract infections that can have an adverse effect on fertility. Awareness of condoms was high among DREAMS invitees, but there was scope to increase their participation in condom promotion activities to enable them to use condoms more and it may be warranted to give greater attention to dispelling myths and misconceptions about condom use. Going forwards, it will be equally important for there to be condom promotion and provision activities for adolescent boys and young men

(DREAMS focused on condom promotion among AGYW), in part because use of condoms (and their purchase) may be seen as a decision to be made by men.

There was no evidence of DREAMS impact on the proportion of AGYW who self-reported transactional sex, even though interventions included social protection and financial capability training, reflecting that structural and economic interventions may take considerable time to impact on HIV-related vulnerability [41–43] and also indicating a need to strengthen them. The strengthening of economic empowerment interventions for AGYW is already recognized as key to improving DREAMS [19], and as these improvements are delivered (in consultation with AGYW, to ensure relevance and appropriateness), they could contribute to reducing transactional sex among AGYW in the future, alongside increased social protection [44].

Pervasive structural factors such as poverty and gender inequity continue to drive HIV risk in all three settings, limiting the ability of AGYW to make strategic life choices and meaning that interventions designed to change AGYW’s behavior are insufficient on their own [45]. DREAMS included community-level interventions to address social norms, and HIV and violence prevention, but most emphasis was on interventions provided directly to AGYW [12]. Going forwards it will be important to strengthen interventions among men, not just in terms of HIV testing and treatment and medical male circumcision uptake but also in terms of behavioral change, condom use, and gender norms and violence, with the latter requiring considerable effort to counter pervasive social norms [46]. In related research, we found there was a modest increase in condom use among young men in Gem and uMkhanyakude during 2017–2019, but not in Nairobi [47], and no evidence of DREAMS impact on AGYW’s attitudes towards gender equity [48].

### **Generalizability, study strengths, and limitations**

Our findings, from diverse settings in Kenya and South Africa, should have broad generalizability to other settings in southern and East Africa where DREAMS has been implemented, and can also inform programming in other settings in which HIV prevention among AGYW is a priority. Strengths of our evaluation include the relatively large size of our cohort study, with around 4000 AGYW enrolled, and random selection followed by high retention. Limitations include that there could be residual confounding of our comparisons between DREAMS invitees and non-invitees, due to aspects of social or sexual risk that were not measured at the time of cohort enrollment and which could be associated with whether or not an AGYW was invited to DREAMS and with our study outcomes. However, we attempted to measure and control for known individual and household characteristics that were used by implementing partners to guide who was invited to DREAMS. Although cohort

retention was high, and similar between DREAMS invitees and non-invitees for younger AGYW, we cannot rule out that the impact of DREAMS was different among the AGYW who were lost to follow-up.

## Conclusion

In its first 3 years of implementation, DREAMS substantially increased knowledge of HIV status among AGYW by making HIV testing more accessible and acceptable. However, more must be done to link AGYW from HIV testing into prevention methods such as PrEP and condom promotion, building on the concerted efforts that have already been made. DREAMS reduced risk behaviors in rural Kenya, demonstrating that comprehensive HIV prevention programming can promote safer sexual partnerships, but absence of impact elsewhere indicated that contextual drivers including poverty, social norms, and inequalities continue to limit young women's prevention choices.

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I.B. and S.F. led the evaluation study and A.Z., D.K. and P.P.H., and M.S. led the study implementation in Nairobi, Gem, and uMkhanyakude, respectively. S.F. and I.B. wrote the first draft of the article, S.M. and A.G.

contributed to the second draft, and all authors contributed to the next draft and approved the final draft. S.M., F.M., A.G., and N.M. led the execution of analyses with contributions from M.O., and S.F. and I.B. provided oversight to analyses. N.C., J.O., and V.K. oversaw data collection, and contributed to interpretation of findings.

## Conflicts of interest

All authors have no conflicts of interest to declare. The impact evaluation of DREAMS was funded by the Bill and Melinda Gates Foundation (Grant OPP1136774, <http://www.gatesfoundation.org>). Foundation staff advised the study team, but did not substantively affect the study design, instruments, interpretation of data, or decision to publish.

## References

1. UNAIDS. Women and HIV: a spotlight on adolescent girls and young women. Geneva, Switzerland: UNAIDS; 2019.
2. Chimbindi N, Mthiyane N, Birdthistle I, Floyd S, McGrath N, Pillay D, *et al.* **Persistently high incidence of HIV and poor service uptake in adolescent girls and young women in rural KwaZulu-Natal, South Africa prior to DREAMS.** *PLoS One* 2018; **13**:e0203193.
3. Baisley K, Chimbindi N, Mthiyane N, Floyd S, McGrath N, Pillay D, *et al.* **High HIV incidence and low uptake of HIV prevention services: the context of risk for young male adults prior to DREAMS in rural KwaZulu-Natal, South Africa.** *PLoS One* 2018; **13**:e0208689.
4. Birdthistle I, Tanton C, Tomita A, de Graaf K, Schaffnit SB, Tanser F, *et al.* **Recent levels and trends in HIV incidence rates among adolescent girls and young women in ten high-prevalence African countries: a systematic review and meta-analysis.** *Lancet Glob Health* 2019; **7**:e1521–e1540.
5. Monasch R, Mahy M. **Young people: the centre of the HIV epidemic.** *World Health Organ Tech Rep Ser* 2006; **938**:15–41discussion 317–341.
6. Zuma T, Seeley J, Sibiyi LO, Chimbindi N, Birdthistle I, Sherr L, *et al.* **The changing landscape of diverse HIV treatment and prevention interventions: experiences and perceptions of adolescents and young adults in rural KwaZulu-Natal, South Africa.** *Front Public Health* 2019; **7**:336.
7. Vandormael A, Akullian A, Siedner M, de Oliveira T, Barnighausen T, Tanser F. **Declines in HIV incidence among men and women in a South African population-based cohort.** *Nat Commun* 2019; **10**:5482.
8. Francis SC, Mthiyane TN, Baisley K, McHunu SL, Ferguson JB, Smit T, *et al.* **Prevalence of sexually transmitted infections among young people in South Africa: a nested survey in a health and demographic surveillance site.** *PLoS Med* 2018; **15**:e1002512.
9. UNAIDS (2016). All in to end the adolescent AIDS epidemic: A progress report. Geneva, Switzerland. [http://www.unaids.org/sites/default/files/media\\_asset/ALL\\_IN2016Progress-Report\\_en.pdf](http://www.unaids.org/sites/default/files/media_asset/ALL_IN2016Progress-Report_en.pdf).
10. United States Department of State. DREAMS Partnership website <https://www.state.gov/pepfar-dreams-partnership/> (Accessed April 2021).
11. Saul J, Bachman G, Allen S, Toiv NF, Cooney C, Beamon T. **The DREAMS core package of interventions: a comprehensive approach to preventing HIV among adolescent girls and young women.** *PLoS One* 2018; **13**:e0208167.
12. Gourlay A, Birdthistle I, Mthiyane NT, Orindi BO, Muuo S, Kwaro D, *et al.* **Awareness and uptake of layered HIV prevention programming for young women: analysis of population-based surveys in three DREAMS settings in Kenya and South Africa.** *BMC Public Health* 2019; **19**:1417.

13. Birdthistle I, Schaffnit SB, Kwaro D, Shahmanesh M, Ziraba A, Kabiru CW, *et al.* **Evaluating the impact of the DREAMS partnership to reduce HIV incidence among adolescent girls and young women in four settings: a study protocol.** *BMC Public Health* 2018; **18**:912.
14. Aral SO. **Sexual risk behaviour and infection: epidemiological considerations.** *Sex Transm Infect* 2004; **80** (Suppl 2):ii8–ii12.
15. UNAIDS. Transactional sex and HIV risk: from analysis to action. 2018.
16. Mavedzenge SN, Luecke E, Ross DA. **Effective approaches for programming to reduce adolescent vulnerability to HIV infection, HIV risk, and HIV-related morbidity and mortality: a systematic review of systematized reviews.** *J Acquir Immune Defic Syndr* 2014; **66** (Suppl 2):S154–S169.
17. UNAIDS. Knowledge is power: know your status, know your viral load. 2018.
18. Wong VJ, Murray KR, Phelps BR, Vermund SH, McCarragher DR. **Adolescents, young people, and the 90-90-90 goals: a call to improve HIV testing and linkage to treatment.** *AIDS* 2017; **31** (Suppl 3):S191–S194.
19. PEPFAR. PEPFAR DREAMS guidance. 2021.
20. Chimbindi N, Birdthistle I, Floyd S, Harling G, Mthiyane N, Zuma T, *et al.* **Directed and target focused multisectoral adolescent HIV prevention: Insights from implementation of the 'DREAMS Partnership' in rural South Africa.** *J Int AIDS Soc* 2020; **23** (Suppl 5):e25575.
21. Indravudh PP, Sibanda EL, d'Elbee M, Kumwenda MK, Ringwald B, Maringwa G, *et al.* **'I will choose when to test, where I want to test': investigating young people's preferences for HIV self-testing in Malawi and Zimbabwe.** *AIDS* 2017; **31** (Suppl 3):S203–S212.
22. Delany-Moretlwe S. ARV based prevention and the promise of MPTs. R4P; 28 January 2021; Cape Town, South Africa 2021.
23. Segal K. The evolution of oral PrEP access: tracking trends in global oral PrEP use over time. R4P; 28 January 2021; Cape Town, South Africa 2021.
24. Chimbindi N, Mthiyane N, Zuma T, Baisley K, Pillay D, McGrath N, *et al.* **Antiretroviral therapy based HIV prevention targeting young women who sell sex: a mixed method approach to understand the implementation of PrEP in a rural area of KwaZulu-Natal, South Africa.** *AIDS Care* 2021:1–9.
25. Byanyima W. Where will we be in 2025? R4P; 27 January 2021; Cape Town, South Africa 2021.
26. Green K. Why differentiated PrEP? R4P; 4 February 2021; Cape Town, South Africa 2021.
27. Rodrigues J. Setting the scene: Where is PrEP headed? R4P; 4 February 2021; Cape Town, South Africa 2021.
28. Musau A. Surveillance data from public and private primary care facilities uncover implementation successes and gaps during preexposure prophylaxis (PrEP) scale-up: results from the Jilinde project in Kenya. R4P; 28 January 2021 Cape Town, South Africa 2021.
29. Atieno H. Bringing PrEP to the people: Democratising access to PrEP through differentiated service delivery before, during, and after COVID-19. How do adolescent girls and young women prefer to receive PrEP services? R4P; 4 February 2021; Cape Town, South Africa 2021.
30. Opito R. Bringing PrEP to the people: Democratising access to PrEP through differentiated service delivery before, during, and after COVID-19. What preferences do men in Uganda have for how they want PrEP delivered now and in the future? R4P; Cape Town, South Africa 2021.
31. Phanuphak N. Differentiated PrEP in practice: Community PrEP - Differentiating PrEP to reach key populations in Thailand. R4P; 4 February 2021; Cape Town, South Africa 2021.
32. Madiang D. Differentiated PrEP in practice: Mobile PrEP – Diversifying PrEP delivery in Kenya to reach adolescent girls and young women. R4P; Cape Town, South Africa 2021.
33. Ho QA. Differentiated PrEP in practice: Virtual PrEP - Next-generation PrEP in Vietnam. R4P; Cape Town, South Africa 2021.
34. Matambanadzo P. Differentiated PrEP in practice: Peer-based PrEP – Sisters with a Voice in Zimbabwe. R4P; Cape Town, South Africa 2021.
35. Shahmanesh M, Okesola N, Chimbindi N, Zuma T, Mdluli S, Mthiyane N, *et al.* **Thetha Nami: participatory development of a peer-navigator intervention to deliver biosocial HIV prevention for adolescents and youth in rural South Africa.** *BMC Public Health* 2021; **21**:1393.
36. Chimbindi N, Birdthistle I, Shahmanesh M, Osindo J, Mushati P, Ondeng'e K, *et al.* **Translating DREAMS into practice: early lessons from implementation in six settings.** *PLoS One* 2018; **13**:e0208243.
37. Delany-Moretlwe S. Long acting injectable cabotegravir is safe and effective in preventing HIV infection in cisgender women: interim results from HPTN 084. R4P; 27 January 2021; Cape Town, South Africa 2021.
38. Wamoyi J, Buller AM, Nyato D, Kyegombe N, Meiksin R, Heise L. **Eat and you will be eaten': a qualitative study exploring costs and benefits of age-disparate sexual relationships in Tanzania and Uganda: implications for girls' sexual and reproductive health interventions.** *Reprod Health* 2018; **15**:207.
39. Wamoyi J, Fenwick A, Urassa M, Zaba B, Stones W. **Women's bodies are shops': beliefs about transactional sex and implications for understanding gender power and HIV prevention in Tanzania.** *Arch Sex Behav* 2011; **40**:5–15.
40. Ali MM, Cleland J. **Long term trends in behaviour to protect against adverse reproductive and sexual health outcomes among young single African women.** *Reprod Health* 2018; **15**:136.
41. Pettifor A, Lippman SA, Gottert A, Suchindran CM, Selin A, Peacock D, *et al.* **Community mobilization to modify harmful gender norms and reduce HIV risk: results from a community cluster randomized trial in South Africa.** *J Int AIDS Soc* 2018; **21**:e25134.
42. Pettifor A, MacPhail C, Hughes JP, Selin A, Wang J, Gomez-Olive FX, *et al.* **The effect of a conditional cash transfer on HIV incidence in young women in rural South Africa (HPTN 068): a phase 3, randomised controlled trial.** *Lancet Glob Health* 2016; **4**:e978–e988.
43. Mannell J, Willan S, Shahmanesh M, Seeley J, Sherr L, Gibbs A. **Why interventions to prevent intimate partner violence and HIV have failed young women in southern Africa.** *J Int AIDS Soc* 2019; **22**:e25380.
44. UNAIDS. HIV and social protection guidance note. Geneva, Switzerland: UNAIDS; 2011.
45. Wamoyi J, Mshana G, Mongi A, Neke N, Kapiga S, Changalucha J. **A review of interventions addressing structural drivers of adolescents' sexual and reproductive health vulnerability in sub-Saharan Africa: implications for sexual health programming.** *Reprod Health* 2014; **11**:88.
46. Kerr-Wilson A, Gibbs A, McAslan Fraser E, Ramsommar L, Parke A, Khuwaja HMA *et al.* (2020). A rigorous global evidence review of interventions to prevent violence against women and girls, What Works to Prevent Violence Against Women and Girls Global Programme, Pretoria, South Africa, <https://www.whatworks.co.za/documents/publications/374-evidence-review/web/file>.
47. Shahmanesh M, Baisley K, Wambiya E, Khagayi S, Mulwa S, Ziraba A, *et al.* **Reaching young men: evaluating the impact of DREAMS on HIV testing, care and prevention among young men in three diverse settings.** *AIDS*; July 2020; San Francisco, USA 2020.
48. Nelson K, Magut F, Mulwa S, Khagayi S, Ziraba A, Kwaro D, *et al.* **Association between DREAMS and attitudes towards gender norms among young women in urban and rural Kenya, measured using an adapted and validated version of the GEM scale.** R4P; January 2021; Cape Town, South Africa 2021.