Structural influences on delivery and use of oral HIV PrEP among adolescent girls and young women seeking post abortion care in Kenya

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Summary

Background Adolescent girls and young women (AGYW) in East and southern Africa experience a disproportionate burden of HIV incidence. Integrating HIV pre-exposure prophylaxis (PrEP) within existing programs is a key component of addressing this disparity.

Methods We evaluated an oral PrEP program integrated into post-abortion care (PAC) in Kenya from March 2021 to November 2022. Technical advisors trained staff at PAC clinics on PrEP delivery, abstracted program data from each clinic, and collected data on structural characteristics. Utilizing a modified Poisson regression, we estimated the effect of structural factors on the probability of PrEP offer and uptake.

Findings We abstracted data on 6877 AGYW, aged 15–30 years, across 14 PAC clinics. PrEP offers were made to 57.4% of PAC clients and 14.1% initiated PrEP. Offers were associated with an increased probability at clinics that had consistent supply of PrEP (relative risk (RR):1.81, 95% CI: 1.1–2.95), inconsistent HIV testing commodities (RR: 1.89, 95% CI: 1.29–2.78), had all providers trained (RR: 1.65, 95% CI: 1.01, 2.68), and were public (RR: 1.89, 95% CI: 1.29–2.78). These same factors were associated with PrEP uptake: consistent supply of PrEP (RR: 2.71, 95% CI: 1.44–5.09), inconsistent HIV testing commodities (RR: 2.55, 95% CI: 1.39–4.67), all providers trained (RR: 2.61, 95% CI: 1.38–4.92), and were public (RR: 2.55, 95% CI: 1.39–4.67).

Interpretation Greater success with integration of HIV prevention into reproductive health services will likely require investments in systems, such as human resources and PrEP and HIV testing commodities, to create stable availability and ensure consistent access.

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Introduction

Adolescent girls and young women (AGYW) ages 15–24 years in East and southern Africa bear a disproportionate burden of new HIV infections, demonstrating unmet need for HIV prevention. Recent estimates show that 63% of new HIV infections in East and southern Africa are among women and 25% are among AGYW.[1] In Kenya, AGYW have a 2.2-fold higher HIV incidence than their male age counterparts and represent one-third of new infections annually.[2,3] National scale-up of

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Research in context

Evidence before this study

Post-abortion care (PAC) settings were previously assessed as a possible entry-point for HIV prevention, or PrEP, services for adolescent girls and young women (AGYW) in Kisumu and Thika, Kenya. Researchers found that among 200 Kenyan AGYW accessing services for PAC, there was a high interest in PrEP (46.4%) and one-third received a referral. Thus, PAC is an as-yet underutilized setting for the integration of PrEP and has potential to serve an unmet need for HIV prevention services for young women.

Added value of this study

To our knowledge, this is the first description of integrating PrEP into post-abortion care in Africa. This project abstracted data on 6877 adolescent girls and young women across 14 PAC clinics in 3 counties in Kenya. Offers of PrEP were made to 57.4% of all PAC clients and 14.1% initiated PrEP. Key system-level factors that were associated with PrEP offers and uptake were stockouts of PrEP and HIV testing commodities, training, and type of clinic (private vs. public).

Implications of all the available evidence

These data highlight some key hurdles to navigate to improve the implementation of PrEP in reproductive health settings. Greater program success will require investments in systems, such as human resources and PrEP and HIV testing commodities, to create stable availability and enable providers to have confidence that PrEP will be available when prescribed.

oral HIV pre-exposure prophylaxis (PrEP) in Kenya was launched in 2017.[4] As an additional measure to combat HIV for AGYW, novel programs are integrating oral PrEP into existing health services, including those for reproductive health (e.g., family planning, maternal and child healthcare). A recent study estimated moderate levels of PrEP uptake, 22%, among Kenyan AGYW when PrEP is offered through family planning programs and high levels when the woman knows that her partner is living with HIV.[5,6]

In addition to the HIV epidemic, young women in Kenya face an epidemic of unintended pregnancy, and ≥40% of unintended pregnancies end with an early termination through clinics providing post-abortion care (PAC).[7,8] A cross-sectional survey of AGYW in Western Kenya engaged in casual or transactional sex indicated that 21% had a previous abortion.[9] PAC settings provide a set of core interventions for essential reproductive health care, including emergency treatment for incomplete abortions, family planning, and sexual health counseling.[10] AGYW account for nearly half of all PAC clients in Kenya.[8] For AGYW receiving PAC, risk for subsequent condomless sex and pregnancy remains high and may be coupled by risk for HIV and other sexually transmitted infections.[11,12] Systematic review of psychosocial status of AGYW after an abortion supports that AGYW often experience internalized and perceived stigma, gendered power dynamics and violence, social isolation as well as learned resilience.[13] In a recent cross-sectional study among 200 Kenyan AGYW accessing services for PAC, the prevalence of *Chlamydia trachomatis* was 18%, 99.5% reported not knowing their partners' HIV status(es), and 95.7% reported not using a condom with sex during the past month.[14] There was also a high interest in PrEP (46.4%) and one-third received a referral suggesting that PAC settings could be a fruitful entry point for integrating PrEP care for AGYW.[14] Thus, PAC is an as-yet underutilized setting for the integration of PrEP and has potential to serve an unmet need for HIV prevention services for young women.

In an implementation science-driven project, entitled PrEP Delivery in Reproductive Health for AGYW, phase 2 (PrEDIRA 2), we launched delivery of PrEP in PAC clinics in Kenya to evaluate uptake and feasibility. To contextualize the structural-level determinants of program implementation and their influence on key program metrics, we drew upon constructs from the Consolidated Framework for Implementation Research (CFIR), particularly from the domains of the inner setting, outer setting, and process.[15,16] While there is a growing body of literature describing the influence of individual and interpersonal factors influencing PrEP use, there is little describing the influence of structural factors. Therefore, the objective of this analysis is to evaluate associations between structural factors and likelihood of PrEP offers and uptake among young women in PAC clinics in Kisumu, Nairobi, and Thika, Kenya.

Methods

In this implementation science-driven evaluation, PrEDIRA 2 integrated PrEP into services for PAC at 14 clinics in Kisumu, Nairobi, and Thika, Kenya and prospectively collected clinic data on AGYW for 6 months after PrEP acceptance. PAC in Kenya is legal in cases to save a woman's life and includes a wide variety of clinical contexts and resource settings.[17] Through project-supported technical advisors (TA) with long-standing experience with PrEP and HIV prevention, the project facilitated: 1) PAC clinic training on HIV risk assessment and clinical management of PrEP clients, 2) linkages between each facility and the Ministry of

Health (MoH) PrEP commodities system to facilitate supply of PrEP medication and HIV test kits, 3) technical support, in the form of individual discussions with providers to troubleshoot challenges, discussions with clinic leadership to share best practices from other locations, and on-the-job training when new staff were assigned to the clinic, and 4) data abstraction of program data from each clinic to monitor key program metrics. PrEP services followed Kenya national guidelines which include self-reported sexual activity, a clinical evaluation to identify medical contraindications, and HIV testing to confirm HIV-negative status prior to PrEP dispensing.[18] Eligible clients were offered PrEP and could accept or decline with reasons for the decline captured in the medical record. All PAC clients were offered PrEP regardless of age and data on women under 30 years old were abstracted from medical records into a web-based data management system (REDCap, ITHS University of Washington).[19,20]

Technical advisors from the project trained staff from participating facilities on PrEP eligibility and PrEP delivery, including but not limited to HIV prevention counseling for AGYW accessing care after pregnancy loss, benefits of PrEP and family planning (FP), specifics of delivering integrated PrEP and FP, and good clinical research practices. We augmented existing PrEP training materials with specific focus on PrEP integrated with PAC services. The final component of clinic-wide training included a one-day onsite visit by the training team to each clinic to observe mock patient visits and discuss patient flow efficiencies with the facility team. At the end of this visit, the training team completed a proficiency checklist. The training team worked closely with the facility to ensure the proficiency in each delivery element before being activated to deliver the intervention. Additional continuing medical education trainings were completed on an as needed basis and included providers that were absent from the initial training day.

Ethical review committees at Kenya Medical Research Institute (CMR/P00158/4209, CCR/020504201), Marie Stopes International (#001-21), and University of Washington (STUDY00012143) approved the research protocol. Given that the data were non human subjects (e.g., from de-identified program logs and aggregate at the clinic-level), consenting of individual participants was not done.

System and clinic factors

Data collection of system- and clinic-level factors included abstraction from clinic-records and qualitative interviews with technical advisors to elicit their expertise and experience with each clinic. PAC clinics were categorized as private or public and with high or low clinic volume based on data from clinic records and further discussions with the technical advisors to finalize these characterizations. To collect additional information on structural influences, we used the Consolidated Framework for Implementation Research (CFIR) to identify domains of system- and clinic-level factors that might be relevant for the PAC settings.[16] Structured interviews were conducted with the technical advisors in August 2022 to elicit descriptions of each clinic as outlined by the CFIR construct definitions and determine the category of each factor that best fit the clinic, treating category as static over the duration of the study.[16] System-level factors included commodities for PrEP and HIV testing, measured by collecting dates of stockouts during the study period; women were counted as exposed if the clinic they attended ever experienced a stockout. Clinic-level factors included: clinic type (private vs. public); clinic volume based on region-specific average of PAC clients across the study period (high vs. low volume) to allow flexibility in capturing the regional differences; the proportion of PAC clinic staff who were PrEP-trained providers (all vs. some); the commitment, involvement, and accountability of PAC administrative leadership with the PrEP program (highly engaged vs. less engaged); the level of resources dedicated for implementation and on-going operations including sufficient numbers of staff to support offering PrEP to all PAC clients (sufficient vs. not) and sufficient space to ensure privacy when offering PrEP to PAC clients (sufficient vs. not); presence of a champion provider for PrEP who were dedicated to PrEP and encouraged their fellow providers to talk about PrEP with clients (present vs. not); and the cohesiveness with which PrEP tasks (paperwork or labwork, for example) were integrated into other standard PAC clinical tasks (cohesive vs. not).

Statistical methods

Each clinic began implementation of their PrEP program on different days (between April 2021 and December 2021), as they were trained on PrEP and established linkages to commodities. Data analyzed from each clinic included time elapsed from PrEP program launch until November 18, 2022. We utilized descriptive statistics to summarize system and clinic factors at the PAC clinics and women who attended the PAC clinics. We generated figures to describe PrEP offers and uptake across time and to describe the proportion of PAC clients that were offered PrEP and initiated PrEP, defined as dispensing of initial PrEP bottle.

We utilized modified Poisson regression models to estimate relative risks (RRs) for the association of structural factors with probability of PrEP offers and uptake among AGYW in PAC clinics. These models employed sandwich estimators to adjust standard errors for use of a binomial outcome and for clustering within clinics, with Fay and Graubard small-sample adjustment for the small number of clusters.[21,22] For exposure variables that were significant at the 0.05 level in univariable

analyses, we constructed multivariable models that included client's age *a priori* and added additional factors that are known to be associated with PrEP uptake through prior work. Each potential confounder that was associated with PrEP offer/use at a p-value <0.2 level in univariable models was included in the final model.[23] Other variables that were collinear or unstable, namely those that were infrequent and therefore difficult to model their effects, were also excluded from the final model. Based on collinearity, separate models for the outcome of PrEP offers were constructed for PrEP commodities and HIV testing commodities/clinic type. Separate models for the outcome of PrEP initiation were constructed for PrEP commodities, HIV testing commodities/clinic type, and training. In a sensitivity analysis, data were limited to the subset of the first 9 months of each clinic's implementation to assess the effect of growing familiarity with PrEP program delivery. SAS 9.4 (Cary, NC) and R (version 4.2.2) were used for statistical analysis, with small-sample adjustment using the R package *saws* (version 0.9-7.0) default method, and Microsoft Excel (Microsoft Corporation) was used for visualizations.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Across 14 PAC clinics, data were abstracted from 6877 AGYW (median age: 24, min: 15, max: 30 years) during the study period between March 1, 2021 and November 18, 2022. Overall, 57% of all AGYW in PAC clinics were offered PrEP (n = 3944) and 14.1% initiated PrEP, defined as dispensing of initial PrEP bottle (n = 970; Fig. 1). The most common reason for PrEP decline was perceived low risk. Across the implementation period of 209 program-months, clinics experienced fluctuations in the number of PAC clients as well as of PrEP offers and PrEP initiations: peaks in PAC clients occurred in March 2022, PrEP offers during June 2022, and PrEP initiations grew over time with high points in March, June, and September 2022 (Fig. 2). In the distribution of PAC clinic characteristics, most clinics were private (n = 8, 57.1%; Table 1), had highly engaged administrative leadership (n = 9, 64.3%), had low client flow (n = 8, 57.1%), had some but not all PAC providers trained to deliver PrEP (n = 8, 57.1%), and did not have staffing numbers (n = 12, 85.7%) and space (n = 8, 57.1%) to facilitate widespread PrEP counseling. One-third of clinics had a PrEP champion provider emerge during the project (n = 5, 35.7%) and it was uncommon for PrEP tasks to be well integrated with other clinical roles (n = 2, 14.3%). Stock outs of PrEP and HIV testing commodities were relatively rare and occurred in 5.8% and 28% of program-months, respectively. Nevertheless, in the distribution of clients within PAC clinics, most AGYW were seen in PAC clinics that had experienced at least some amount of PrEP commodities stock outs (n = 5174, 75.2%; Table 1), had a high clinic volume (n = 4341, 63.1%), and had highly engaged administrative leadership (n = 3842, 55.9%). Public clinics all experienced at least one HIV testing stockout while no private clinics did.

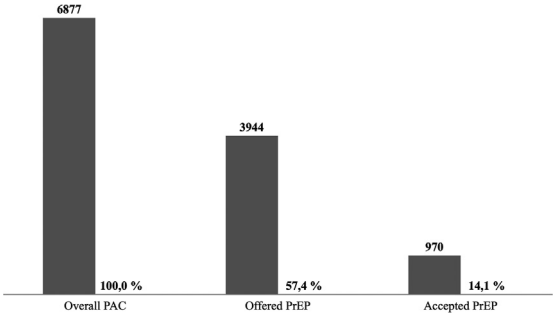

Fig. 1: **PrEP cascade outcomes among PAC clients.**

In univariable models, PrEP offers were associated with 65–89% increase in probability among women in PAC clinics that had never experienced PrEP commodities stock out vs. ever (86.3% vs. 47.8%, relative risk (RR): 1.81, 95% CI: 1.1–2.95; Table 2), had ever experienced HIV testing commodities stock out vs. never (80.5% vs. 42.5%, RR: 1.89, 95% CI: 1.29–2.78), had all providers trained vs. some (80.8% vs. 48.9%, RR: 1.65, 95% CI: 1.01, 2.68), and were public vs. private (80.5% vs. 42.5%, RR: 1.89, 95% CI: 1.29–2.78). Our multivariable model included client age, PrEP commodities, HIV testing commodities/clinic type, leadership support, staffing, and role cohesion. We adjusted training for client age, role cohesion, and staffing due to collinearity with other variables. PrEP offers were associated with a 39–77% increase in probability among women in PAC clinics that had never experienced PrEP commodities stock outs (adjusted relative risk (aRR): 1.39, 95% CI: 1.05–1.84), ever experiences HIV testing commodities stock outs (aRR: 1.72, 95% CI: 1.00, 2.96), had all providers trained (aRR: 1.77, 95% CI: 1.13, 2.79), and were public clinics (aRR: 1.72, 95% CI: 1.00, 2.96).

PrEP uptake was associated with over a 2.5-fold increase in probability among women in PAC clinics that had never experienced PrEP commodities stock out vs. ever (26.8% vs. 9.9%, RR: 2.71, 95% CI: 1.44–5.09; Table 3), had ever experienced HIV testing commodities stock out vs. never (22.4% vs. 8.8%, RR: 2.55, 95% CI: 1.39–4.67), had all providers trained vs. some (25.8% vs. 9.9%, RR: 2.61, 95% CI: 1.38–4.92), and were public vs. private clinics (22.4% vs. 8.8%, RR: 2.55, 95% CI: 1.39–4.67). Our multivariable models were limited by collinearity. HIV testing commodities/clinic type were

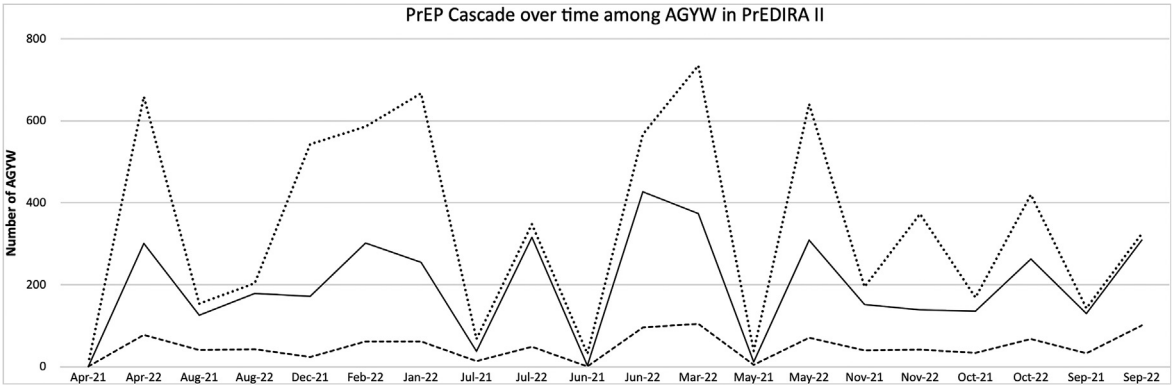

Fig. 2: **PrEP offers and PrEP uptake among AGYW PAC clients, over time.**

adjusted for client age, space, and staffing. PrEP commodities was adjusted for client age and staffing, and training was adjusted for client age, space, and staffing. After adjustment, PrEP uptake was associated with an approximate 2-fold increase in probability among women in PAC clinics that had never experienced PrEP commodities stock outs vs. ever (aRR: 2.34, 95% CI: 1.31–4.20), had ever experienced HIV testing commodities stock out vs. never (aRR: 2.64, 95% CI: 1.54–4.51), had all providers trained (aRR: 1.93, 95% CI: 1.01–3.72), and were public vs. private clinics (aRR: 2.64, 95% CI: 1.54–4.51).

The results were largely similar when limiting to data among the first 9 months of a program implementation (Tables 2 and 3). Differences between the full study period and the initial 9 months of each clinics program included magnitude of the associations being larger for PrEP uptake in the initial 9 months. In contrast to the full study period, high volume vs. low volume clinics were associated with a 13% lower probability of PrEP offers (49.7% vs. 56.7%, RR: 0.87, 95% CI: 0.47–1.63) and 9% lower probability of PrEP uptake (11.3% vs. 12.5%, RR: 0.91, 95% CI: 0.34–2.44) in the initial 9 months, however these associations were not statistically significant. Alternative parametrizations of administrative support and role cohesion did not substantially change interpretations.

Discussion

To our knowledge, this is the first description of implementation metrics when PrEP is integrated into post-abortion care with PrEP services in Africa. The PrEDIRA 2 project abstracted data on nearly 7000 AGYW across 14 PAC clinics in 3 counties in Kenya. PrEP was frequently offered to (60%) and infrequently initiated by (14% overall, and 25% of those offered) PAC clients. Across the implementation period, clinics experienced fluctuations in the number of PAC clients as well as of PrEP offers and PrEP initiations. The CFIR

	PAC clinics, N (%)	Clients, N (%)
	Total N = 14	Total N = 6877
System factors		
Ever experienced PrEP commodities stock out	9 (64.3%)	5174 (75.2%)
Ever experienced HIV testing commodities stocked out	6 (42.9%)	2682 (39.0%)
Clinic factors		
Public clinic (clinic type)	6 (42.9%)	2682 (39.0%)
High clinic volume (clinic volume)	6 (42.9%)	4341 (63.1%)
All PAC providers trained	6 (42.9%)	1816 (26.1%)
Highly engaged facility leadership	9 (64.3%)	3842 (55.9%)
Sufficient Staffing for PrEP	2 (14.3%)	155 (2.3%)
Sufficient Space for PrEP	6 (42.9%)	2788 (40.5%)
Had a champion provider present	5 (35.7%)	2321 (33.8%)
Had cohesion of PrEP tasks within other clinical tasks	2 (14.3%)	673 (9.8%)

Table 1: **Distribution of system-level factors among PrEDIRA 2 PAC clinics and clients.**

	All data (N = 6877)				First 9 months of each clinic's program (N = 5102)			
	N (%)	Crude model RR 95% CI (p-value)	Adjusted model 1[a] aRR 95% CI (p-value)	Adjusted model 2[b] aRR 95% CI (p-value)	N (%)	Crude model RR 95% CI (p-value)	Adjusted model 1[a] aRR 95% CI (p-value)	Adjusted model 2[b] aRR 95% CI (p-value)
Systematic factors								
PrEP commodities (ever vs. never stocked out)								
Ever	2474/5173 (47.8%)	Ref	Ref		1790/4016 (44.6%)	Ref	Ref	
Never	1470/1703 (86.3%)	1.81 1.10, 2.95 (0.03)	1.39 1.05, 1.84 (0.03)		895/1086 (82.4%)	1.85 1.09, 3.14 (0.03)	1.44 1.00, 2.09 (0.05)	
HIV testing commodities (ever vs. never stocked out)/Clinic type								
Ever/Public	2160/2682 (80.5%)	1.89 1.29, 2.78 (0.005)	1.72 1.00, 2.96 (0.05)		1143/1509 (75.8%)	1.76 1.11, 2.79 (0.02)	1.49 0.87, 2.57 (0.1)	
Never/Private	1784/4195 (42.5%)	Ref	Ref		1542/3593 (42.9%)	Ref	Ref	
Clinic volume								
High client flow	2529/4341 (58.3%)	1.04 0.59, 1.84 (0.87)			1479/2975 (49.7%)	0.87 0.47, 1.63 (0.64)		
Low client flow	1415/2536 (55.8%)	Ref			1206/2127 (56.7%)	Ref		
Clinic factors								
Trained providers								
All providers	1467/1816 (80.8%)	1.65 1.01, 2.68 (0.05)		1.77 1.13, 2.79 (0.03)	844/1104 (76.5%)	1.66 0.97, 2.83 (0.06)		1.66 1.07, 2.6 (0.03)
Some providers	2477/5061 (48.9%)	Ref		Ref	1841/3998 (46.1%)	Ref		Ref
Leadership support								
Less engaged	1340/3035 (44.2%)	Ref	Ref	Ref	965/2418 (39.9%)	Ref	Ref	Ref
Highly engaged	2604/3842 (67.8%)	1.53 0.82, 2.89 (0.15)	1.29 0.96, 1.76 (0.08)	1.58 0.97, 2.57 (0.06)	1720/2684 (64.1%)	1.61 0.88, 2.94 (0.1)	1.31 0.83, 2.06 (0.19)	1.53 0.88, 2.67 (0.11)
Adequate staffing (& Time) for PrEP								
No	3789/6722 (56.4%)	Ref	Ref	Ref	2550/4967 (51.3%)	Ref	Ref	Ref
Yes	155/155 (100%)	1.77 0.94, 3.34 (0.06)	0.57 0.34, 0.96 (0.04)	1.00 0.64, 1.57 (0.98)	135/135 (100%)	1.95 1.04, 3.65 (0.04)	0.62 0.35, 1.08 (0.08)	0.89 0.52, 1.53 (0.54)
Space for PrEP								
No	2135/4089 (52.2%)	Ref			1556/3178 (49.0%)	Ref		
Yes	1809/2788 (64.9%)	1.24 0.41, 1.56 (0.47)			1129/1924 (58.7%)	1.2 0.56, 2.55 (0.58)		
Champion provider presence								
No	2515/4556 (55.2%)	Ref			1674/3374 (49.6%)	Ref		
Yes	1429/2321 (61.6%)	1.12 0.51, 2.44 (0.74)			1011/1728 (58.5%)	1.18 0.51, 2.72 (0.64)		
Role cohesion (of PrEP tasks within other clinical tasks)								
Yes	529/673 (78.6%)	1.43 0.54, 3.76 (0.19)	0.61 0.31, 1.22 (0.11)	0.85 0.32, 2.24 (0.58)	420/531 (79.1%)	1.6 0.45, 5.63 (0.16)	0.58 0.22, 1.49 (0.12)	0.75 0.22, 2.57 (0.38)
No	3415/6204 (55.1%)	Ref	Ref	Ref	2265/4571 (49.6%)	Ref	Ref	Ref

aRR: adjusted relative risk; PrEP: HIV pre-exposure prophylaxis; RR: relative risk. [a]Adjusted for client's age and all other variables p-value <0.2, except training which was collinear with clinic type/HIV commodities and PrEP commodities. Model included PrEP commodities, clinic type/HIV commodities, leadership support, staffing and role cohesion. [b]Adjusted for client's age and all other variables p-value <0.2, except clinic type/HIV commodities and PrEP commodities which were collinear with training. Model included leadership support, training, role cohesion, and staffing.

Table 2: **Associations of Structural Factors with PrEP offers among PAC clients.**

	All data (N = 6877)					First 9 months of each clinic's program (N = 5102)				
	N (%)	Crude model RR 95% CI (p-value)	Adjusted model 1[a] aRR 95% CI (p-value)	Adjusted model 2[b] aRR 95% CI (p-value)	Adjusted model 3[c] aRR 95% CI (p-value)	N (%)	Crude model RR 95% CI (p-value)	Adjusted model 1[a] aRR 95% CI (p-value)	Adjusted model 2[b] aRR 95% CI (p-value)	Adjusted model 3[c] aRR 95% CI (p-value)
Systematic factors										
PrEP commodities (ever vs. never stocked out)										
Ever	513/5174 (9.9%)	Ref		Ref		345/4016 (8.6%)	Ref		Ref	
Never	457/1703 (26.8%)	2.71 1.44, 5.09 (0.009)		2.34 1.31, 4.20 (0.02)		256/1086 (23.6%)	2.74 1.33, 5.66 (0.01)		2.23 1.10, 4.52 (0.03)	
HIV testing commodities (ever vs. never stocked out)										
Ever/Public	601/2682 (22.4%)	2.55 1.39, 4.67 (0.0072)	2.64 1.54, 4.51 (0.0069)			311/1509 (20.6%)	2.55 1.34, 4.88 (0.01)	3.12 1.77, 5.50 (0.0042)		
Never/Private	369/4195 (8.8%)	Ref	Ref			290/3593 (8.1%)	Ref	Ref		
Clinic volume										
High client flow	646/4341 (14.9%)	1.16 0.49, 2.78 (0.7)				336/2974 (11.3%)	0.91 0.34, 2.44 (0.82)			
Low client flow	324/2536 (12.8%)	Ref				265/2127 (12.5%)	Ref			
Clinic factors										
Trained providers										
All providers	469/1816 (25.8%)	2.61 1.38, 4.92 (0.01)			1.93 1.01, 3.72 (0.05)	286/1104 (25.9%)	3.29 1.68, 6.43 (0.0043)			2.77 1.63, 4.71 (0.0048)
Some providers	501/5061 (9.9%)	Ref			Ref	315/3998 (7.9%)	Ref			Ref
Leadership support										
Less engaged	302/3035 (10.0%)	Ref				205/2418 (8.5%)	Ref			
Highly engaged	668/3842 (17.4%)	1.74 0.53, 5.71 (0.3)				396/2684 (14.8%)	1.74 0.53, 5.67 (0.3)			
Adequate staffing (& Time) for PrEP										
No	889/6722 (13.2%)	Ref	Ref	Ref	Ref	532/4967 (10.7%)	Ref	Ref	Ref	Ref
Yes	81/155 (52.3%)	3.95 0.63, 24.87 (0.08)	0.2 0.05, 0.76 (0.03)	0.54 0.12, 2.49 (0.24)	0.55 0.13, 2.29 (0.24)	69/135 (51.1%)	4.77 0.68, 33.32 (0.07)	0.14 0.04, 0.54 (0.02)	0.43 0.1, 1.93 (0.17)	0.48 0.11, 1.98 (0.19)
Space for PrEP										
No	410/4089 (10.0%)	Ref	Ref		Ref	287/3178 (9.0%)	Ref	Ref		Ref
Yes	560/2788 (20.1%)	2.0 0.85, 4.71 (0.1)	0.74 0.5, 1.1 (0.1)		0.75 0.31, 1.81 (0.39)	314/1924 (16.3%)	1.81 0.66, 4.94 (0.2)	1.03 0.64, 1.66 (0.85)		1.03 0.50, 2.12 (0.9)
Champion provider presence										
No	567/4556 (12.5%)	Ref				340/3374 (10.1%)	Ref			
Yes	403/2321 (17.4%)	1.4 0.53, 3.65 (0.42)				261/1728 (15.1%)	1.5 0.49, 4.59 (0.4)			
Role cohesion (of PrEP tasks within other clinical tasks)										

(Table 3 continues on next page)

	All data (N = 6877)					First 9 months of each clinic's program (N = 5102)				
	N (%)	Crude model RR 95% CI (p-value)	Adjusted model 1[a] aRR 95% CI (p-value)	Adjusted model 2[b] aRR 95% CI (p-value)	Adjusted model 3[c] aRR 95% CI (p-value)	N (%)	Crude model RR 95% CI (p-value)	Adjusted model 1[a] aRR 95% CI (p-value)	Adjusted model 2[b] aRR 95% CI (p-value)	Adjusted model 3[c] aRR 95% CI (p-value)
(Continued from previous page)										
Yes	137/673 (20.4%)	1.52 0.33, 6.96 (0.32)				103/531 (19.4%)	1.78 0.21, 15.05 (0.27)			
No	833/6204 (13.4%)	Ref				498/4571 (10.9%)	Ref			

aRR: adjusted relative risk; PrEP: HIV pre-exposure prophylaxis; RR: relative risk. [a]Adjusted for client's age and all other variables p-value <0.2, except training and PrEP commodities which were collinear with clinic type/HIV commodities. Model included HIV commodities/clinic type, space, and staffing. [b]Adjusted for client's age and all other variables p-value <0.2, except training, space, and clinic type/HIV commodities which were collinear with PrEP commodities. Model included PrEP commodities and staffing. [c]Adjusted for client's age and all other variables p-value <0.2, except clinic type/HIV commodities and PrEP commodities which were collinear with training. Model included training, space, and staffing.

Table 3: **The association of structural factors and PrEP initiations among PAC clients.**

framework provides a foundation of defining and categorizing the variety of factors that may influence the process and the achievements of PrEP programs. In PAC clinics, the key structural factors, as informed by the CFIR framework, that were associated with both PrEP offers and uptake were stockouts of PrEP and HIV testing commodities, training, and type of clinic (private vs. public). Similar signals were picked up across the full study period and in the first 9 months of each PAC clinic's PrEP program roll out. We hypothesize that underlying the findings of PrEP and HIV testing commodities being associated with increases in PrEP offers and uptake is that clinics experienced more stockouts because they achieve higher levels of PrEP offers and uptake overall as compared to clinics that were not as rigorous in reaching clients with PrEP.

This implementation project included a wide variety of PAC clinics. Some public PAC clinics were nested within gynecology or maternal and child health wards of general and referral hospitals that tended to experience higher client volumes. Small, private PAC clinics in Kisumu were standalone community care clinics that offered primary care, HIV/STI care, and maternal care, where there were lower client volumes and few providers. Private clinics in Nairobi had an array of reproductive health services including family planning, maternal care, and HIV/STI care and were either high volume or low volume clinics. Given the vast differences between these settings, while PrEP training and programming used the same materials across settings, the experiences of providers and clients with PrEP services were distinct with respect to the health systems environment in which they operate.

Structural drivers have significant bearing on communities' access to treatment as well as individual choices about uptake and adherence to PrEP. As elicited in other studies, low proportions of trained providers and frequent staff turnover can yield inconsistency in the quality of care and sometimes leads to increased clinic wait times, delayed linkages to needed care, negative patient interactions with staff, and counselling that de-centers the patients' needs and experiences.[24–27] In terms of material resources, health providers also cite availability of medications and HIV testing services as a critical component to creating and sustaining successful program and when deficient, programs can fail to provide services.[24] Strengthening HIV programs throughout the health sector requires investments in human resources and mobilizing systems to support long-term planning for commodities.[27]

While the focus on this work is the structural influences on PrEP care, the interplay between individual- and system-level factors are nuanced.[28] Evidence from other PrEP implementation studies have reported that PrEP uptake and persistence among AGYW are limited by stigma, pill burden, low risk perception, low awareness of PrEP products, and PrEP misconceptions within

their communities when PrEP is integrated into other reproductive health care settings in East and southern Africa.[29,30] Young age is often cited as a barrier to PrEP awareness, uptake, and continuation despite the higher prevalence of HIV in these subgroups, suggesting increased efforts and more tailored approaches to reach AGYW.[30] Other implementation studies have also found that clinic-level barriers of insufficient physical spaces and drug stockouts to limit PrEP delivery, as well as an increased workload when integrating PrEP into reproductive health services that may be mitigated through task sharing with lower-cadre providers, such as nurses or peer educators, and improving workflow.[30,31] Together, individual and clinic-level barriers identify opportunities for multilevel interventions to address psychosocial barriers to PrEP uptake and continuation and to facilitate a clinical encounter that better serves communities.[28]

There are limitations to these findings, including the dichotomization of variables capturing structural constructs. For example, the technical advisors described the engagement of administrative leadership with a range of characteristics that were used to dichotomize each clinic into being highly engaged vs. less engaged, and the impact of this clinical factor on PrEP offers and uptake may be diluted or misclassified. However, iterative parametrizations did not substantially change interpretations. The dichotomization of stockouts in place of time trends may have similar limitations. Additionally, most factors did not have this same limitation because we were able to quantitatively determine whether all or some providers were trained, clinic volume, and private vs. public clinic type. Another potential limitation is that there may be some bias in the technical advisors' descriptions of PAC clinics, however we balanced this limitation with the trade off of technical advisor's familiarity with each clinic and captured data in a methodological manner. In our 14 clinics, clinic type (private/public) was completely collinear with HIV testing stockouts and we are therefore unable to independently estimate those effects. Another limitation is that we assessed data across the entire study period, which may not account for seasonal trends, changes to the structural factors, and the PAC clinic's familiarity with and mastery of PrEP counseling and initiation that grows organically with time and we have not conducted a time trend to assess whether key metrics of success increased over time, which is common when a new or revised service is put into practice. However, we did assess data limited to the initial 9 months of PrEP program implementation for each clinic and results were largely similar. We also recognize that individual-level factors are critical to understanding client's choices around PrEP uptake and continuation, and the interplay between structural and individual factors warrants further exploration in future research. We were unable to further assess individual-level factors beyond age. Lastly, we had a small number of clinics, which limited our ability to examine structural factors that were less common and robustly generate adjusted models.

Key recommendations for challenges within health systems that stem from this work are echoed by other PrEP programs in Africa and include the need for robust supply chain management with coordination and prediction of stock demands for PrEP and HIV testing commodities, to better prevent bottlenecks and serve key populations for HIV prevention.[25,32,33] Sufficient staffing and PrEP training are fundamental factors to increase a facility's ability to provide PrEP services to clients and avoid missed opportunities.[25] Lastly, administrative leadership support and involvement in promoting PrEP programming has significant bearing on day-to-day activities and potential to improve quality of services and reduce staff turnover. Individual facility leadership can be empowered to bring such data to higher levels within their health systems to effectuate supply chain system changes.

These data highlight some key hurdles to navigate the implementation of PrEP in reproductive health settings. Greater program success will require investments in systems, such as human resources and PrEP and HIV testing commodities, to create stable availability and enable providers to have confidence that PrEP will be available when prescribed. In facilitating greater PrEP offers and initiations, persistence in improved HIV prevention coverage for priority populations will be essential in reducing the disproportionately high HIV incidence among young women in East and southern Africa. Integrating PrEP into PAC settings is feasible and serves as opportunity to introduce PrEP more widely in the healthcare system and service points familiar to women. Reducing the impact of systemic problems directly impacts lives and can protect and empower young women.

Contributors

NM and RH conceptualized and acquired funding for the PrEDIRA II project. EB, SK, JM, NM, KN, and RH supervised, developed the methodology, and led the implementation of the project. LE, LJ, MM, FM, BN, RN, CN, and IW collected the data. YZ conducted data validation, led the data analysis, and wrote the original draft. KT provided statistical direction. All authors reviewed and edited the manuscript.

Data sharing statement

Data are available upon request from icrc@uw.edu.

Declaration of interests

The authors declare no competing interests.

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