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PEP in Africa: prospects, opportunities and challenges

Guest Editors: Euphemia L. Sibanda, Julie Fox, Peter Godfrey-Faussett
Supplement Editor: Alberto Rossi

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JIAS JOURNAL OF THE INTERNATIONAL AIDS SOCIETY

EDITORIAL

HIV Post Exposure Prophylaxis: prospects, opportunities and challenges

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Despite great improvements over the last decade, HIV incidence remains unacceptably high, with 1.2 million acquisitions globally in 2023, and 450,000 in sub-Saharan Africa [1]. This is way off the global target of 370,000 new HIV acquisitions. The recorded reductions in new acquisitions are attributed to the successful scale-up of HIV treatment and several prevention interventions, including pre-exposure prophylaxis (PrEP) [2]. Implementation and uptake of HIV post-exposure prophylaxis (PEP—use of antiretroviral medication to prevent HIV acquisition after a potential exposure), however, has been limited, despite it being part of World Health Organization (WHO) guidelines since 2014. In many settings, its use has been limited to occupational and sexual violence exposures, with missed opportunities for HIV prevention. PEP is an effective intervention whose improved scale-up will be important for driving the attainment of prevention targets. Although no randomized trials were conducted, evidence of efficacy comes from animal studies [3, 4], later reinforced by systematic reviews and meta-analyses [5]. In humans, evidence of efficacy comes from case series, case-control studies [6] and systematic reviews that underscore the value of PEP [7]. It is also extrapolated from clinical trials investigating perinatal transmission of HIV [8].

Prior to 2024, WHO guidelines recommended that PEP be available from centralized services which put a strain on health systems and led to delays in accessing PEP. Other barriers included a lack of knowledge on PEP among providers, particularly community-based providers, and potential beneficiaries of PEP [9]. In light of these barriers, in 2024, WHO issued new guidelines which advocate for community-based distribution of PEP and through task sharing [9].

To facilitate delayed access, PEP guidelines allow for a window of 72 hours from exposure to the first PEP dose despite limited evidence for its efficacy after 24 hours. For those who access PEP, adherence is commonly sub-optimal with 36–65% completing the full 28-day course [10] and uptake most often after the critical 24-hour window period [11]. In the 2024 guidelines, WHO did not recommend changes to the 28-day duration or window period from exposure to uptake, but instead focussed on rapid uptake and a decentralization of services to facilitate this and greater uptake in general [9]. There is recognition that some individuals using PEP will have repeated or ongoing exposures to HIV and could, therefore, benefit from transitioning from PEP to PrEP. WHO guidelines also provide guidance for this transition [9].

For sub-Saharan Africa, data on PEP is limited but, as with the global picture, uptake and availability is generally low. There are no large-scale demonstration projects and with new prevention drugs in the pipeline, a methodology for evaluating PEP drugs is needed: in the era of PrEP and universal test and treat, efficacy studies are no longer affordable due to large sample sizes required. To realize the maximum impact of PEP, it is important to recognize that product innovations with long-acting HIV prevention drugs present the possibility of a single drug dose for PEP but as with other areas of medicine, there will be challenges in moving to wide-scale implementation particularly when drug quantities for PEP are not high volume [12].

For this supplement, we invited the submission of multidisciplinary articles designed to advance the rollout of PEP in sub-Saharan Africa. After careful review, the editorial team selected 17 contributions that illustrate current PEP advances and challenges to improve the delivery and uptake of PEP across sub-Saharan Africa.

As new drugs are developed for PEP and PrEP, we need to overcome longstanding challenges to assessing them in the presence of lower HIV incidence and availability and ethical responsibility to providing PrEP in prevention studies. The supplement is divided into five sections, covering the PEP pipeline and challenges for investigating new regimens, WHO PEP guidelines and implications for Africa, and three sections covering different aspects of PEP research from within Africa.

In the first section, we provide two articles, the first discussing trial designs to show the efficacy of PEP (Ortblad et al.) [13] and the second describing regulatory pathways for licensing of new PEP drugs (Miller et al.) [14]. This section is drawn to a close by a pharmacokinetics modelling paper, evaluating the potential efficacy of 2 and 3 drug PEP, with a duration from exposure to dosing and finally duration of dosage (Von Kleist et al.) [15].

The next section discusses the implications and potential challenges that programmes may face in implementing

the WHO guidelines. The feasibility and acceptability of the WHO guidelines are highlighted by the systematic review that Kennedy et al. conducted to explore community delivery of PEP and task shifting [16]. Although the evidence was limited, the review generally suggests positive outcomes—feasibility, acceptability and cost-effectiveness of the approaches. The commentary by Magni et al. brings together perspectives from programme implementers from five African countries [17]. They show that adoption of the guidelines would require programmes to tackle poor knowledge and acceptability of PEP, programmatic readiness including the need for training of providers, and considerations for improving integration between PEP and PrEP. An important question for the implementation of the guidelines is on cost-effectiveness, which is addressed in a commentary on the economics of HIV prevention, where Garnett and Godfrey-Faussett explore the plausibility of cost-effectiveness of PEP in sub-Saharan Africa [18]. They review studies that suggest that transmission within a partnership is not linear so it can be assumed that if transmission is going to occur, it is most likely in the first few sex acts without a condom and in which the virus is not fully suppressed. They discuss various determinants of cost-effectiveness and conclude that although PEP is worthwhile in settings of high HIV prevalence and unsuppressed viral load, it is likely to only be cost-effective when promoted for the first few unprotected (condomless and/or in virally unsuppressed people) sex acts in new partnerships. An analysis of implementation planning for PEP from five sub-Saharan African countries by Resar et al. showed a shift to expand the use of PEP beyond occupational and sexual violence exposures [19]. These plans were incorporated in national budgets which highlights potential programme readiness to shift to the new WHO guidelines. Taken together, these four studies demonstrate a promising platform for implementing the WHO guidelines while highlighting the hurdles that need to be addressed.

The next three papers go into detail about specific barriers to implementing the guidelines, particularly highlighting the most vulnerable groups that need to be targeted. Laterra et al. showed poor knowledge of PEP among adolescent girls and young women in Eswatini [20]. The lowest knowledge levels were among participants who had not been reached by programmes. Schluck et al. also highlight poor knowledge of PEP among people vulnerable to HIV acquisition in Kenya, with lack of education being a predictor of poor knowledge [21]. Taken together, these two studies highlight the need to develop models that target hard-to-reach groups. Analysis of a cohort of PEP users in Malawi (Tweya et al.) showed that about a third had ongoing exposure to HIV, with high rates of seroconversion reported [22]. This emphasizes the importance of integrating PEP with PrEP and facilitating the appropriate transitions.

The rest of the papers provide insights from different PEP delivery models. Three papers explore PEP in the setting of gender-based violence and showcase the need to improve the rapid uptake of PEP upon presentation. Kanagasabai et al. present data from 14 PEPFAR-supported countries where PEP was provided to survivors of sexual violence [23]. They found poor completion rates in this group. Duffy et al. provided important qualitative insights from health workers on how the implementation of PEP for individuals who have suffered sexual violence can be optimized [24]. Adewumi et al. highlight the feasibility of offering PEP to survivors of sexual violence at police stations [25].

The final four papers focussed on implementation research on delivery approaches among different groups with high vulnerability to HIV. These tended to be smaller-scale studies within novel settings. Kuguyo et al. piloted peer-led delivery of PEP vouchers among students enrolled in colleges in Zimbabwe [26]. They demonstrated the acceptability of PEP among students, with 30% of students who collected PEP vouchers redeeming them. Roche et al. evaluated pharmacy delivery of PEP and PrEP in Kenya, highlighting the high acceptability of the model and acceptable rates of follow-up HIV testing after the use of PEP [27]. Naik et al. showcased a pharmacy-led delivery model and online delivery of both PEP and PrEP, highlighting transitions between the two prevention methods [28]. Ayieko et al. [29] describe approaches to PEP delivery within the SEARCH programme. Although participant numbers are still not large, their results highlight that PEP is feasible and an appropriate choice for some people.

Taken together, these studies underscore the importance of acknowledging choice and providing more diverse PEP settings as key tenets to increasing PEP availability and speedy uptake. For PEP to achieve its potential impact on the HIV epidemic, it needs to reach populations with the greatest need. These populations often face disparities in health access, either within countries or regions where health resources are limited.

PEP might substantially reduce HIV in settings where people experience high HIV incidence and for whom PrEP use is not possible, for example cases of gender-based violence. However, all these papers serve as a reminder that PEP delivery is not easy, evidence for use after 24 hours is not available and uptake dependent on many factors.

Ongoing research and evaluation into number of drugs, duration of therapy and pipeline drugs as well as implementation research to optimize delivery pathways will help inform best practices. This is even more critical in this era of drastic cuts to international funding [30], where modelling has shown that HIV prevention efforts will be the most affected [31].

The future positioning of daily PEP for 28 days is likely to be different given advances in the development of long-acting prevention agents such as monthly oral MK-8527 [32]. These long-acting oral agents are not yet available but are promising advances that can potentially simplify PEP regimens. Providers need to expand PEP user's choice of access methods. HIV prevention in Africa remains crucial if we are to reach the goal of HIV no longer being a public health challenge. Reductions in investment at this stage threaten to reverse a decade of solid progress in the region.

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COMPETING INTERESTS

The authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

JF and ELS contributed to the initial draft of the manuscript. PG-F provided feedback, reviewed and edited the draft, and approved the final version prior to submission.

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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

REFERENCES

1. UNAIDS. Fact Sheet 2024: Global HIV Statistics. Geneva: UNAIDS; 2024.
2. UNAIDS. 2024 Global AIDS Update: The Urgency of Now—AIDS at a Crossroads. Geneva: UNAIDS; 2024.
3. Otten RA, Smith DK, Adams DR, Pullium JK, Jackson E, Kim CN, et al. Efficacy of postexposure prophylaxis after intravaginal exposure of pig-tailed macaques to a human-derived retrovirus (human immunodeficiency virus type 2). J Virol. 2000;74(20):9771–5.
4. Tsai C-C, Emau P, Follis KE, Beck TW, Benveniste RE, Bischofberger N, et al. Effectiveness of postinoculation (R)-9-(2-phosphonylmethoxypropyl) adenine treatment for prevention of persistent simian immunodeficiency virus SIVmne infection depends critically on timing of initiation and duration of treatment. J Virol. 1998;72(5):4265–73.
5. Irvine C, Egan KJ, Shubber Z, Van Rompay KK, Beanland RL, Ford N. Efficacy of HIV postexposure prophylaxis: systematic review and meta-analysis of nonhuman primate studies. Clin Infect Dis. 2015;60 Suppl 3:S165–9.
6. Cardo DM, Culver DH, Ciesielski CA, Srivastava PU, Marcus R, Abiteboul D, et al. A case-control study of HIV seroconversion in health care workers after percutaneous exposure. Centers for Disease Control and Prevention Needlestick Surveillance Group. N Engl J Med. 1997;337(21):1485–90.
7. Ford N, Shubber Z, Calmy A, Irvine C, Rapparini C, Ajose O, et al. Choice of antiretroviral drugs for postexposure prophylaxis for adults and adolescents: a systematic review. Clin Infect Dis. 2015;60(Suppl 3):S170–6.
8. New York State Department of Health AIDS Institute. Post-exposure prophylaxis (PEP) to prevent HIV infection. New York; 2024.
9. World Health Organisation. Guidelines for HIV post-exposure prophylaxis. Geneva: WHO; 2024.
10. Ford N, Irvine C, Shubber Z, Baggaley R, Beanland R, Vitoria M, et al. Adherence to HIV postexposure prophylaxis: a systematic review and meta-analysis. AIDS. 2014;28(18):2721–7.
11. Muriuki EM, Kimani J, Machuki Z, Kiarie J, Roxby AC. Sexual assault and HIV postexposure prophylaxis at an urban African hospital. AIDS Patient Care STDs. 2017;31(6):255–60.
12. Flexner C. The future of long-acting agents for preexposure prophylaxis. Curr Opin HIV AIDS. 2022;17(4):192–8.
13. Ortblad KF, Brown ER, Heffron R, Ngure K, Mujugira A, Donnell D. Research designs to generate evidence of HIV post-exposure prophylaxis effectiveness for new long-acting agents. J Int AIDS Soc. 2025;28(Suppl. 1):e26475.
14. Miller, Schaefer R. Do we need a regulatory path for HIV post-exposure prophylaxis? J Int AIDS Soc. 2025;28(Suppl. 1):e26449.
15. Zhang L, Collins S, Julie Fox, von Kleist M. Modelling the impact of initiation delay, duration and prior PrEP usage on the prophylactic efficacy of FTC/TDF-containing post-exposure prophylaxis. J Int AIDS Soc. 2025;28(Suppl. 1):e26454.
16. Kennedy CE, Dawit R, Yeh PT, Rodolph M, Ford N, Schmidt HA. HIV post-exposure prophylaxis (PEP) in community settings and by lay health workers or through task sharing: a systematic review of effectiveness, case studies, values and preferences, and costs. J Int AIDS Soc. 2025;28(Suppl. 1):e26448.
17. Magni S, Byamukama D, Haske MS, Mukami J, Moyo I, Auerbach JD. Implementing the new WHO guidelines on HIV post-exposure prophylaxis: perspectives from five African countries. J Int AIDS Soc. 2025;28(Suppl. 1):e26447.
18. Garnett GP, Godfrey-Faussett P. How plausible is it that PEP would be cost-effective in sub-Saharan Africa? J Int AIDS Soc. 2025;28(Suppl. 1):e26455.
19. Resar D, Mwamelo AJ, Olowu A, Drakes J, Macul H, de Gusmao E. Untapped potential of post-exposure prophylaxis in sub-Saharan Africa: a comparative analysis of PEP implementation planning in Kenya, Mozambique, Nigeria, Uganda, and Zambia. J Int AIDS Soc. 2025;28(Suppl. 1):e26471.
20. Laterra A, Spaid Miedema SS, Li M, Mndzebele P, Nzuza-Motsa N, Charania SN. Factors associated with PEP awareness among adolescent girls and young women in Eswatini. J Int AIDS Soc. 2025;28(Suppl. 1):e26486.
21. Schluck G, Romo ML, Kosgei J, Thigpen MC, Burns N, Bor R. Limited awareness and use of HIV post-exposure prophylaxis among people vulnerable to HIV acquisition in Western Kenya: a cross-sectional robust Poisson regression analysis. J Int AIDS Soc. 2025;28(Suppl. 1):e26472.
22. Tweya H, Chimpandule T, Wu W, Goeke L, Zheng Z, Mbiriyawanda S. Characteristics of individuals who received post-exposure prophylaxis and HIV seroconversion in Malawi: an analysis of national routine HIV testing data. J Int AIDS Soc. 2025;28(Suppl. 1):e26473.
23. Kanagasabai U, Davis SM, Thorsen V, Rowlinson E, Laterra A, Hegle J. Poor post-exposure prophylaxis (PEP) completion despite improved CDC-supported post-violence service delivery in 14 PEPFAR-supported sub-Saharan African countries, 2018–2023. J Int AIDS Soc. 2025;28(Suppl. 1):e26469.
24. Duffy M, Xavier EMF, de Almeida A, Correia D, dos Prazeres MN, Adriano J. Healthcare provider recommendations to improve post-exposure prophylaxis access and adherence in Mozambique. J Int AIDS Soc. 2025;28(Suppl. 1):e26452.
25. Adewumi B, Cain M, Kanagasabai U, Dahal S, Collins-Kalu D, Ayuba AM. Strengthening post-exposure prophylaxis uptake among survivors of sexual violence through immediate access at police stations in Nigeria's Federal Capital Territory. J Int AIDS Soc. 2025;28(Suppl. 1):e26460.
26. Kuguyo O, Mancitshana L, Mangenah C, Tumushime MK, Ruhode N, Matsikir E. Developing and evaluating a community-driven intervention to promote uptake of HIV and contraception services among students enrolled in colleges and universities in Zimbabwe. J Int AIDS Soc. 2025;28(Suppl. 1):e26461.
27. Roche SD, Omollo V, Mogere P, Asewe M, Gakuo S, Banerjee P. A modified pharmacy provider-led delivery model of oral HIV pre- and post-exposure prophylaxis in Kenya: a pilot study extension. J Int AIDS Soc. 2025;28(Suppl. 1):e26467.
28. Kiptinness C, Naik P, Kareithi T, Thuo N, Okello P, Culquichicon C. Online delivery of oral HIV pre- and post-exposure prophylaxis: findings from the prospective ePrEP Kenya pilot. J Int AIDS Soc. 2025;28(Suppl. 1):e26468.
29. Ayieko, Balzer LB, Aoko C, Sunday H, Kakande E, Kabami J. Uptake and patterns of PEP use within the context of a dynamic choice HIV prevention model in rural Uganda and Kenya: SEARCH Study. J Int AIDS Soc. 2025;28(Suppl. 1):e26450.
30. United States White House. Reevaluating and realigning United States foreign aid. 2025. Accessed March 17, 2025. https://www.whitehouse.gov/presidential-actions/2025/01/reevaluating-and-realigning-united-states-foreign-aid/.
31. Brink DT, Martin-Hughes R, Bowring AL, Wulan N, Burke K, Tidhar T, et al. Impact of an international HIV funding crisis on HIV infections and mortality in low-income and middle-income countries: a modelling study. Lancet HIV. 2025;12(5):e346–54. https://doi.org/10.1016/S2352-3018(25)00074-8.
32. Kapoor Y, Evans B, Carstens R, Diamond T, Grandhi A, Gillespie G, et al. MK-8527 PK/PD threshold and phase II dose selection for monthly oral HIV-1 preexposure prophylaxis. In: Conference on Retroviruses and Opportunistic Infections 2025 (CROI 2025). San Francisco. CROI 2025; 2025.

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COMMENTARY

Research designs to generate evidence of HIV post-exposure prophylaxis effectiveness for new long-acting agents

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Abstract

Introduction: New longer-acting antiretroviral (ARV) drugs—that is single doses with antiviral activity for at least a month—are being utilized for HIV treatment and pre-exposure prophylaxis (PrEP) but have not been explored for post-exposure prophylaxis (PEP). A "one-and-done" simplification of PEP has the potential to serve the HIV prevention needs of individuals not being met with traditional services and expand overall biomedical HIV prevention coverage. We discuss challenges with the assessment of PEP effectiveness in human trials and potential study designs that could generate evidence needed to inform the use of new, single-administered, long-acting ARVs for PEP.

Discussion: Challenges with determining the effectiveness of new long-acting PEP agents in human trials include the low likelihood of observing an HIV acquisition and the short period for outcome assessment (likely 1 month) following PEP administration. Additional challenges include recruiting individuals in the brief window in which they could benefit (<72 hours of a potential HIV exposure) and ethics of conducting informed consent during a period of high stress/vulnerability. Consequently, design approaches where the efficacy goal is to establish that the HIV incidence rate following PEP administration (of the standard or a novel agent) approaches zero should be considered. HIV RNA testing conducted within 5 days of a potential exposure could define prevention per exposure. Novel recruitment venues—such as community-based retail or online pharmacies—could be used to reach individuals after a potential exposure. Potential study designs include one- or two-arm individual-level product assignment aimed at demonstration of short-course efficacy or longer-term effectiveness compared to a background rate; cluster-randomized controlled trials of recruitment venues; and novel individual-level approaches that either do not or do utilize randomization in combination with choice, enabling assessment of preferences and effectiveness.

Conclusions: Over the past decade, multiple new HIV PrEP products—but no new PEP products—have been developed to meet the diverse needs of individuals seeking HIV prevention services. Challenges exist with generating PEP effectiveness evidence, but they are not insurmountable. Effectiveness research on new PEP products could advance the number of HIV prevention options available.

Keywords: effectiveness; HIV; HIV prevention; long-acting prophylaxis; post-exposure prophylaxis; study designs

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1 | INTRODUCTION

New long-acting antiretroviral (ARV) drugs—in the form of 2-monthly injections, semiannual injections and monthly pills—are now available or in late-stage development as HIV treatment and/or pre-exposure prophylaxis (PrEP) use [1–3]. These drugs additionally offer a potential "one-and-done" approach to HIV post-exposure prophylaxis (PEP), a potential simplification of the current daily oral regimen, but it remains unclear what would be required to establish them as effective for PEP use.

Most current PEP guidelines recommend a daily, oral three-drug ARV regimen for 28 days [4]. This recommendation is based on extrapolations from HIV treatment studies demonstrating superior halting of HIV disease progression and reduced risk of drug resistance with three- versus two-drug regimens [5], as well as the availability of daily co-formulated three-drug pills [6]. However, poor drug tolerability and low completion rates have challenged the implementation of three-drug PEP regimens [7]; especially regimens containing protease inhibitors, which result in side effects (~70%) and premature course completion (~30–50%) for many users [8, 9]. Further, despite evidence in animal data on the increased safety and potency of three- versus two-drug PEP regimens [10], associated laboratory testing requirements and dosage recommendations based on

Table 1. Design challenges with demonstration of PEP effectiveness in a human trial

Challenge	Details
Exposure to HIV unknown	Self-reported potential HIV exposures result in uncertainty around whether the encounter was a "true" exposure (i.e. the exposing partner may not be living with HIV)
Undetectable = Untransmissible	Even after a "true" HIV exposure to an individual living with HIV, there may be no or low-risk transmission if the exposing partner is HIV virally suppressed or on the way there.
High potential effectiveness of new long-acting agent	If a new long-acting PEP agent is highly effective, then the risk of HIV acquisition and chance of observing the primary endpoint (i.e. incident HIV infection) is very small.
Speed of drug absorption for new agents unknown	Uncertainties exist around how rapidly new long-acting ARVs are absorbed, which may present challenges for using these agents as PEP; however, these remain hypotheses.
Unknown SOC PEP effectiveness	Current PEP guidelines are based on animal model data and observational cohorts; no robust effectiveness evidence from human trials exists.
Evaluation period for effectiveness short	Since the potential HIV exposure occurred in the past, the follow-up duration for an observed event (i.e. HIV infection) is short, likely only 1 month or potentially shorter to control for potential new HIV exposures.
PEP demand unknown	Historic restrictions on PEP access and limited data on PEP dispensing result in uncertainties around PEP demand; which could challenge the recruitment of potential trial participants, especially during the brief window of PEP effectiveness.
Operational speed of PEP delivery critical	PEP effectiveness is greatest within 24 hours and up to 72 hours of HIV exposure; novel PEP delivery models are needed to reach individuals within that window.
Conducting informed consent	The time-sensitive nature of the intervention, lack of effectiveness evidence for the SOC and ethical considerations present challenges for informed consent.

Abbreviations: ARV, antiretroviral; PEP, post-exposure prophylaxis; SOC, standard-of-care.

two-drug regimens have not been simplified for three-drug regimens.

While PEP has been available as an HIV prevention tool for more than three decades, it remains underutilized and understudied. Since ARVs were demonstrated as effective for PrEP and approved in 2012 [11], most HIV programmes have focused on oral PrEP delivery and reserved PEP for emergency situations (e.g. occupational HIV exposures, instances of sexual assault). Global PrEP dispensing is carefully monitored and complimented with metrics of success; no such monitoring or metrics exist for PEP [6]. Meanwhile, the promise of PrEP as an HIV prevention tool has been challenged by poor uptake and adherence; individuals struggle with daily pill taking, cycle in and out of periods of PrEP need, and cannot always anticipate encounters associated with HIV risk [12, 13]. Consequently, some individuals may prefer PEP over PrEP for their HIV prevention needs. Recent implementation studies have found that when PEP is co-delivered as an HIV prevention option with PrEP, PEP uptake is high and PEP-to-PrEP transition low [14–17]. Many preference studies have demonstrated the appeal of long-acting ARVs to PrEP users [18–22]; these long-acting agents are likely to also appeal to PEP users.

In this paper, our intent is to present conceptual approaches for a PEP efficacy or effectiveness study, rather than concrete trial designs; recognizing the importance of collaboration with regulatory authorities, clinicians, biostatisticians, ethicists and community members to select and develop a specific design. Additionally, we outline design challenges with PEP effectiveness research and consider possible settings for implementation. In these studies, we assume the goal is to establish evidence that a selected long-acting ARV—that is a single dose with a dosing interval of at least a month—has comparable effectiveness to the current three-drug PEP regimen, the standard-of-care (SOC). A long-acting PEP regimen has strong potential to overcome uptake and adherence obstacles faced by the daily SOC—as demonstrated with PrEP [1–3], simplify PEP implementation and increase the number of HIV prevention options avaliable.

2 | DISCUSSION

2.1 | Challenges with assessing PEP effectiveness

To assess effectiveness of new long-acting ARVs for PEP use in a rigorous human trial, several design challenges exist (Table 1). First, the likelihood of an observed HIV infection following PEP initiation is low because many HIV exposures that trigger initiation are not true exposures (i.e. the exposing partner is not living with HIV); many true exposures may be associated with low or no HIV transmission risk (if the exposing partner's HIV viral levels are low or undetectable). While the potential effectiveness of a new long-acting PEP agent is likely high—as is the existing PEP SOC, it is unknown whether long-acting systemic ARV formulations are absorbed quickly enough to prevent HIV acquisition post-exposure.

Other design challenges include the unknown effectiveness of the current PEP SOC and the short evaluation period

for PEP effectiveness following a potential HIV exposure. The current PEP SOC effectiveness data comes from animal models and observational cohorts [10, 23–26]; no powered human efficacy trials have ever been conducted. Additionally, the evaluation period following a potential PEP exposure is short—likely only 1 month—compared to a PrEP or treatment effectiveness trial, where participants can be evaluated for months or years. The SOC PEP agent recommends consistent daily dosing for 28 days—to maintain systemic levels of active drugs during the initial HIV replication and infectivity period—with HIV testing at the end of this period [4]. With novel agents that are administered once and maintain high systemic levels for a month or longer, it may be important to test for HIV sooner. The opportunity for additional HIV exposures following PEP administration also increases with time (e.g. through sexual activity, injection equipment sharing), making it difficult to determine whether an HIV acquisition is a result of PEP failure or new exposure.

Recruitment for a PEP effectiveness trial may also be challenging as the demand for PEP remains largely unknown, the window in which individuals could benefit from PEP is brief and ethical considerations may restrict the populations considered for recruitment. In many settings, PEP is not widely available [27] and access is restricted to individuals who have experienced an occupational HIV exposure or sexual assault. Thus, the feasibility of accessing potential PEP clients and engaging them in clinical research during the acute period in which PEP could demonstrate effectiveness—that is within 72 hours, and ideally 24 hours, of a potential exposure [28]—remains unknown. To help ensure PEP reaches individuals in the window of benefit, innovative delivery models that facilitate quick PEP access are necessary [29]. Quick PEP delivery, however, may complicate the informed consent process—which is necessary for joint decision-making around the use of a novel agent compared to the SOC, especially an SOC that lacks rigorous effectiveness evidence [6]. To facilitate consent during a moment of potential high stress and uncertainty, researchers could consider strategies utilized to consent survivors of psychological trauma or sexual assault—such as having trained counsellors on site to support consenting participants or assuring participants of their autonomy throughout the process [29, 30].

Finally, another challenge with assessing PEP effectiveness—outside of those related to study design—is obtaining funding for a human trial; which is likely to be expensive and unlikely to be commercially viable for pharmaceutical companies.

2.2 | Settings and populations for PEP effectiveness trials

To reach individuals who could benefit from PEP within 72 hours of an exposure associated with HIV risk, strategic recruitment venues (with capacity for ARV dispensing) in HIV endemic settings need to be identified to achieve sample sizes sufficient to demonstrate PEP effectiveness. Established healthcare facilities—which were successfully utilized as recruitment venues for PrEP efficacy trials [31]—may be poor recruitment venues for PEP efficacy trials since they often are far from where individuals live, overcrowded and have limited hours of operation [12, 32–35]. Rather, recruitment venues that are community-based (i.e. outside healthcare facilities and near to where people live), located near hotspots of sexual activity and open on weekends/evenings when HIV exposures are more likely to occur may be potentially more high-yield for PEP trials.

Examples of such community-based venues could include retail pharmacies—especially those located near universities or bars—and online pharmacies that offer on-demand telehealth visits followed by quick courier-delivered services. Recent implementation studies that delivered PEP and PrEP via these novel delivery platforms in Kenya demonstrated high PEP uptake; with 68% (3228/4772) of retail pharmacy PrEP/PEP clients [36] and 88% (1549/1754) of online pharmacy PrEP/PEP clients [17] initiating PEP. These venues are settings where individuals seek other sexual and reproductive health services, including emergency contraception—which is sought more frequently at retail pharmacies than at public clinics in Kenya [37]; engaging such clients could facilitate PEP reach to individuals who might not otherwise engage. However, implementation challenges for delivering long-acting PEP products in community settings would need to be addressed, such as cold chains, reliable electricity and the delivery of HIV RNA testing [38].

In many PEP implementation studies and programmes, transitioning clients from PEP to PrEP has remained a persistent challenge. In studies that implemented strategies to support PEP-to-PrEP transition, <50% of PEP clients (between 11% and 49%) later initiated PrEP [39]. This evidence suggests that some individuals might only have periodic HIV exposures better suited for PEP use or that some individuals might prefer repeat PEP use over continuous PrEP use as a long-term HIV prevention strategy—a preference we could leverage when designing PEP effectiveness trials [40–42].

2.3 | Potential trial approaches for assessment of PEP effectiveness

The ultimate trial endpoint to determine the efficacy of a novel long-acting PEP agent is incident HIV infection. Assessing this endpoint soon after PEP administration may be necessary to avoid the potential for new HIV exposures. HIV RNA testing can detect the virus within 5 days (interquartile range 3.1–8.1 days) of a potential exposure [43]. Thus, a study endpoint using HIV RNA testing could commence as soon as 1-week post-treatment, with additional assessments up to 1 month to verify no infection occurred. However, few HIV acquisitions are likely to be observed in a PEP effectiveness trial; which makes a traditional, fully powered non-inferiority trial comparing incidence rates between two groups infeasible. Smaller trials would be possible if we reached a consensus about: (1) whether the "efficacy" goal is to establish that the probability of HIV infection following PEP administration (of the SOC or a long-acting agent) is sufficiently low; and (2) what threshold would be considered sufficiently low.

Design approaches where the "efficacy" goal is to establish that the rate of HIV acquisition following PEP administration approaches zero should be considered. Borrowing from contraceptive efficacy trials [44], this could be based on a consensus-based, evidence-driven threshold and the trial

Table 2. Potential designs for demonstration of PEP effectiveness in a human trial

Description	Population	Outcome	Estimand	Advantages	Challenges	Example designs
1. Individual-level randomization: short-course efficacy *(per exposure)*						
Randomize individuals; follow-up for 1–6 months	Individuals seeking PEP	HIV infection[a] at 1 month (primary) and when LA agent no longer active (secondary)	Proportion with HIV in each study group	• Can demonstrate per exposure efficacy	• Depends on fixed or background HIV incidence rate • Difficult to power for comparison of different PEP agents • Need to consider returning participants (re-randomize?[b])	• Emergency contraception [47] • COVID [48]
2. Individual-level randomization: long-term effectiveness *(repeated exposures using PEP)*						
Randomize individuals; follow-up for a pre-specified trial duration	Individuals seeking PEP (or with PEP use history) interested in a PEP-based HIV prevention strategy	HIV infection[a] (frequency of testing TBD)	Proportion with HIV in each study group; after a pre-determined follow-up time	• Likely pragmatic design • Adequate statistical power more likely since assessing effectiveness (i.e. dependent on user compliance) versus efficacy	• Recruitment of clients interested in repeat PEP use as an HIV prevention strategy • Participants may drop out differentially if they dislike their assigned PEP regimen	• On demand PrEP [49] • Doxy PEP [50, 51]
3. Cluster-level randomization						
Randomize delivery settings (i.e. pharmacies, clinics)	Clients of delivery set-tings/recruitment venues with high PEP dispensing	HIV infection[a] (individual level)	Proportion with HIV in each study group; after pre-determined follow-up time (cluster adjusted)	• Simpler implementation at site level	• Participants may select sites that offer their preferred agent, resulting in potential contamination • High implementation costs • Complicated logistics • Large sample size needed	• Pharmacy PrEP/PEP delivery [52] • Leprosy [53]

(*Continued*)

Table 2. (Continued)

Description	Population	Outcome	Estimand	Advantages	Challenges	Example designs
4. Individual-level, no randomization: 100% choice						
Allow individuals to choose the SOC or LA PEP agent	People seeking PEP	HIV infection[a]	Proportion with HIV in each study group	• No ethical concerns • Participants receive preferred PEP agent	• If choice associated with the probability of true HIV exposure, observed differences will be confounded with choice	• Open-label extension studies for CAB-LA versus FTC/TDF [54] • Cross-over study designs with choice period [55]
5. Individual-level, hybrid randomization and choice: preference design						
Allow individuals to choose their PEP product (SOC or LA agent) or choose to be randomized (SOC vs. LA agent)	People seeking HIV PEP	HIV infection[a]	Proportion with HIV in each study group	• Can elucidate efficacy of different interventions and impact of product preference and assignment on effectiveness	• Accounting for differences in product choices based on product characteristics • Difficult to plan power when proportion willing to be randomized unknown.	Never been done in HIV literature; other examples include: • Trials for mental health or addiction treatment [56]

Abbreviations: CAB-LA, long-acting injectable cabotegravir; FTC, emtricitabine; LA, long-acting; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; SOC, standard-of-care; TDF, tenofovir disoproxil fumarate.

[a]All incident HIV infections would ideally be confirmed with HIV RNA testing.

[b]Re-randomization of returning participants could be challenging if they return within the window of effectiveness for the long-acting PEP agent.

powered on the upper bound 95% confidence interval for the probability of HIV acquisition following PEP administration. To address challenges with low observed HIV acquisition rates in PrEP efficacy trials, statistical methods were developed to estimate background HIV infection rates [45, 46]; PEP efficacy trials would benefit from the development of similar methods with the difference being that these would likely need to focus on exposure-level versus cumulative HIV incidence rates.

Retaining incident HIV infection as the endpoint, we have identified five potential study design concepts that could be utilized to demonstrate the efficacy or effectiveness of a long-acting PEP agent in a human trial (Table 2). All the designs proposed could aim to compare HIV incidence rates between two groups or demonstrate an HIV incidence rate approaching zero—or a consensus-based threshold—in one or more groups with proven HIV acquisition risk.

The first two individual-level trial designs propose randomizing individuals seeking PEP to either the SOC or a new long-acting agent. The first individual-level trial design is focused on the demonstration of short-term per-exposure PEP efficacy. In this design, individuals are followed for one PEP course and the proportion that acquired HIV in each group is assessed at a fixed duration following PEP administration. There are several options for follow-up in this design. In the simplest approach, participants are followed for 1 month and eligible for PEP administration once. In a more complicated approach, participants can repeat PEP use (outside the window of the long-acting agent's potential effectiveness) and be re-randomized or re-dosed. Because the risk of HIV acquisition with either PEP agent is likely near zero, an evaluation against a consensus-based threshold, rather than a two-group comparison, would be suggested.

The second individual-level trial design focuses on the demonstration of the effectiveness of repeat PEP use over time. For this design, individuals interested in a PEP-based HIV prevention strategy would be recruited and followed for a pre-determined observation period (longer than 1 or 6 months). With this approach—which would likely require a pragmatic, unblinded design—different effectiveness may occur due to differences in the uptake of and adherence to the two PEP agents over a longer observation period, increasing the feasibility of achieving sufficient statistical power between the two groups due to higher resulting HIV incidence rates. Challenges, however, would include the recruitment of clients interested in repeat PEP over PrEP use as an HIV prevention strategy and potential differences in loss-to-follow-up within groups based on clients' satisfaction with their assigned PEP agent.

The next potential design is a cluster-level trial, with randomization of high-yield PrEP dispensing locations (i.e. retail pharmacies) to deliver either the SOC or long-acting PEP agent. With this design, we could compare the proportion of participants in each study group who acquired HIV after a pre-determined study period and adjust for clustering. The advantages of this design would be that implementation is simpler at a site versus individual level. Challenges, however, would be the high implementation costs and complicated logistics associated with recruiting, consenting and monitoring the large sample size required for a cluster-level trial. A potential risk of this design is contamination between study groups if participants select sites that offer their preferred PEP agent.

The final two individual-level designs would integrate individuals' preferences for HIV prevention products into our PEP effectiveness assessment. In the first of these designs, there would be no randomization, and individuals seeking PEP could either select the SOC or long-acting agent after being given sufficient information on both. The advantages of this approach are that there are no ethical concerns and participants receive their preferred PEP agent; challenges arise, however, if participants' choice is associated with their per-exposure HIV acquisition risk, which might confound observed differences in HIV incidence rates between the study groups. In the second of these designs, a preference trial, individuals seeking PEP could choose to either receive their preferred PEP agent or, if they did not have a preference, be randomized to one of two agents. Advantages with this approach are the ability to assess the impact of product preference and assignment on PEP effectiveness, while challenges include accounting for differences in choices made because of product characteristics and the need for a large sample size to accommodate the (unknown) proportion unwilling to be randomized.

In all these designs, understanding and supporting the validity of a choice to repeat PEP rather than convert to ongoing PrEP, would need to be explored. There is little data on the demand/need for repeated PEP use and little understanding of whether oral on-demand PrEP (with a 2-1-1 schedule) [49], or PrEP itself, is utilized in practice as PEP. One possible approach is for each enrolled participant to be offered, following a PEP "event," the opportunity to transition to PrEP, access on-demand PrEP (for eligible, male participants) or repeat PEP use. Then, participants who do not choose a PrEP option could contribute evidence of PEP use at future times of potential HIV exposure. For each new exposure, repeated or cross-over randomization—which allows for allocation to different PEP agents at each event—could be considered. While long-acting PEP agents would complicate the repeated randomization approach, the prospect of experiencing different products may appeal to participants and enable the collection of preference data based on user experience.

We acknowledge the significant challenges in developing approaches to assess the efficacy or effectiveness of long-acting PEP agents. After all, the current SOC PEP agent was not based on a human efficacy trial and there are only a few examples of trials evaluating PEP efficacy [57, 58]. Nonetheless, the considerable promise of a long-acting PEP agent justifies a creative, collaborative effort to develop an approach to establish the effectiveness of this new potential HIV prevention tool.

3 | CONCLUSIONS

For decades, HIV prevention programmes were limited by the interventions (biomedical and other) and implementation strategies that supported their delivery. With the availability of new long-acting ARVs, we have entered a new era of choice in HIV programming. As we move forward with multiple PrEP products and options for HIV prevention, new opportunities

to enhance and simplify PEP services are needed. One-time PEP use facilitated with long-acting ARVs could be a game-changer for individuals who struggle with daily pill taking, have challenges anticipating encounters associated with HIV exposure and value discretion with the use of a biomedical HIV prevention product. While challenges may exist to the generation of such effectiveness evidence, that should not prevent the exploration of paths forward. To end the AIDS epidemic, we need to engage individuals whose needs are unmet by existing HIV programmes; expanding the number of PEP options available will help achieve this objective.

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AUTHORS' CONTRIBUTIONS

The topic of this commentary was developed by DD with authors KFO, RH, AM, KN and ERB contributing to the generation of ideas included in the manuscript. KFO and DD drafted the first version of the manuscript with input from authors RH, AM, KN and ERB. All authors edited the manuscript and approved the final version for publication.

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REFERENCES

1. Landovitz RJ, Donnell D, Clement ME, Hanscom B, Cottle L, Coelho L, et al. Cabotegravir for HIV prevention in cisgender men and transgender women. New Engl J Med. 2021;385(7):595–608.
2. Bekker L-G, Das M, Abdool Karim Q, Ahmed K, Batting J, Brumskine W, et al. Twice-yearly lenacapavir or daily F/TAF for HIV prevention in cisgender women. New Engl J Med. 2024;391(13):1179–92.
3. Kelley CF. Twice-yearly lenacapavir for HIV prevention in cisgender gay, bisexual, and other men, transgender women, transgender men, and gender-nonbinary people who have sex with partners assigned male at birth: interim analysis results from the PURPOSE 2 study. Oral presentation at HIVR4P 2024: 5th HIV Research for Prevention Conference, Lima, Peru, October 6–10, 2024.
4. World Health Organization. Guidelines for HIV post-exposure prophylaxis [Internet]. Geneva: WHO; 2024 [cited 10 Oct 2024]. Available from: https://iris.who.int/bitstream/handle/10665/378221/9789240095137-eng.pdf?sequence=1
5. Hammer SM, Squires KE, Hughes MD, Grimes JM, Demeter LM, Currier JS, et al. A controlled trial of two nucleoside analogues plus indinavir in persons with human immunodeficiency virus infection and CD4 cell counts of 200 per cubic millimeter or less. New Engl J Med. 1997;337(11):725–33.
6. Mayer KH, Allan-Blitz LT. Post-exposure prophylaxis to prevent HIV: new drugs, new approaches, and more questions. Lancet HIV. 2023;10(12):e816–e24.
7. Auerbach JD, Malone S, Forsyth AD. Occupational post-exposure prophylaxis among healthcare workers: a scoping review of factors affecting optimal utilization. J Int AIDS Soc. 2024;27(8):e26341.
8. Leal L, León A, Torres B, Inciarte A, Lucero C, Mallolas J, et al. A randomized clinical trial comparing ritonavir-boosted lopinavir versus raltegravir each with tenofovir plus emtricitabine for post-exposure prophylaxis for HIV infection. J Antimicrob Chemother. 2016;71(7):1987–93.
9. Parkin J, Murphy M, Anderson J, El-Gadi S, Forster G, Pinching A. Tolerability and side-effects of post-exposure prophylaxis for HIV infection. Lancet. 2000;355(9205):722–3.
10. Bourry O, Brochard P, Souquiere S, Makuwa M, Calvo J, Dereudre-Bosquet N, et al. Prevention of vaginal simian immunodeficiency virus transmission in macaques by postexposure prophylaxis with zidovudine, lamivudine and indinavir. AIDS. 2009;23(4):447–54.
11. Murchu EO, Marshall L, Teljeur C, Harrington P, Hayes C, Moran P, et al. Oral pre-exposure prophylaxis (PrEP) to prevent HIV: a systematic review and meta-analysis of clinical effectiveness, safety, adherence and risk compensation in all populations. BMJ Open. 2022;12(5):e048478.
12. Antonini M, Silva IE, Elias HC, Gerin L, Oliveira AC, Reis RK. Barriers to pre-exposure prophylaxis (PrEP) use for HIV: an integrative review. Rev Bras Enferm. 2023;76(3):e20210963.
13. Haberer JE, Mujugira A, Mayer KH. The future of HIV pre-exposure prophylaxis adherence: reducing barriers and increasing opportunities. Lancet HIV. 2023;10(6):e404–e11.
14. Ong'wen P, Roche SD, Omollo V, Kareithi T, Juma L, Kiptinness C, et al. Uptake of HIV post-exposure prophylaxis (PEP) in private retail pharmacies in Kenya: early findings from the Pharm PrEP study. Oral presentation at AIDS 2024: 25th International AIDS Conference, Munich, Germany, July 22–26, 2024.
15. Kamya MR, Balzer LB, Ayieko J, Kabami J, Kakande E, Chamie G, et al. Randomized trial of SEARCH dynamic choice HIV prevention including injectable cabotegravir (CAB-LA). Oral presentation at CROI 2024: 31st Conference on Retroviruses and Opportunistic Infections, Denver, CO, March 3–6, 2024.
16. Kareithi T, Kiptinness C, Thuo N, Okello P, Nyamu M, Naik P, et al. Predictors of PEP-to-PrEP transition among individuals seeking HIV PEP in an online pharmacy delivery model in Kenya: findings from a pilot study. Poster presentation at HIVR4P 2024: 5th HIV Research for Prevention Conference, Lima, Peru, October 6–10, 2024.
17. Kiptinness C, Naik P, Thuo N, Rafferty M, Jomo E, Nyamasyo N. Online delivery of HIV prophylaxis services in Kenya: results from the ePrEP Kenya pilot study. Poster presentation at AIDS 2024: 25th International AIDS Conference, Munich, Germany, July 22–26, 2024.
18. Lorenzetti L, Dinh N, van der Straten A, Fonner V, Ridgeway K, Rodolph M, et al. Systematic review of the values and preferences regarding the use of injectable pre-exposure prophylaxis to prevent HIV acquisition. J Int AIDS Soc. 2023;26:e26107.
19. Ngure K, Mugo NR, Bukusi EA, Kiptinness C, Oware K, Gakuo S, et al. Pills, injections, rings, or implants? PrEP formulation preferences of PrEP-experienced African women for HIV prevention. J Acquir Immune Defic Syndr. 2021;88(4):e30–e2.
20. Minnis AM, Montgomery ET, Napierala S, Browne EN, van der Straten A. Insights for implementation science from 2 multiphased studies with end-users of potential multipurpose prevention technology and HIV prevention products. J Acquir Immune Defic Syndr. 2019;82:S222–S9.
21. Ngongo P, Mbogua J, Ndegwa J, Githuka G, Bender B, Manguyu F. A survey of stakeholder perceptions towards pre-exposure prophylaxes and prospective HIV microbicides and vaccines in Kenya. J AIDS Clin Res. 2017;8(678):2.
22. Khoza N, Etima J, Tolley E, Bula A, Chitukuta M, Namey E, et al. Acceptability of injectable cabotegravir versus daily oral TDF/FTC for PrEP: lesson from HPTN 084. Poster presentation at AIDS 2022: 24th International AIDS Conference, Montreal, Canada, July 29–Aug 2, 2022.
23. Tsai C-C, Emau P, Follis KE, Beck TW, Benveniste RE, Bischofberger N, et al. Effectiveness of postinoculation (R)-9-(2-phosphonylmethoxypropyl) adenine treatment for prevention of persistent simian immunodeficiency virus SIV_{mne} infection depends critically on timing of initiation and duration of treatment. J Virol. 1998;72(5):4265–73.
24. Otten RA, Smith DK, Adams DR, Pullium JK, Jackson E, Kim CN, et al. Efficacy of postexposure prophylaxis after intravaginal exposure of pig-tailed macaques to a human-derived retrovirus (human immunodeficiency virus type 2). J Virol. 2000;74(20):9771–5.

25. Schechter M, Do Lago RF, Mendelsohn AB, Moreira RI, Moulton LH, Harrison LH, et al. Behavioral impact, acceptability, and HIV incidence among homosexual men with access to postexposure chemoprophylaxis for HIV. J Acquir Immune Defic Syndr. 2004;35(5):519–25.
26. Cardo DM, Culver DH, Ciesielski CA, Srivastava PU, Marcus R, Abiteboul D, et al. A case–control study of HIV seroconversion in health care workers after percutaneous exposure. N Engl J Med. 1997;337(21):1485–90.
27. Allan-Blitz LT, Mayer KH. Updated guidelines on HIV post-exposure prophylaxis: continued efforts towards increased accessibility. J Int AIDS Soc. 2024;27(11):e26393.
28. Shih C-C, Kaneshima H, Rabin L, Namikawa R, Sager P, McGowan J, et al. Postexposure prophylaxis with zidovudine suppresses human immunodeficiency virus type 1 infection in SCID-hu mice in a time-dependent manner. J Infect Dis. 1991;163(3):625–27.
29. Campbell R, Goodman-Williams R, Javorka M. A trauma-informed approach to sexual violence research ethics and open science. J Interpers Violence. 2019;34(23–24):4765–93.
30. Abu-Rus A, Bussell N, Olsen DC, Davis-Ku MA, Alissa L, Arzoumanian MA. Informed consent content in research with survivors of psychological trauma. Ethics Behav. 2019;29(8):595–606.
31. Baeten JM, Donnell D, Ndase P, Mugo NR, Campbell JD, Wangisi J, et al. Antiretroviral prophylaxis for HIV prevention in heterosexual men and women. New Engl J Med. 2012;367(5):399–410.
32. Ajema C, Mbugua C, Memiah P, Wood C, Cook C, Kotut R, et al. Addressing the dual health epidemics of HIV and sexual abuse among children and adolescents in Kenya: uptake of HIV counseling and post-exposure prophylaxis. Adoles Health Med Ther. 2017; 9:1-9.
33. Izulla P, McKinnon LR, Munyao J, Karanja S, Koima W, Parmeres J, et al. HIV postexposure prophylaxis in an urban population of female sex workers in Nairobi, Kenya. J Acquir Immune Defic Syndr. 2013;62(2):220–25.
34. Mack N, Odhiambo J, Wong CM, Agot K. Barriers and facilitators to pre-exposure prophylaxis (PrEP) eligibility screening and ongoing HIV testing among target populations in Bondo and Rarieda, Kenya: results of a consultation with community stakeholders. BMC Health Serv Res. 2014;14(1):1–12.
35. Patel RC, Stanford-Moore G, Odoyo J, Pyra M, Wakhungu I, Anand K, et al. "Since both of us are using antiretrovirals, we have been supportive to each other": facilitators and barriers of pre-exposure prophylaxis use in heterosexual HIV serodiscordant couples in Kisumu, Kenya. J Int AIDS Soc. 2016;19(1) :21134.
36. Ortblad KF. Leveraging private-sector pharmacies to expand reach of biomedical HIV prevention interventions. Symposium: Putting People at the Center of Prevention: New Models of Delivery. Oral presentation at CROI 2025: Conference on Retroviruses and Opportunistic Infections, San Francisco, CA, March 12, 2025.
37. Rono B, Mogaka F, Nyerere B, Rota G, Harrington E, Lagat H, et al. Contraceptive method mix and PrEP choice among young women seeking contraception at retail pharmacies in Kenya. Oral presentation at HIVR4P 2024: 5th HIV Research for Prevention Conference, Lima, Peru, October 6–10, 2024.
38. Roche SD, Omollo V, Mogere P, Asewe M, Gakuo S, Banerjee P, et al. Anticipated preferences for long-acting HIV PrEP among current oral PrEP users at pharmacies: findings from a pilot study extension. Oral presentation at IAS 2023: 12th IAS Conference on HIV Science, Brisbane, Australia, July 23–26, 2023.
39. Atim M, Girometti N, Hyndman I, McOwan A, Whitlock G, Group DSC, et al. Post-exposure prophylaxis in the era of pre-exposure prophylaxis. HIV Med. 2020;21(10):668–70.
40. Beymer MR, Bolan RK, Flynn RP, Kerrone DR, Pieribone DL, Kulkarni SP, et al. Uptake and repeat use of postexposure prophylaxis in a community-based clinic in Los Angeles, California. AIDS Res Hum Retroviruses. 2014;30(9):848–55.
41. Izulla P, McKinnon LR, Munyao J, Ireri N, Nagelkerke N, Gakii G, et al. Repeat use of post-exposure prophylaxis for HIV among Nairobi-based female sex workers following sexual exposure. AIDS Behav. 2016;20:1549–55.
42. Restar AJ, Tocco JU, Mantell JE, Lafort Y, Gichangi P, Masvawure TB, et al. Perspectives on HIV pre- and post-exposure prophylaxes (PrEP and PEP) among female and male sex workers in Mombasa, Kenya: implications for integrating biomedical prevention into sexual health services. AIDS Edu Prev. 2017;29(2):141–53.
43. Fiebig EW, Wright DJ, Rawal BD, Garrett PE, Schumacher RT, Peddada L, et al. Dynamics of HIV viremia and antibody seroconversion in plasma donors: implications for diagnosis and staging of primary HIV infection. AIDS. 2003;17(13):1871–79.
44. Food and Drug Administration Center for Drug Evaluation and Research. Establishing effectiveness and safety for hormonal drug products intended to prevent pregnancy guidance for industry [Internet]. Rockville, MD: FDA; 2019 [cited 10 Oct 2024]. Available from: https://www.fda.gov/regulatory-information/search-fda-guidance-documents/establishing-effectiveness-and-safety-hormonal-drug-products-intended-prevent-pregnancy-guidance
45. Parkin N, Gao F, Grebe E, Cutrell A, Das M, Donnell D, et al. Facilitating next-generation pre-exposure prophylaxis clinical trials using HIV recent infection assays: a consensus statement from the Forum HIV Prevention Trial Design Project. Clin Pharmacol Ther. 2023;114(1):29–40.
46. Cutrell A, Donnell D, Dunn DT, Glidden DV, Grobler A, Hanscom B, et al. HIV prevention trial design in an era of effective pre-exposure prophylaxis. HIV Clin Trials. 2017;18(5–6):177–88.
47. Li RHW, Lo SST, Gemzell-Danielsson K, Fong CHY, Ho PC, Ng EHY. Oral emergency contraception with levonorgestrel plus piroxicam: a randomised double-blind placebo-controlled trial. Lancet. 2023;402(10405):851–58.
48. Boulware DR, Pullen MF, Bangdiwala AS, Pastick KA, Lofgren SM, Okafor EC, et al. A randomized trial of hydroxychloroquine as postexposure prophylaxis for Covid-19. New Engl J Med. 2020;383(6):517–25.
49. Molina JM, Capitant C, Spire B, Pialoux G, Cotte L, Charreau I, et al. On-demand preexposure prophylaxis in men at high risk for HIV-1 infection. N Engl J Med. 2015;373(23):2237–46.
50. Molina JM, Charreau I, Chidiac C, Pialoux G, Cua E, Delaugerre C, et al. Post-exposure prophylaxis with doxycycline to prevent sexually transmitted infections in men who have sex with men: an open-label randomised substudy of the ANRS IPERGAY trial. Lancet Infect Dis. 2018;18(3):308–17.
51. Luetkemeyer AF, Donnell D, Cohen SE, Dombrowski JC, Grabow C, Haser G, et al. Doxycycline to prevent bacterial sexually transmitted infections in the USA: final results from the DoxyPEP multicentre, open-label, randomised controlled trial and open-label extension. Lancet Infect Dis. 2025;S1473-3099(25)00085-4. Online ahead of print.
52. ClinicalTrials.gov. Pharmacy-based PrEP delivery in Kenya 2024 [Internet]. 2024 [cited 10 Oct 2024]. Available from: https://clinicaltrials.gov/study/NCT05842122.
53. Hasker E, Assoumani Y, Randrianantoandro A, Ramboarina S, Braet SM, Cauchoix B, et al. Post-exposure prophylaxis in leprosy (PEOPLE): a cluster randomised trial. Lancet Glob Health. 2024;12(6):e1017–26.
54. Katz AWK, Balán IC, Reddy K, Etima J, Weber K, Tauya T, et al. Women's experience receiving drug feedback and adherence counseling in MTN-025/HOPE–an HIV prevention open-label trial of the dapivirine vaginal ring. AIDS Behav. 2022;26(11):3607–19.
55. Nair G, Celum C, Szydlo D, Brown ER, Akello CA, Nakalega R, et al. Adherence, safety, and choice of the monthly dapivirine vaginal ring or oral emtricitabine plus tenofovir disoproxil fumarate for HIV pre-exposure prophylaxis among African adolescent girls and young women: a randomised, open-label, crossover trial. Lancet HIV. 2023;10(12):e779–e89.
56. Chen S, Wang W. A scoping review on two-stage randomized preference trial in the field of mental health and addiction. BMC Psychiatry. 2023;23(1):192.
57. Fox JM, Lee MJ, Fairhead CL, Ledwaba-Chapman LM, Nori AV, McQuillan O, et al. Self-start HIV postexposure prophylaxis (PEPSE), to reduce time to first dose and increase efficacy. Sex Transm Infect. 2023;99(6):367–72.
58. Inciarte A, Leal L, González E, León A, Lucero C, Mallolas J, et al. Tenofovir disoproxil fumarate/emtricitabine plus ritonavir-boosted lopinavir or cobicistat-boosted elvitegravir as a single-tablet regimen for HIV post-exposure prophylaxis. J Antimicrob Chemother. 2017;72(10):2857–61.

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VIEWPOINT

Do we need a regulatory path for HIV post-exposure prophylaxis?

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HIV post-exposure prophylaxis (PEP) is an important but underutilized HIV prevention tool. The scientific rationale for PEP is based on (1) the known mechanism of action of antiretrovirals in interfering with HIV replication and establishment of infection, (2) animal and pharmacokinetic/pharmacodynamic studies, and (3) studies among healthcare workers and other populations treated with zidovudine-based PEP, resulting in initial PEP guidelines [1]. Since these early studies, no comparative PEP efficacy trials have been conducted. Despite the absence of efficacy data, PEP guidelines by the US Centers for Disease Control and Prevention (CDC), World Health Organization (WHO) and other agencies have been updated based on the availability of more potent and tolerable regimens, further supportive animal studies, extrapolation from treatment studies, and non-randomized research [1, 2]. Contemporary PEP recommendations consist of a 28-day, three-drug oral regimen. However, other than zidovudine for preventing vertical transmission, no antiretroviral product has a labelled indication for PEP. It is thus implemented "off-label" based on recommendations by normative bodies.

Adherence to the recommended 28-day oral PEP regimen is often suboptimal [3, 4] and incomplete adherence may contribute to HIV seroconversion [5]. New long-acting antiretroviral drug formulation could thus improve PEP effectiveness and impact. However, demonstrating the efficacy (or effectiveness) of new products as PEP faces considerable challenges, including the low likelihood of HIV acquisition following PEP initiation and an effective standard-of-care PEP regimen (as discussed by Ortblad et al. in this supplement [6]). Given the consensus about existing PEP efficacy, placebo-controlled trials are not ethical, and active-control randomized non-inferiority trials may require unfeasibly large sample sizes. Considering these challenges, do we need a regulatory path for PEP, and if so, what would it look like?

An approved indication from a trusted regulatory authority implies rigorous science, review and benefit versus risk considerations for that indication, transparently debated in public—or with public access to the process. It builds confidence among policymakers, healthcare providers and users. An approved indication authorizes the marketing of that product for that indication, possibly resulting in improved awareness and access. A labelled indication may facilitate coverage through health insurance or public healthcare systems, further improving access. More available products with a PEP indication would increase product choice, aligning with user preferences and needs and potentially improving uptake and effective use. Finally, regulatory approvals for a PEP indication may improve global access through regulation by reliance. In this process, a regulatory authority utilizes the assessment of another trusted authority when evaluating a product. This is of particular benefit to regulatory authorities with more limited resources and can accelerate approval timelines and increase the availability of products.

Various drugs are used as PEP to reduce infectious disease risks. Oseltamivir phosphate was approved for influenza PEP based on randomized household transmission studies [7]. By the late 2000s, it was widely approved—including in the United States [8], European Union [9] and South Africa [10]—and available in over 80 countries [11]. Approval by the European Medicines Agency facilitated WHO prequalification in 2009 [12]. In contrast, doxycycline is being integrated into clinical practice in the United States as PEP for non-HIV sexually transmitted infections (STIs) (doxy-PEP) without regulatory PEP indication; rather, it is recommended by the US CDC for some individuals based on randomized clinical trials [13]. In other countries, such as the UK [14], doxy-PEP is not recommended, and it remains to be seen how uptake by providers and patients will evolve over time and across geographies. However, these examples may not be generalizable to HIV PEP as the transmission rate and incidence of influenza and non-HIV STIs are higher than those of HIV, and these clinical studies were able to compare the PEP agent against a placebo or no PEP.

Contraception may illustrate possible regulatory pathways for HIV PEP. US Food and Drug Administration (FDA) guidance for hormonal contraception recognizes that (1) placebo-controlled trials are not feasible, (2) expected pregnancy rates are high in the absence of contraception, and (3) the treatment effect is high [15]. Together with the understanding of drug mechanisms of action, this justifies single-arm, open-label trials, with comparison to historical controls to establish efficacy measured by the Pearl Index (the number of unintended pregnancies per 100 years of exposure) and life table analyses [15]. This ensures efficient drug development for increased product choice. Emergency

contraception could be considered analogous to HIV PEP. For example, ulipristal acetate was approved by the US FDA for emergency contraception in 2010 based on an open-label single-arm and a single-blind comparative clinical trial [16]. In both trials, primary analyses compared the observed pregnancy rate among those who received emergency contraception with the expected pregnancy rate.

Assuming ample pharmacokinetic, pharmacodynamic and safety evidence, the major hurdle for an HIV PEP labelled indication is demonstrating efficacy: "Does the drug prevent HIV after exposure?" Applying the emergency contraception regulatory pathway, a study would not address "Is the new drug better than existing ones?" but demonstrate no or hardly any HIV acquisitions in settings with at least a modest number of expected acquisitions in the absence of PEP. A sub-analysis might be considered for exposures with known-serostatus index cases (e.g. in healthcare settings). It might be useful for studies to offer a standard-of-care 28-day oral regimen option. This would not be intended to generate comparative effectiveness evidence but data on preferences and acceptability. Further secondary outcomes might include adherence, return to follow-up visits, patient satisfaction, and adverse events.

There are clear potential advantages in a regulatory PEP indication, improving trust by providers and users, increasing access, and resulting in more choices for those who could benefit from PEP. This, in turn, can improve the uptake and effective use of PEP. Whether the pathways for a PEP indication proposed here or elsewhere in this supplement are acceptable to communities and regulatory authorities requires input from all stakeholders. Such multistakeholder processes to facilitate consensus have supported novel clinical trial designs for HIV pre-exposure prophylaxis [17] and they should be used to clarify critical issues around PEP, involving regulators, communities, ethicists, researchers, and industry. Through such collaboration, the untapped potential of PEP can be realized.

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COMPETING INTERESTS

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AUTHORS' CONTRIBUTIONS

VM produced the first draft of the manuscript. VM and RS finalized the manuscript.

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REFERENCES

1. Mayer KH, Allan-Blitz L-T. Post-exposure prophylaxis to prevent HIV: new drugs, new approaches, and more questions. Lancet HIV. 2023;10(12):e816–e24.
2. Allan-Blitz L-T, Mayer KH. Updated guidelines on HIV post-exposure prophylaxis: continued efforts towards increased accessibility. J Int AIDS Soc. 2024;27(11):e26393.
3. Oldenburg CE, Bärnighausen T, Harling G, Mimiaga MJ, Mayer KH. Adherence to post-exposure prophylaxis for non-forcible sexual exposure to HIV: a systematic review and meta-analysis. AIDS Behav. 2014;18(2):217–25.
4. Chacko L, Ford N, Sbaiti M, Siddiqui R. Adherence to HIV post-exposure prophylaxis in victims of sexual assault: a systematic review and meta-analysis. Sex Transm Infect. 2012;88(5):335–41.
5. Beymer MR, Weiss RE, Bolan RK, Kofron RM, Flynn RP, Pieribone DL, et al. Differentiating nonoccupational postexposure prophylaxis seroconverters and non-seroconverters in a community-based clinic in Los Angeles, California. Open Forum Infect Dis. 2017;4(2):ofx061.
6. Ortblad KF, Heffron R, Ngure K, Mujugira A, Brown ER, Donnell D. Research designs to generate evidence of HIV post-exposure prophylaxis effectiveness for new long-acting agents. J Int AIDS Soc. 2025.
7. Welliver R, Monto AS, Carewicz O, Schatteman E, Hassman M, Hedrick J, et al. Effectiveness of oseltamivir in preventing influenza in household contacts: a randomized controlled trial. JAMA. 2001;285(6):748–54.
8. Gilead Sciences. Roche receives FDA approval of Tamiflu™, first pill to treat the most common strains of influenza (A&B). Foster City, CA: Gilead Sciences; 1999 [updated October 27, 1999; accessed February 19, 2025]. Available from: https://www.gilead.com/news/news-details/1999/roche-receives-fda-approval-of-tamiflu-first-pill-to-treat-the-most-common-strains-of-influenza-ab.
9. Gilead Sciences. Roche receives approval in Europe for Tamiflu(R). Foster City, CA: Gilead Sciences; 2002 [updated June 26, 2002; accessed February 19, 2025]. Available from: https://www.gilead.com/news/news-details/2002/roche-receives-approval-in-europe-for-tamiflur.
10. Independent Online (IOL). Tamiflu registered as bird flu precaution 2006. [updated February 20, 2006; accessed February 19, 2025]. Available from: https://www.iol.co.za/news/south-africa/tamiflu-registered-as-bird-flu-precaution-267097.
11. FierceBiotech. Roche introduces program to facilitate corporate pandemic stockpiling of Tamiflu. New York: Fierce Biotech; 2008 [updated June 27, 2008; accessed February 19, 2025]. Available from: https://www.fiercebiotech.com/biotech/roche-introduces-program-to-facilitate-corporate-pandemic-stockpiling-of-tamiflu.
12. World Health Organization (WHO). WHO Prequalification Programme—WHO PUBLIC ASSESSMENT REPORT (WHOPAR)—Tamiflu® 75 mg hard capsules. Geneva: WHO; 2025.
13. Bachmann LH, Barbee LA, Chan P, Reno H, Workowski KA, Hoover K, et al. CDC clinical guidelines on the use of doxycycline postexposure prophylaxis for bacterial sexually transmitted infection prevention, United States, 2024. MMWR Recomm Rep. 2024;73(2):1–8.
14. Kohli M, Medland N, Fifer H, Saunders J. BASHH updated position statement on doxycycline as prophylaxis for sexually transmitted infections. Sex Transm Infect. 2022;98(3):235–6.
15. U.S. Food & Drug Administration (FDA). Establishing effectiveness and safety for hormonal drug products intended to prevent pregnancy—guidance for industry. Silver Springs, MD: U.S. FDA; 2019.
16. Richardson AR, Maltz FN. Ulipristal acetate: review of the efficacy and safety of a newly approved agent for emergency contraception. Clin Ther. 2012;34(1):24–36.
17. Parkin N, Gao F, Grebe E, Cutrell A, Das M, Donnell D, et al. Facilitating next-generation pre-exposure prophylaxis clinical trials using HIV recent infection assays: a consensus statement from the Forum HIV Prevention Trial Design Project. Clin Pharmacol Ther. 2023;114(1):29–40.

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RESEARCH ARTICLE

Modelling the impact of initiation delay, duration and prior PrEP on the efficacy of post-exposure prophylaxis containing a tenofovir/emtricitabine backbone

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Abstract

Introduction: Pre- and post-exposure prophylaxis (PrEP and PEP) are important pillars of the HIV prevention portfolio to reduce the risk of acquisition just before or after HIV exposure. While PrEP efficacy has been elucidated in many randomized clinical trials, corresponding data for PEP is extremely difficult to obtain in a controlled setting. Consequently, it is almost impossible to study the impact of PEP initiation delay and duration on HIV risk reduction clinically, which would inform recommendations on PEP use.

Methods: We employ pharmacokinetics, pharmacodynamics and viral dynamics models, along with individual factors, such as drug adherence to investigate the impact of initiation delay and PEP duration on HIV risk reduction. We evaluated PEP using two- and three-drug regimens with a TDF/FTC backbone. Moreover, we study PEP efficacy in the context of PrEP-to-PEP transitions.

Results: In our simulations, early initiation of PEP emerged as a pivotal factor for HIV risk reduction. We found that 2-drug (TDF/FTC) PEP may insufficiently protect when initiated > 1 hour post-exposure. When adding a third drug, early initiation was still a critical factor; however, over 90% efficacy could be achieved when PEP was initiated 48 hours post-exposure and taken for at least 14–28 days, depending on the efficacy of the third-drug component. When investigating PrEP-PEP transitions, we observed that preceding PrEP can (1) contribute directly to prophylactic efficacy, and (2) boost subsequent PEP efficacy by delaying initial viral dynamics and building-up drug concentrations, overall facilitating self-managed transitioning between PrEP and PEP.

Conclusions: Our study confirms the critical role of early (< 48 hours) PEP initiation, preferably with three drugs taken for 28 days. Self-start with TDF/FTC and later addition of a third drug is better than not self-starting. Furthermore, our study highlights the synergy between recent PrEP intake and PEP and may help to inform recommendations on PEP use.

Keywords: HIV; mathematical modelling; post-exposure prophylaxis; pre-exposure prophylaxis; quantitative systems pharmacology; TDF/FTC

Additional information may be found under the Supporting Information tab of this article.

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1 | INTRODUCTION

An estimated 1.3 million individuals acquired the human immunodeficiency virus (HIV) in 2023 [1]. To date, with a handful of exceptions, there is no cure [2]. However, treatment with antiviral drugs prevents AIDS, as well as transmission [3, 4]. Currently, treatment needs to be taken life-long, which, in addition to individual burden, requires treatment availability, medical care infrastructure and funding. HIV prevention through vaccination would constitute an ideal means to fight the pandemic. However, all recent vaccine trials prematurely terminated due to failure in demonstrating clinical efficacy [5]. In the absence of effective vaccines, pre-exposure prophylaxis (PrEP) has partly taken its place. Four effective regimens are currently available: once daily emtricitabine (FTC) with either tenofovir disoproxil fumarate (TDF) or tenofovir alafenamide (TAF) can be administered orally, long-acting cabotegravir (CAB) can be injected every 2 months. Monthly dapivirine (DPV) vaginal rings to prevent acquisition through receptive vaginal intercourse recently received a positive

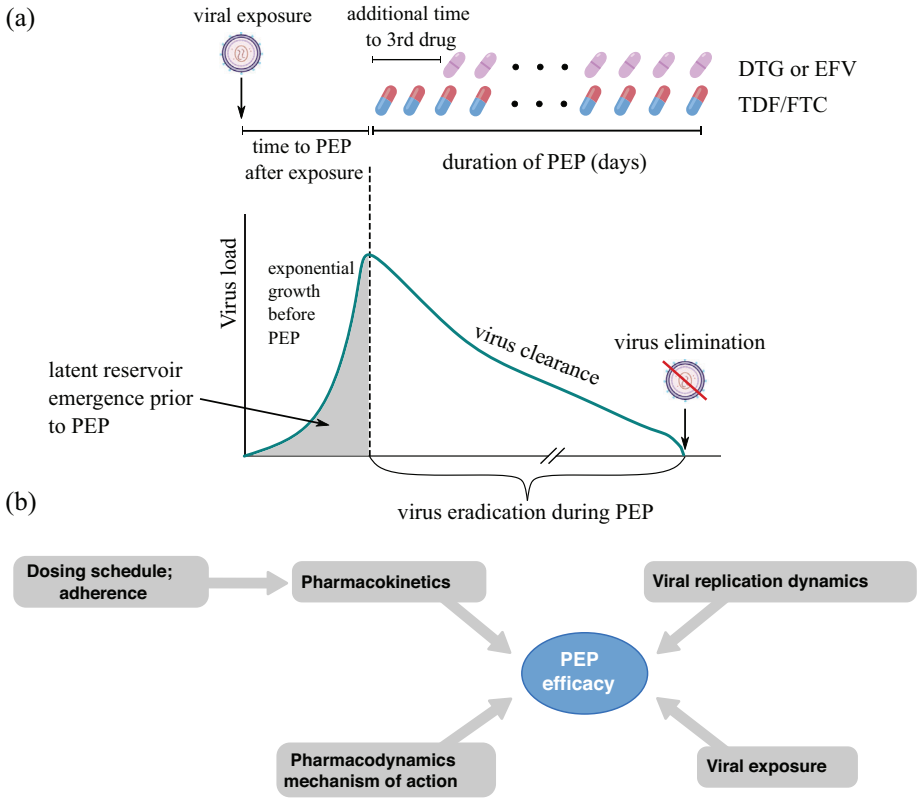


Figure 1. Schematic of post-exposure prophylaxis and key parameters influencing PEP efficacy in the mathematical model. (a) PEP is initiated after virus exposure. In the time between virus exposure and PEP initiation, virus may grow exponentially. The total amount of virus replication during this time may be related to the probability of emergence of latently infected cells, which render infection irreversible (grey area). Depending on the duration of viral growth before PEP and conditioned that latent infected cells have not yet emerged, PEP must be taken long enough to ensure that all replicating viruses are eliminated. (b) Schematic of model constituents for estimating PEP efficacy. Pharmacokinetic models relate arbitrary dosing patterns to target site concentration-time profiles. Through mechanism-of-action models, we predict their impact of early viral dynamics. Lastly, we compute the probability that all virus compartments will be eliminated during PEP, after a particular viral exposure occurred. We use these integrated models to calculate the *per exposure* reduction in HIV acquisition probability (PEP efficacy). Abbreviations: DTG, dolutegravir; EFV, efavirenz; FTC, emtricitabine; PEP, post-exposure prophylaxis; TDF, tenofovir disoproxil fumarate.

review by the European Medicines Agency. PrEP with twice-yearly injectable lenacapavir is submitted for review by regulatory agencies. Of the available PrEP options, oral TDF/FTC is widely available as a generic and rolled out in both low- and high-income countries.

Post-exposure prophylaxis (PEP) taken after suspected sexual or occupational exposure to HIV [6] denotes another important preventive measure to reduce acquisition risk. Current guidelines recommend to initiate oral PEP within 72 hours after suspected virus exposure and to continue the regimen for 28 days [6–8]. National [6, 8] and international guidelines [7] differ with regard to recommending two- or three-drug regimens for PEP: For example, TDF/FTC + raltegravir or dolutegravir (DTG) are recommended in the United States, whereas the WHO 2014 guidelines also discuss scenarios where two-drug regimens with generics may be recommended. To date, TDF/FTC denotes the preferred backbone in PEP, whereas different choices of third-component drugs may be used [9]. However, because of operational and ethical challenges, no randomized controlled trial has been conducted to test PEP efficacy directly. Current evidence for non-occupational PEP efficacy has been synthesized from animal transmission models and observational and case studies of PEP use [6, 8]. However, results from observational studies may be impacted by many factors such as individual adherence and risk behaviour [10] and differences in regard to utilized PEP drugs [8]. Although the developed guidelines are based on impressive trans-disciplinary synthesis of evidence across heterogeneous data sources, it has not been possible to elucidate the sensitivity of a particular PEP regimen to delays in initiation, PEP duration, as well as the impact of PrEP on PEP efficacy.

In the absence of randomized controlled trial data on PEP efficacy, mathematical modelling may support the synthesis of evidence, by integrating available knowledge on drug pharmacokinetics (PK), as well as early viral dynamics. However, to our knowledge, no such modelling exists to date. To analyse PEP efficacy for two- and three-drug regimens, to test the impact of delays in "time to PEP," PEP duration Figure 1a, as well as the transition from PrEP to PEP, we utilized an integrated mathematical model combining drug PK at their target site [11–13], mechanistic models of direct drug

action [14], initial viral dynamics [15] and viral exposure [16] (Figure 1b).

2 | METHODS

We combined population PK models of oral FTC, TDF, DTG and efavirenz (EFV), an older generation antiretroviral [12, 17–19], with viral dynamics models [20, 21] and a novel numerical scheme [15] to estimate the prophylactic efficacy of PEP for different dosing patterns, as well as PrEP-to-PEP transitions. While individual models had been validated previously [11–13, 22], the overarching goal of this study was to understand the sensitivity of PEP efficacy towards delay in PEP initiation after virus exposure, as well as the duration of PEP, with and without prior PrEP utilization.

2.1 | Prophylactic efficacy

In clinical trials, *average* HIV risk reduction is quantified in terms of incidence reduction in an intervention versus a control arm [23–26]. In a mathematical model of within-host viral replication, the same quantity can be derived by computing the reduction of infection probability *per viral exposure* due to a prophylactic regimen S:

$$\phi = 1 - \frac{P_I\left(Y_t, S\right)}{P_I\left(Y_t, \emptyset\right)}, \tag{1}$$

where $P_I(Y_t, S)$ and $P_I(Y_t, \emptyset)$ denote the infection probability in the presence and absence of a prophylactic regimen S when Y_t drug-susceptible viral particles enter a replication-enabling compartment at time t. Notably, the infection probability is the complement of the virus elimination probability $P_E(Y_t, S)$.

2.2 | Virus exposure model

We used previously developed exposure models for sex without condoms [16]. In these models, the number of infectious viruses (inoculum size Y_t) that are transmitted to and reaching an anatomical site where they may spark an infection, are estimated from a binomial distribution, $Y_t \sim B(\mathrm{VL}, r)$, where VL denotes the donor virus load, and the "success rate" r depended on the type of exposure. Throughout this study, unless stated otherwise, we utilize the exposure model designed for receptive vaginal intercourse.

2.3 | HIV viral dynamics model

To compute the viral elimination probability in the exposed host for prophylactic regimen S, we employ a within-host viral dynamics model [20, 21], depicted in Text S1. The model considers replication of free infectious viruses, early and productively infected T cells, as well as long-lived cells such as macrophages and latently infected T cells, which are believed to be an obstacle for the within-host clearance of HIV [27]. The model was derived from first principles [20] and allows to model pharmacodynamic (PD) effects of all antiviral classes [22]. Moreover, it allows to incorporate state-of-the-art population PK models.

2.4 | Pharmacokinetics

We used the previously developed PK models of FTC [18] and TDF [18], which allow to predict prodrug PK in blood plasma, as well as the PK of the active phosphorylated moieties in peripheral blood mononuclear cells (PBMCs). In line with recent findings [11], we assume that the concentration of tenofovir-diphosphate (TFV-DP) and emtricitabine-triphosphate (FTC-TP) in PBMCs predict prophylactic effect. Furthermore, we adopted PK models for DTG [12] and EFV [13]. To capture the impact of individual PK variability, we sampled PK parameters for 1000 virtual patients per drug, utilizing distributions described in the aforementioned original sources. We considered oral doses of 300/200, 50 and 400 mg for TDF/FTC, DTG and EFV and daily dosing schedules as depicted in Figures 2–5a.

2.5 | PK-PD link

To evaluate the combinatorial effect of FTC-TP and TFV-DP (the active intracellular components of TDF/FTC), we adopted a model for the molecular mechanism of action and drug–drug interaction [14]. For DTG and EFV, their direct effect can be modelled using the Emax equation [28], corrected by plasma protein binding [12, 13], and was assumed to be additive with the TDF/FTC backbone, due to lack of evidence for non-additivity (DTG), or a lack of parameters to describe synergy (EFV).

2.6 | Numerics

We adopted the numerical scheme from [15] to formulate a set of ordinary differential equations that allows computing extinction probabilities $P_E(Y_t, S)$ of each compartment of the viral dynamics model, subject to PK and PD of the considered drugs, Equation (S16) in Text S1.

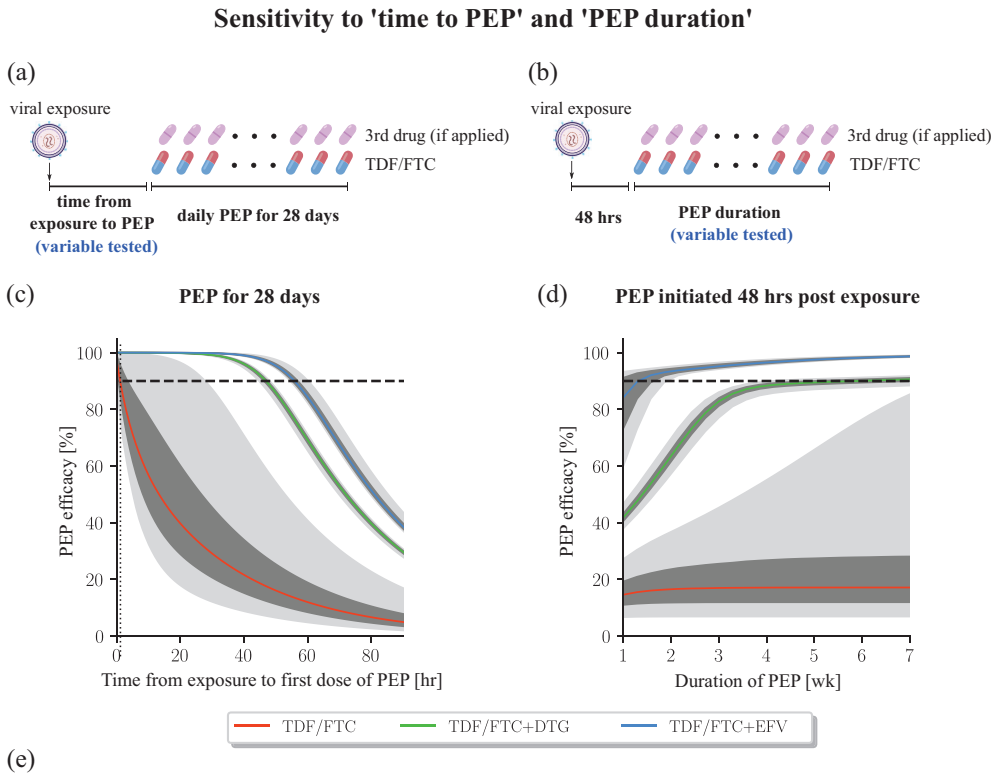
2.7 | Software availability

Computer codes are available at https://github.com/KleistLab/PEP under the MIT license [29].

3 | RESULTS

3.1 | "Time to PEP" is the most critical parameter

Currently, the WHO recommends to initiate PEP up to 3 days after potential viral exposure and to continue PEP for 28 days [7]. Using our modelling framework, we evaluated how PEP initiation delay may alter prophylactic efficacy. As a first test case, we explored the efficacy of 2-drug (oral TDF/FTC) PEP, as these drugs may be available in many settings where PrEP is implemented. We created 1000 virtual individuals and simulated individual PK based on the dosing profiles in Figure 2a. Using the model, we then computed the prophylactic efficacy for each virtual individual, if a 2-drug PEP with daily TDF/FTC was initiated at different time points post-exposure with drug-susceptible virus and taken for 28 days. Figure 2c depicts summary statistics of derived PEP efficacy estimates across the cohort of virtual individuals (median, interquartile ranges and 95% confidence intervals). From the



(e)

Time from exposure to first dose of PEP	TDF/FTC			TDF/FTC + DTG			TDF/FTC+EFV		
	PEP duration			PEP duration			PEP duration		
	2 weeks	4 weekss	7 weeks	2 weeks	4 weeks	7 weeks	2 weeks	4 weeks	7 weeks
0 – 1hr	> 89% (78%, 99%)	>90% (78%, 99%)	> 91% (78%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)
1 – 8hr	>60% (38%, 94%)	>61% (38%, 99%)	>61% (38%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)
8 – 12 hr	>51% (28%, 90%)	>52% (28%, 98%)	>52% (28%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)
12 – 20 hr	> 38% (18%, 79%)	> 40% (18%, 96%)	> 40% (18%, 99%)	> 98% (96%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)	>99% (99%, 99%)
20 – 48 hr	>16% (6%, 37%)	>17% (6%, 57%)	>17% (6%, 87%)	>63% (57%, 70%)	>88% (85%, 90%)	>90% (88%, 92%)	>93% (91%, 96%)	>96% (95%, 98%)	>98% (98%, 99%)
72 hr	8% (3%, 18%)	8% (3%, 28%)	8% (3%, 49%)	32% (28%, 36%)	50% (47%, 52%)	52% (50%, 54%)	56% (53%, 63%)	64% (61%, 71%)	74% (72%, 79%)

Figure 2. Sensitivity of TDF/FTC-based PEP on initiation delay and PEP duration. (a) Schematic of the dosing regimen in panel C, where the variable tested is "time to PEP." (b) Schematic of the dosing regimen in panel D, where the variable tested is "PEP duration." (c) PEP efficacy of TDF/FTC (red line), TDF/FTC + EFV (blue line) or TDF/FTC + DTG (green line) when initiated at different delays post virus exposure and taken for 28 days once-daily. The vertical dotted line indicates PEP initiation 1 hour after exposure. (d) Efficacy of TDF/FTC (red line), TDF/FTC + EFV (blue line) and TDF/FTC + DTG (green line) when initiated 48 hours post virus exposure and taken for different durations. (e) Numerical results for different "times to PEP," "PEP durations" and regimen. Values denote the median efficacy and 95% confidence interval evaluated at the maximum "time to PEP" of the indicated interval (e.g. 8 hours for the 2–8 hours interval). All computations were conducted on 1000 virtual patients. The daily oral dose for each drug corresponds to 300/200 mg TDF/FTC, 50 mg DTG and 400 mg EFV. The coloured lines depict the median predicted PEP efficacy, whereas the dark- and light grey areas present the inter-quartile range and the 95% confidence range, respectively. Dashed horizontal lines indicate 90% prophylactic efficacy. Abbreviations: DTG, dolutegravir; EFV, efavirenz; FTC, emtricitabine; PEP, post-exposure prophylaxis; TDF, tenofovir disoproxil fumarate.

simulations, it is evident that ≥ 90% 2-drug PEP efficacy is only achieved if TDF/FTC is initiated within 1 hour after virus exposure. Efficacy steeply drops to < 50% when TDF/FTC-PEP was initiated 20 hours after virus exposure. We also found that a longer duration of 2-drug TDF/FTC PEP could not compensate for delayed initiation (Figure 2b,d red line) with efficacy remaining low (median efficacy < 20%), when PEP was initiated 48 hours after virus exposure and taken for up to 7 weeks. We tested whether a third drug component (DTG or EFV) may impact on prophylactic efficacy and change

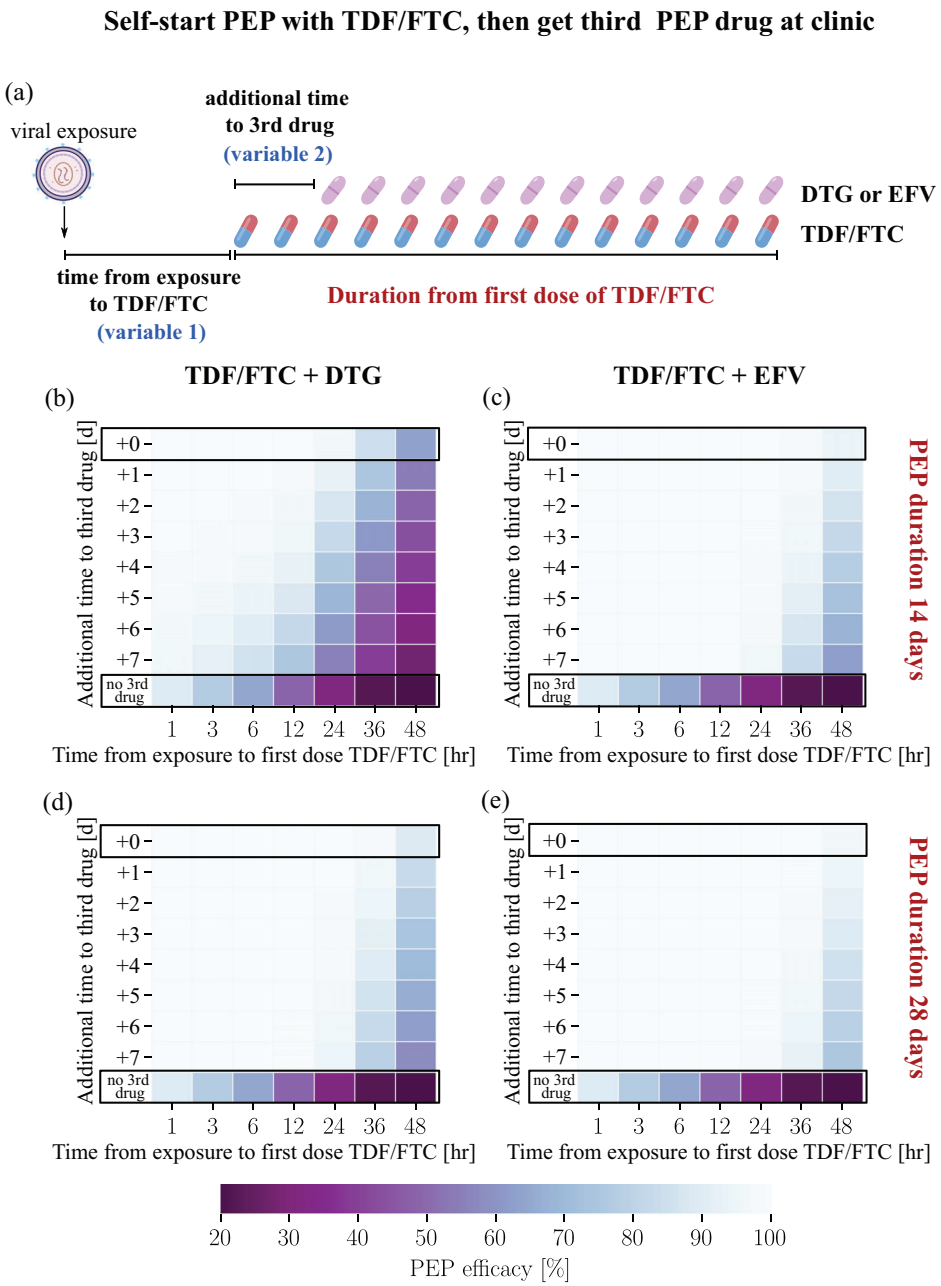


Figure 3. Efficacy of TDF/FTC-based PEP with delayed initiation of TDF/FTC and further delay of the third drug. (a) Schematic of the dosing regimen. For the drug combinations TDF/FTC + DTG and TDF/FTC + EFV, PEP efficacy was computed for virus exposures occurring within 1–48 hours before the first dose of TDF/FTC. The third drug was then added to the PEP regimen 1–7 days after the first dose of TDF/FTC. (b) PEP efficacy for the drug combination TDF/FTC + DTG, PEP duration was 14 days from the first dose of TDF/FTC. (c) Corresponding PEP efficacy for TDF/FTC + EFV. (d) PEP efficacy for TDF/FTC + DTG when taken for 28 days after the first TDF/FTC dose. (e) Corresponding PEP efficacy for TDF/FTC + EFV. The daily oral dose for each drug corresponds to 300/200 mg TDF/FTC, 50 mg DTG and 400 mg EFV. In panels B–E, the top row outlined in black denotes the scenario where the third drug is immediately added to the TDF/FTC backbone; the bottom row represents the scenario where no third drug was added to the TDF/FTC backbone. DTG, dolutegravir; EFV, efavirenz; FTC, emtricitabine; PEP, post-exposure prophylaxis; TDF, tenofovir disoproxil fumarate.

sensitivity to "time to PEP" and "PEP duration," Figures 2a–d. Compared to 2-drug PEP, 3-drug PEP provided > 88% protection against sexual transmission, when initiated 48 hours post-exposure and continued for 4 weeks (Figure 2e). When initiated 48 hours post-exposure, we predicted that TDF/FTC + EFV provided 91–96% HIV risk reduction when taken at least for 2 weeks, whereas TDF/FTC + DTG provided 85–90% HIV risk reduction when taken for at least 4 weeks. In contrast to 2-drug PEP, we predicted that PEP efficacy with TDF/FTC + EFV or DTG can increase with an extended duration of PEP.

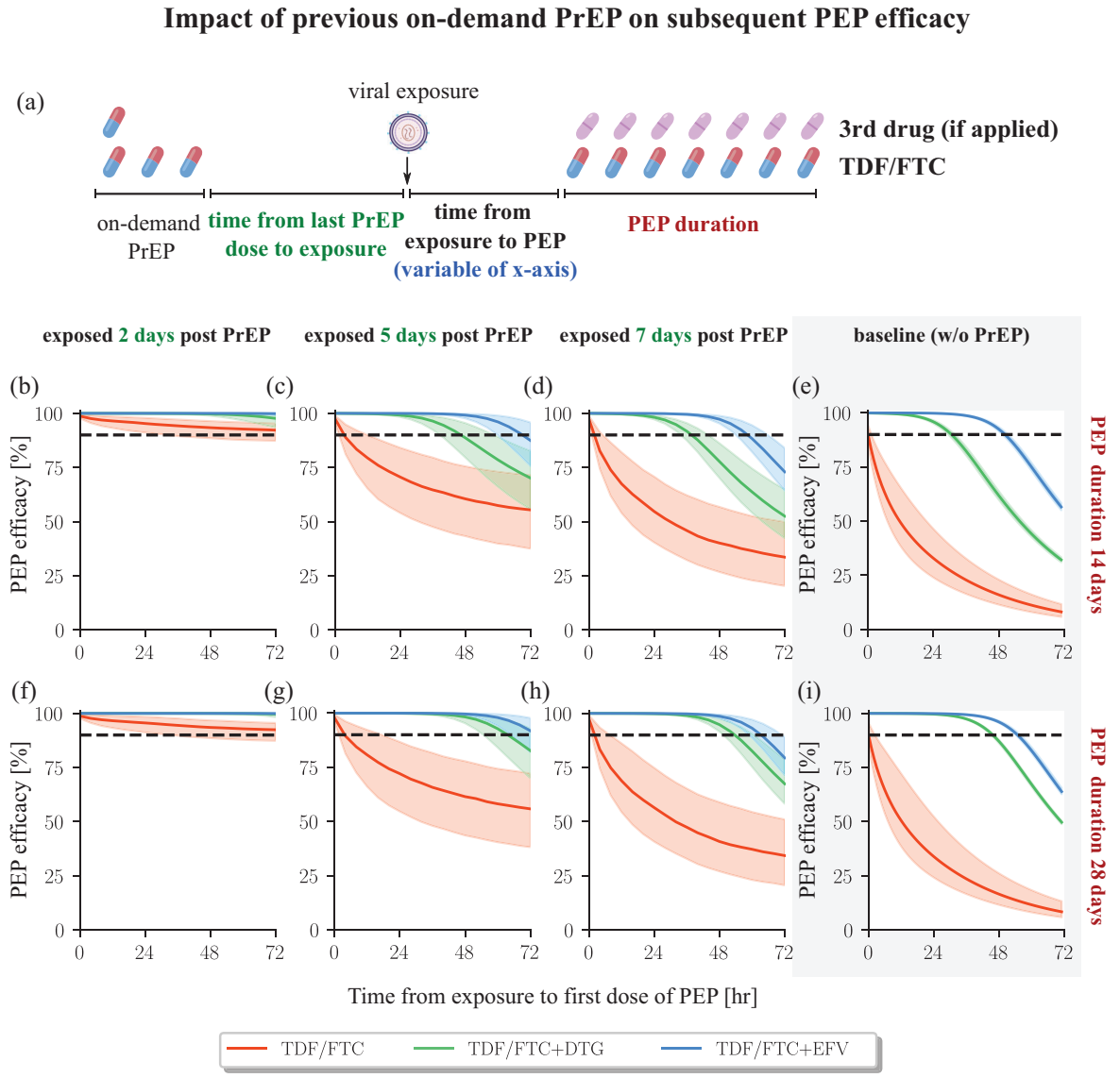


Figure 4. PEP efficacy following on-demand PrEP. (a) Schematic of the dosing regimen. TDF/FTC was initially administered as "on-demand" PrEP (2-1-1), followed by viral exposure after a certain period. Subsequently, the PEP regimen was initiated after various time intervals, potentially incorporating a third drug. (b–d) The efficacy profiles for PEP with overall duration of 14 days, and the exposure occurred 2, 5 and 7 days after the on-demand PrEP, respectively. (f–h): The efficacy profiles for PEP with overall duration of 28 days. (e and i): PEP efficacy of baseline scenario without preceding PrEP. All computations were performed on 1000 virtual patients. The daily dose for each drug corresponds to 200 mg FTC, 300 mg TDF, 50 mg DTG and 400 mg EFV. The coloured lines represent the median efficacy value in cases where PEP was initiated at the respective time point along the x-axis. Dashed horizontal lines indicate 90% prophylactic efficacy. The shaded areas depict the quantile range of prophylactic efficacy. Abbreviations: DTG, dolutegravir; EFV, efavirenz; FTC, emtricitabine; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; TDF, tenofovir disoproxil fumarate.

3.2 | Third drug may be added later, if TDF/FTC is initiated quickly

In many settings, all three drugs may not be available within a reasonable time. However, TDF/FTC may be readily available to individuals who already used, or have access to PrEP. We investigated whether PEP initiation with TDF/FTC ("self-start") and later addition of a third drug may effectively prevent acquisition (schematic in Figure 3a). Reading Figures 3b–e bottom-to-top indicates that adding DTG or EFV to a TDF/FTC backbone increases PEP efficacy (lowest row: TDF/FTC only) and that earlier addition of the third drug results in greater efficacy (top row). Reading Figures 3b–e horizontally (left-to-right) indicates that the earlier TDF/FTC is initiated, the better. For the three-drug combinations, a temporal "window of opportunity" arises, where the PEP efficacy exceeds 90%. For TDF/FTC + DTG, the duration of PEP strongly impacts on its prophylactic efficacy (compare panels B and D in Figure 3), whereas the impact is less strong for PEP with TDF/FTC + EFV, which is already efficient when

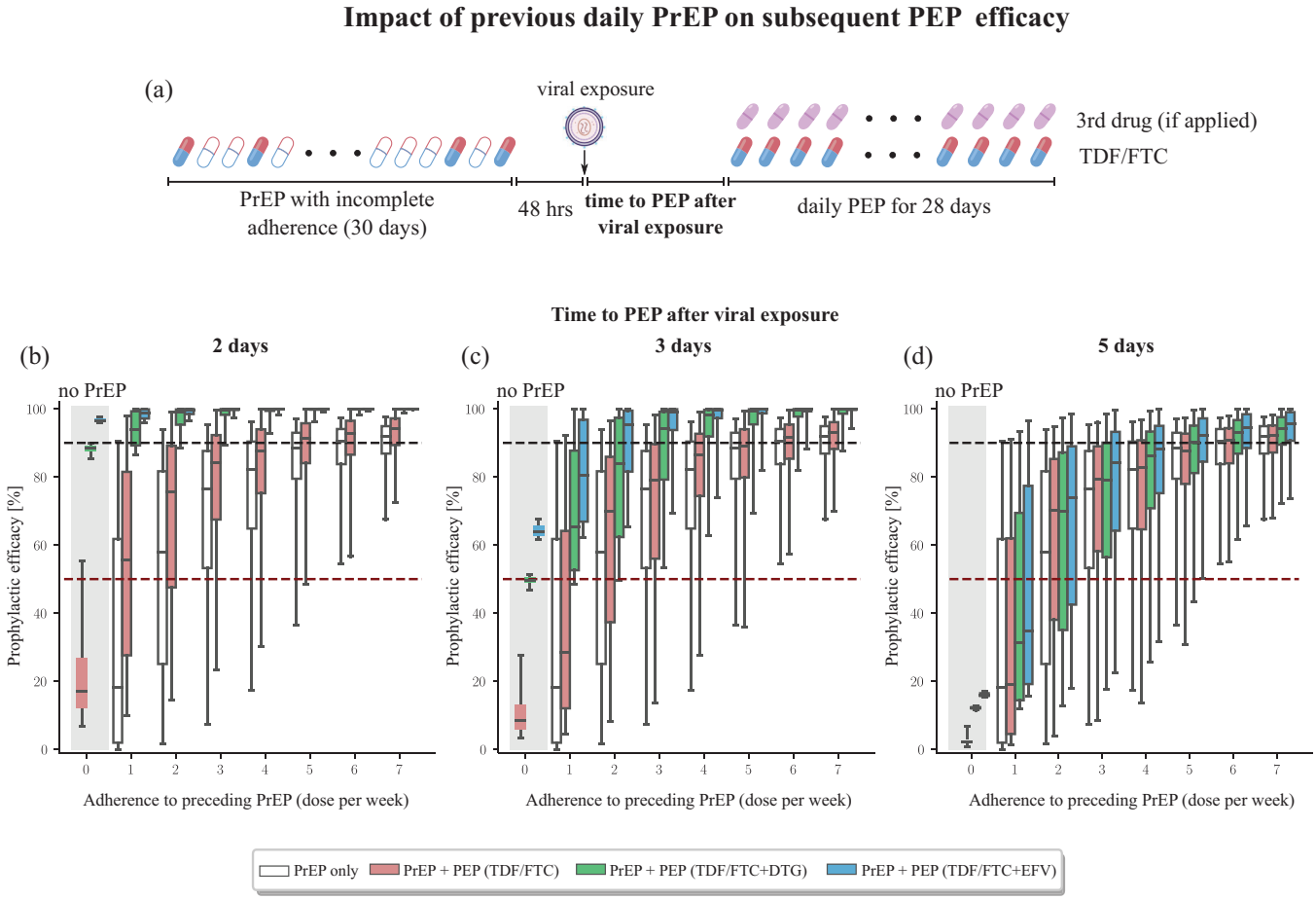


Figure 5. Predicted efficacy of once-daily PEP, in cases where PrEP was recently taken. (a) Schematic of dosing regimen: PrEP with incomplete, variable levels of adherence was taken and stopped 48 hours before virus exposure. PEP with either TDF/FTC, or TDF/FTC + DTG or EFV was then initiated after a variable delay and taken for 28 days. PEP efficacy is calculated with regard to preceding PrEP adherence, as well as delay in PEP initiation. (b–d) Computed prophylactic efficacy for the distinct PrEP+PEP regimen, if PEP was initiated 2, 3 or 5 days post-exposure and taken daily for 28 days. The daily oral dose for each drug corresponds to 300/200 mg TDF/FTC, 50 mg DTG and 400 mg EFV. The grey-shaded area indicates PEP efficacy, with no prior PrEP, while empty boxplots highlight the prophylactic effect of preceding PrEP, without subsequent PEP. Boxplots show the median, interquartile ranges and whiskers encompass the 95% confidence interval. Dashed red lines indicate 50% prophylactic efficacy, while dashed black lines indicate 90% prophylactic efficacy. Abbreviations: DTG, dolutegravir; EFV, efavirenz; FTC, emtricitabine; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; TDF, tenofovir disoproxil fumarate.

taken for 2 weeks. The simulations highlight that if TDF/FTC is available within 12–24 hours, the third drug should be added within a week, and PEP should preferably be taken for 28 days from the first TDF/TFC dose. Efficacy did not change when TDF/FTC was initiated with a double dose (Figure S2).

3.3 | Previous PrEP can boost subsequent PEP efficacy and widen the "window of opportunity"

The pharmacologically active components of TDF and FTC (TFV-DP and FTC-TP, respectively) are built-up slowly within HIV target cells [16–18, 30], necessitating almost instantaneous initiation of 2-drug (TDF/FTC) PEP (Figure 2c). However, due to the long half-life of TFV-DP and FTC-TP in PBMCs (4–7 and 1–2.2 days, respectively [31–35], they may persist if PrEP had been taken in the past. To assess the combined impact of past TDF/FTC PrEP intake and PEP, we investigated the efficacy of PEP following an "on-demand" (2-1-1) PrEP regimen [36] (schematic in Figure 4a). In our simulations, viral exposure occurs 2 (panels B and F), 5 (panels C and G) or 7 (panels D and H) days after the last PrEP "on demand" dose. A two- or three-drug PEP regimen is then initiated within 0–72 hours post virus exposure (x-axis) and continued for either for 14 (panels B–E) or 28 days (panels F–I).

Reading Figures 4b–d and f–h left-to-right shows that if the last PrEP-on-demand dosing event was 7 days ago, the added benefit of earlier PrEP-on-demand on subsequent PEP efficacy had almost vanished, compare to Figures 4e and i (no preceding PrEP). However, if PrEP-on-demand was taken less than 7 days prior to virus exposure, it increases subsequent PEP efficacy, as residual FTC-TP and TFV-DP concentrations may be present that either prevent acquisition in some individuals, delay sero-conversion [37, 38] or result in a "pre-loading" of drug concentrations for subsequent PEP. For

example, if on-demand-PrEP was stopped 2 days prior to virus exposure, subsequent PEP with TDF/FTC may be >90% efficient, even when initiated within 3 days, Figure 4b,f. For the three-drug PEP regimen, we observed a >90% efficacy even when on-demand-PrEP was stopped 5 days prior, provided that PEP was initiated within 48 hours after viral exposure and taken for >14 days, Figure 4c,g. Overall, we observe that past PrEP usage combined with PEP can increase efficacy.

Next, we investigated the concomitant impact of preceding daily PrEP with 1–7 average doses per week (denoted as 1/7–7/7), stopped 2 days before viral exposure, in conjunction with subsequent 2-drug or 3-drug PEP, initiated 2, 3 or 5 days after virus exposure and taken for 28 days (schematic in Figure 5a). As controls, we performed simulations without earlier PrEP (grey-shaded areas), as well as PrEP-only simulations (empty boxplots) in Figures 5b–d. Our simulations confirm the combined action of PrEP and PEP: Earlier PrEP boosts the efficacy of PEP, if PEP is initiated 2 or 3 days post-exposure, Figure 5b,c. Compared both to "no-PrEP" (grey-shaded areas), as well as "no-PEP" (empty boxplots), prophylactic efficacy is increased for the PrEP+PEP combination. However, PEP does not offer any additional protection when initiated 5 days post-exposure (compare empty vs. coloured boxplots in Figure 5d). Interestingly, our model predicts that PrEP-only with 100% adherence offers > 90% protection, when stopped 2 days before virus exposure (empty bars in Figure 5d). Also, for the PrEP+PEP combination, we observe > 90% protection, if 4/7 doses of earlier PrEP were taken and 3-drug PEP was initiated 3 days post-exposure. For comparison, PEP-only offers only 50% (TDF/FTC+DTG) and 65% (TDF/FTC+EFV) protection if initiated 3 days post-exposure (Figures 2c and 5c). If PEP is initiated 2 days post-exposure, preceding PrEP may lift prophylactic efficacy from 90% (TDF/FTC+DTG) and 95% (TDF/FTC+EFV) to almost complete protection, if at least three-out-of-seven versus two-out-of-seven PrEP doses were taken and succeeding PEP contained TDF/FTC+DTG versus TDF/FTC+EFV.

Lastly, we tested scenarios in which the probability of PEP adherence declined substantially over time. We modelled PrEP with incomplete adherence 48 hours prior to virus exposure (schematic: Figure S4A). For exploratory purposes, we further assumed a substantial decrease in PEP adherence after 7 days, Figure S4B. Overall, compared to a full 28 days PEP regimen simulated in Figure 5b, we can see a drug-specific decline in efficacy that is clearly seen in simulations without preceding PrEP (grey shaded area in Figure 5c): Two-drug TDF/FTC is already quite inefficient (< 20%) when initiated 2, 3 or 5 days post-exposure and hence poor PEP adherence has only a minimal further impact on its already low efficacy. (grey-shaded areas in Figures 5b–d vs. Figures S4C–E). In contrast, for the three-drug combinations, we see that poor PEP adherence negatively impacts on prophylactic efficacy (compare shaded areas in Figure 5b,c with Figure S4C,D). However, if ≥4/7 doses of earlier PrEP were taken and subsequent 3-drug PEP was initiated ≤ 3 days post-exposure, we predicted that prophylactic efficacy may exceed 90%.

In summary, we observe that preceding PrEP can substantially boost subsequent PEP efficacy for all drug regimens, if stopped 2 days before suspected virus exposure (Figure 4), or taken at 4/7 days on average (Figures 5 and S4). Moreover, preceding PrEP can "buy time" by slowing initial viral growth before PEP is initiated (compare schematic in Figure 1). Our simulations further highlighted that daily PrEP-only with 100% adherence may provide > 90% protection, if stopped no more than 48 hours before exposure (Figures 5d and S4E). If PrEP was stopped 72 hours before exposure, prophylactic efficacy is 10% lower, compared to 48 hours, Figures S3 and S5.

4 | DISCUSSION

The aim of this study was to evaluate the impact of delays in "time to PEP," PEP duration and PrEP-to-PEP transition, based on a combined model of drug-specific PK and viral dynamics. Our modelling by and large confirms UK, US and WHO guidelines on PEP [6–8], which recommend to combine a TDF/FTC backbone with a third drug, initiate PEP as early as possible and to take it for 28 days. Moreover, our simulations indicate that early PEP initiation after suspected virus exposure denotes the most critical parameter. For TDF/FTC two-drug PEP, instantaneous (within 1 hour post-exposure) initiation would be required. Adding a third drug to the TDF/FTC backbone "buys time." However, protection may still be incomplete (Figure 2c), if a three-drug PEP was initiated 72 hours post virus exposure and taken for 28 days. The duration of PEP is important to ensure that all replication-competent virus is cleared (compare Figure 1a). EFV has a long half-life compared to DTG (40–55 hours vs. 13.5–15.9 hours) [12, 13], such that therapeutic levels may persist for EFV, even after PEP is stopped. For EFV, the long half-life may, therefore, increase the likelihood that the virus is cleared before the drug is washed out of the body (compare Figure 1a), making the duration of PEP intake a less sensitive parameter for EFV compared to DTG. While early PEP initiation may be particularly difficult in settings with less established health infrastructure, we found that individuals taking PrEP up to the time of exposure (−3 days) could re-initiate the regimen and may add a third drug when it becomes available. The combined effects of PrEP+PEP in this scenario indicate synergy, which could arise from the fact that previous PrEP delays initial viral replication [38], or pre-loads drug levels for subsequent PEP.

Our work has a number of limitations: Foremost, there is a lack of data that could be inputted into the model, due to a lack of clinical research into PEP. To strengthen the model, further clinical trials with clinically relevant endpoints may be required.

Our simulations refer to exposures with "wild type" viruses after typical sexual intercourse [16]. Notably, increasing inoculum sizes have a diminishing effect on prophylactic efficacy [30]. Moreover, non-nucleoside reverse transcriptase inhibitor (NNRTI) drug resistance, which may amount to 10–20% of transmitted viruses in Africa and the Americas [39, 40] may severely diminish EFV-based PEP efficacy [13] and thus the suitability of EFV as a PEP component. Notably, while we include EFV in our analysis to explore the impact of third-drug components with very high molecular potency [41], we are not advocating EFV for PEP as it is contraindicated both

for psychological side effects and low risk of serious liver toxicity. However, while some clinical trials suggest the superiority of integrase inhibitors (DTG over EFV) [42–45] with regard to "time to viral load suppression," we would like to emphasize that viral load kinetics decay more strongly for integrase inhibitors, merely because they inhibit a later stage of the viral replication cycle and not because of superior efficacy (or potency) [46–48]. Hence, the current preference for integrase inhibitors in PEP regimen should be motivated by tolerability and low prevalence of drug resistance rather than alleged efficacy. We did not investigate ritonavir-boosted protease inhibitors lopinavir (LPV/r) or atazanavir (ATV/r) as third-drug components in our model [7]. While these compounds have high molecular potency [41], we expect PEP efficacy to be similar to EFV. However, previous work suggests very steep dose-response curves for LPV/r and ATV/r, implying that the prophylactic effect may rapidly drop in case of incomplete PEP adherence, or discontinuation [49]. In our model, we assume that the effect of the considered drugs is associated with systemic drug levels. Both EFV and DTG are lipophilic drugs that can rapidly cross cellular membranes by passive diffusion, such that their unbound drug concentration in plasma strongly correlates with effect-site concentrations ("free drug hypothesis" [50, 51]) With regard to TDF/FTC, their phosphate moieties (TFV-DP/FTC-TP) in PBMCs were used as an effect marker, since our recent work [11] indicated strong correlation with effect, whereas concentrations in tissue homogenates were not predictive.

With regard to PD, we simulated synergistic effects between TFV-DP and FTC-TP, based on recent results [14] and assumed that the direct antiviral effects of DTG and EFV are additive to the TDF/FTC backbone, because either there was no evidence for non-additivity (DTG) or parameters were lacking (EFV).

In our simulations, we modelled viral challenges after sexual exposure (receptive vaginal intercourse). Notably, the majority of non-occupational PEP is administered after potential sexual exposure (PEPSE) [52] and women denote the major HIV risk group [53]. Occupational virus exposures, through for example needle-stick injuries may lead to the translocation of larger amounts of viruses, which may negatively impact on prophylactic efficacy [30]. Consequently, the validity of our predictions with regard to occupational exposures warrants further ongoing investigation.

5 | CONCLUSIONS

Our modelling suggests that "time to PEP" denotes the most critical parameter. Three-drug PEP, preferably initiated no later than 48 hours after virus exposure, and taken for 28 days remains the optimal regimen. Three-drug PEP for 14 days is less efficient than 28 days and 2-drug (TDF/FTC) PEP only has high efficacy, if started within 1 hour after exposure. Self-start 2-drug (TDF/FTC) PEP with a subsequent addition of a third drug in the clinic works better than not self-starting. Lastly, previous PrEP intake < 7 days prior to virus exposure boosts subsequent PEP efficacy and may widen the window period for "time to PEP" past 72 hours.

AUTHORS' AFFILIATIONS

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COMPETING INTERESTS

JF received research funding from GSK for a shingles vaccine study. The remaining authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

LZ and MvK wrote the manuscript with help from JF and SC. LZ and MvK designed the research. LZ performed the research, and LZ, MvK, JF and SC analysed the data.

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DATA AVAILABILITY STATEMENT

All data and computational codes are available at https://github.com/KleistLab/PEP [29].

REFERENCES

1. UNAIDS. Global HIV and AIDS statistics — 2023 fact sheet. 2023.
2. Ndung'u T, McCune JM, Deeks SG. Why and where an HIV cure is needed and how it might be achieved. Nature. 2019;576:397–405.
3. Eisinger RW, Dieffenbach CW, Fauci AS. HIV viral load and transmissibility of HIV infection: undetectable equals untransmittable. JAMA. 2019;321:451–2.
4. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Prevention of HIV-1 infection with early antiretroviral therapy. N Engl J Med. 2011;365:493–505.
5. Landovitz RJ, Scott H, Deeks SG. Prevention, treatment and cure of HIV infection. Nat Rev Micro. 2023;21:657–70.
6. Cresswell F, Asanati K, Bhagani S, Boffito M, Delpech V, Ellis J, et al. UK guideline for the use of HIV post-exposure prophylaxis 2021. HIV Med. 2022;23:494–545.
7. World Health Organization. Guidelines on post-exposure prophylaxis for HIV and the use of co-trimoxazole prophylaxis for HIV-related infections among adults, adolescents and children: recommendations for a public health approach. 2014.
8. Dominguez KL, Smith DK, Thomas V, Crepaz N, Lang K, Heneine W, et al.Updated guidelines for antiretroviral postexposure prophylaxis after sexual, injection drug use, or other nonoccupational exposure to HIV—United States, 2016. 2016.
9. Schechter M, Do Lago RF, Mendelsohn AB, Moreira RI, Moulton LH, Harrison LH, et al. Behavioral impact, acceptability, and HIV incidence among homosexual men with access to postexposure chemoprophylaxis for HIV. J Acquir Immune Defic Syndr. 2004;35:519–25.
10. Zhang L, Iannuzzi S, Chaturvedula A, Irungu E, Haberer JE, Hendrix CW, et al. Model-based predictions of protective HIV pre-exposure prophylaxis adherence levels in cisgender women. Nat Med. 2023;29:2753–62.
11. Duwal S, Dickinson L, Khoo S, von Kleist M. Hybrid stochastic framework predicts efficacy of prophylaxis against HIV: an example with different dolutegravir prophylaxis schemes. PLoS Comput Biol. 2018;14:e1006155.
12. Duwal S, Seeler D, Dickinson L, Khoo S, von Kleist M. The utility of efavirenz-based prophylaxis against HIV infection. A systems pharmacological analysis. Front Pharmacol. 2019;10:199.
13. Iannuzzi S, von Kleist M. Mathematical modelling of the molecular mechanisms of interaction of tenofovir with emtricitabine against HIV. Viruses. 2021;13:1354.
14. Zhang L, Wang J, von Kleist M. Numerical approaches for the rapid analysis of prophylactic efficacy against HIV with arbitrary drug-dosing schemes. PLoS Comput Biol. 2021;17:e1009295.
15. Duwal S, Sunkara V, von Kleist M. Multiscale systems-pharmacology pipeline to assess the prophylactic efficacy of NRTIs against HIV-1. CPT Pharmacometrics Syst Pharmacol. 2016;5:377–87.

16. Garrett KL, Chen J, Maas BM, Cottrell ML, Prince HA, Sykes C, et al. A pharmacokinetic/pharmacodynamic model to predict effective HIV prophylaxis dosing strategies for people who inject drugs. J Pharmacol Exp Ther. 2018;367:245–51.
17. Burns RN, Hendrix CW, Chaturvedula A. Population pharmacokinetics of tenofovir and tenofovir-diphosphate in healthy women. J Clin Pharmacol. 2015;55:629–38.
18. Dickinson L, Amin J, Else L, Boffito M, Egan D, Owen A, et al. Pharmacokinetic and pharmacodynamic comparison of once-daily efavirenz (400 mg vs. 600 mg) in treatment-naive HIV-infected patients: results of the ENCORE1 study. Clin Pharmacol Ther. 2015;98:406–16.
19. Von Kleist M, Menz S, Huisinga W. Drug-class specific impact of antivirals on the reproductive capacity of HIV. PLoS Comput Biol. 2010;6:e1000720.
20. von Kleist M, Menz S, Stocker H, Arasteh K, Schütte C, Huisinga W. HIV quasispecies dynamics during pro-active treatment switching: impact on multi-drug resistance and resistance archiving in latent reservoirs. PLoS One. 2011;6:e18204.
21. Duwal S, von Kleist M. Top-down and bottom-up modeling in system pharmacology to understand clinical efficacy: an example with NRTIs of HIV-1. Eur J Pharm Sci. 2016;94:72–83.
22. Baeten JM, Donnell D, Ndase P, Mugo NR, Campbell JD, Wangisi J, et al. Antiretroviral prophylaxis for HIV prevention in heterosexual men and women. N Engl J Med. 2012;367:399–410.
23. Marrazzo JM, Ramjee G, Richardson BA, Gomez K, Mgodi N, Nair G, et al. Tenofovir-based preexposure prophylaxis for HIV infection among African women. N Engl J Med. 2015;372:509–18.
24. Delany-Moretlwe S, Hughes JP, Bock P, Ouma SG, Hunidzarira P, Kalonji D, et al. Cabotegravir for the prevention of HIV-1 in women: results from HPTN 084, a phase 3, randomised clinical trial. Lancet. 2022;399:1779–89.
25. Thigpen MC, Kebaabetswe PM, Paxton LA, Smith DK, Rose CE, Segolodi TM, et al. Antiretroviral preexposure prophylaxis for heterosexual HIV transmission in Botswana. N Engl J Med. 2012;367:423–34.
26. Chun T-W, Moir S, Fauci AS. HIV reservoirs as obstacles and opportunities for an HIV cure. Nat Immunol. 2015;16:584–9.
27. Chou T-C. Theoretical basis, experimental design, and computerized simulation of synergism and antagonism in drug combination studies. Pharmacol Rev. 2006;58:621–81.
28. Zhang L, von Kleist M. PEP: modelling the impact of 'time to PEP', 'PEP duration' and PrEP-to-PEP transition on prophylactic efficacy. 2024.
29. Duwal S, Schütte C, von Kleist M. Pharmacokinetics and pharmacodynamics of the reverse transcriptase inhibitor tenofovir and prophylactic efficacy against HIV-1 infection. PLoS One. 2012;7:e40382.
30. Castillo-Mancilla JR, Zheng J-H, Rower JE, Meditz A, Gardner EM, Predhomme J, et al. Tenofovir, emtricitabine, and tenofovir diphosphate in dried blood spots for determining recent and cumulative drug exposure. AIDS Res Hum Retroviruses. 2013;29:384–90.
31. Yager JL, Brooks KM, Castillo-Mancilla JR, Nemkov C, Morrow M, Peterson S, et al. Tenofovir-diphosphate in peripheral blood mononuclear cells during low, medium and high adherence to emtricitabine/tenofovir alafenamide vs. emtricitabine/tenofovir disoproxil fumarate. AIDS. 2021;35:2481–7.
32. Chen X, Seifert SM, Castillo-Mancilla JR, Bushman LR, Zheng J-H, Kiser JJ, et al. Model linking plasma and intracellular tenofovir/emtricitabine with deoxynucleoside triphosphates. PLoS One. 2016;11:e0165505.
33. Anderson PL, Liu AY, Castillo-Mancilla JR, Gardner EM, Seifert SM, McHugh C, et al. Intracellular tenofovir-diphosphate and emtricitabine-triphosphate in dried blood spots following directly observed therapy. Antimicrob Agents Chemother. 2018;62:10–1128.
34. Louissaint NA, Cao Y-J, Skipper PL, Liberman RG, Tannenbaum SR, Nimmagadda S, et al. Single dose pharmacokinetics of oral tenofovir in plasma, peripheral blood mononuclear cells, colonic tissue, and vaginal tissue. AIDS Res Hum Retroviruses. 2013;29:1443–50.
35. Antoni G, Tremblay C, Delaugerre C, Charreau I, Cua E, Castro DR, et al. On-demand pre-exposure prophylaxis with tenofovir disoproxil fumarate plus emtricitabine among men who have sex with men with less frequent sexual intercourse: a post-hoc analysis of the ANRS IPERGAY trial. Lancet HIV. 2020;7:e113–20.
36. Donnell D, Ramos E, Celum C, Baeten J, Dragavon J, Tappero J, et al. The effect of oral preexposure prophylaxis on the progression of HIV-1 seroconversion. AIDS. 2017;31:2007–16.
37. Ambrosioni J, Petit E, Liegeon G, Laguno M, Miró JM. Primary HIV-1 infection in users of pre-exposure prophylaxis. Lancet HIV. 2021;8:e166–74.
38. Moyo S, Hunt G, Zuma K, Zungu M, Marinda E, Mabaso M, et al. HIV drug resistance profile in South Africa: findings and implications from the 2017 national HIV household survey. PLoS One. 2020;15:e0241071.
39. World Health Organization. HIV drug resistance—brief report 2024. 2024.
40. Shen L, Peterson S, Sedaghat AR, McMahon MA, Callender M, Zhang H, et al. Dose-response curve slope sets class-specific limits on inhibitory potential of anti-HIV drugs. Nat Med. 2008;14:762–6.
41. Rutherford GW, Horvath H. Dolutegravir plus two nucleoside reverse transcriptase inhibitors versus efavirenz plus two nucleoside reverse transcriptase inhibitors as initial antiretroviral therapy for people with HIV: a systematic review. PLoS One. 2016;11:e0162775.
42. Kanters S, Vitoria M, Zoratti M, Doherty M, Penazzato M, Rangaraj A, et al. Comparative efficacy, tolerability and safety of dolutegravir and efavirenz 400mg among antiretroviral therapies for first-line HIV treatment: a systematic literature review and network meta-analysis. EClinicalMedicine. 2020;28:100573.
43. Bangalee A, Hanley S, Bangalee V. Dolutegravir as first-line antiretroviral therapy in South Africa: beware the one-size-fits-all approach. S Afr Med J. 2022;112:787–90.
44. Jacobson K, Ogbuagu O. Integrase inhibitor-based regimens result in more rapid virologic suppression rates among treatment-naïve human immunodeficiency virus–infected patients compared to non-nucleoside and protease inhibitor–based regimens in a real-world clinical setting: a retrospective cohort study. Medicine (Baltimore). 2018;97:e13016.
45. Andrade A, Guedj J, Rosenkranz SL, Lu D, Mellors J, Kuritzkes DR, et al. Early HIV RNA decay during raltegravir-containing regimens exhibits two distinct subphases (1a and 1b). AIDS. 2015;29:2419–26.
46. Donahue DA, Sloan RD, Kuhl BD, Bar-Magen T, Schader SM, Wainberg MA. Stage-dependent inhibition of HIV-1 replication by antiretroviral drugs in cell culture. Antimicrob Agents Chemother. 2010;54:1047–54.
47. Sedaghat AR, Dinoso JB, Shen L, Wilke CO, Siliciano RF. Decay dynamics of HIV-1 depend on the inhibited stages of the viral life cycle. Proc Natl Acad Sci USA. 2008;105:4832–7.
48. Duwal S, Dickinson L, Khoo S, von Kleist M. Mechanistic framework predicts drug-class specific utility of antiretrovirals for HIV prophylaxis. PLoS Comput Biol. 2019;15:e1006740.
49. Smith DA, Di L, Kerns EH. The effect of plasma protein binding on in vivo efficacy: misconceptions in drug discovery. Nat Rev Drug Discov. 2010;9:929–39.
50. Avery LB, Bakshi RP, Cao YJ, Hendrix CW. The male genital tract is not a pharmacological sanctuary from efavirenz. Clin Pharmacol Ther. 2011;90:151–6.
51. Sultan B, Benn P, Waters L. Current perspectives in HIV post-exposure prophylaxis. HIV/AIDS-Res Palliat Care. 2014;6:147–58.
52. Murewanhema G, Musuka G, Moyo P, Moyo E, Dzinamarira T. HIV and adolescent girls and young women in sub-Saharan Africa: a call for expedited action to reduce new infections. IJID Regions. 2022;5:30–32.
53. World Health Organization and Others. Post-exposure prophylaxis to prevent HIV infection: joint WHO/ILO guidelines on post-exposure prophylaxis (PEP) to prevent HIV infection. World Health Organization; 2007.

SUPPORTING INFORMATION

Additional information may be found under the Supporting Information tab for this article:

Text S1: This supplementary text contains the detailed viral dynamics model and the numerical approach (PGS) to compute the extinction probability.

Figure S1. Illustration of the viral dynamic model and the interference mechanisms of different drug classes.

Figure S2. Efficacy of TDF/FTC-based PEP with delayed initiated double-dose TDF/FTC and further delay of the third drug.

Figure S3. Predicted efficacy of once-daily PEP, in case where PrEP was stopped 72hours before exposure.

Figure S4. Predicted efficacy of PEP with strongly declining adherence, in cases where PrEP was stopped 48hours before exposure.

Figure S5. Predicted efficacy of PEP with strongly declining adherence, in cases where PrEP was stopped 72hours before exposure.

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CORRECTION

The following article for this Supplement was published before the original collection was released. It can be found in its respective issue.

Kennedy CE, Dawit R, Yeh PT, Rodolph M, Ford N, Schmidt HMA, Schaefer R, Baggaley R, and Macdonald V. HIV post–exposure prophylaxis in community settings and by lay health workers or through task sharing: a systematic review of effectiveness, case studies, values and preferences, and costs. *J Int AIDS Soc.* 2025;28(5):e26448. https://doi.org/10.1002/jia2.26448

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REVIEW

HIV post-exposure prophylaxis in community settings and by lay health workers or through task sharing: a systematic review of effectiveness, case studies, values and preferences, and costs

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Abstract

Introduction: Post-exposure prophylaxis (PEP) for HIV prevention has been inadequately promoted, provided and used. Expanded access and task sharing could increase the HIV prevention impact of PEP, but scientific evidence to inform programmatic and policy decisions has not been synthesized.

Methods: To inform World Health Organization guidelines, we conducted a systematic review of studies examining the provision of PEP in community settings, and by trained lay health workers or through task sharing. We searched CINAHL, PsycINFO, PubMed, EMBASE and scientific conferences for studies published between January 2012 and October 2023. We screened abstracts and extracted data in duplicate. The effectiveness review included randomized controlled trials and comparative observational studies; risk of bias was assessed using Cochrane Collaboration and Evidence Project tools, and the certainty of the evidence was assessed using GRADE. We also summarized implementation case studies, values and preferences studies, and cost and cost-effectiveness studies.

Results: For provision of PEP in community settings, we identified one effectiveness study, three case studies, one values and preferences study, and one cost study. Very low certainty evidence from one study in Kenya and Uganda suggested that PEP uptake, when offered as part of a dynamic prevention package, was highest in the community setting (vs. outpatient or antenatal care settings). For provision of PEP by trained lay health workers or task sharing, we identified three effectiveness studies, two case studies, four values and preferences studies, and one cost study. Very low certainty evidence from Kenya, Uganda and the United States suggested that engagement of lay providers or pharmacists increased PEP uptake and completion and decreased HIV acquisition. Studies from six countries found most health workers supported PEP provision by non-specialist providers. One modelling study suggested community-based provision may be cost-effective or cost-saving in Africa.

Discussion: Evidence on expanding PEP access through community delivery or task sharing is limited but generally suggests positive outcomes, feasibility, acceptability and cost-effectiveness of these approaches. Indirect evidence from HIV treatment and pre-exposure prophylaxis further supports these approaches.

Conclusions: Programmes should be expanded to include community delivery and task sharing to dispense, distribute, provide and monitor PEP.

Keywords: community delivery; HIV; lay health workers; PEP; post-exposure prophylaxis; systematic review

Additional information may be found under the Supporting Information tab of this article.

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1 | INTRODUCTION

The use of antiretroviral drugs as post-exposure prophylaxis (PEP) for HIV prevention has been shown to be effective [1] and recommended by the World Health Organization [2] for over three decades, with updates to reflect newer drug combinations, yet PEP remains an underutilized HIV prevention tool. In many parts of the world, PEP is not widely available outside of hospital settings for healthcare-associated occupational or sexual assault exposures. Experience with pre-exposure prophylaxis (PrEP) suggests that access in community settings and engaging a range

of providers can expand access and use [3]. PEP may also have the potential to be more strategically used for HIV prevention through expanded access in community settings, and through task sharing between health workers, including trained lay health workers. In the United States, laws have been recently changed to allow pharmacists to initiate or prescribe PEP in New York (as of 2017) [4] and California (as of 2019) [5], along with several other states. Similarly, pharmacies have been proposed as a promising location for PEP prescribing to increase access in South Africa [6]. However, the scientific evidence to inform programmatic and policy decisions about expanded PEP provision has not been synthesized.

We sought to conduct a systematic review of studies related to the provision of HIV PEP in community settings, and by trained lay health workers or through task sharing.

2 | METHODS

We reviewed effectiveness, case studies, values and preferences, and cost data related to PEP in community settings, and by trained lay health workers or through task sharing. We present methods and results for each of these separately, starting with studies of intervention effectiveness.

2.1 | Effectiveness review

The effectiveness review covered two complementary interventions framed using the PICO (population, intervention, comparator, outcomes) approach. The first PICO question asked, should PEP be offered in community settings? The second PICO question asked, should PEP be offered by lay health workers or through task sharing?

2.1.1 | PICO 1: PEP in community settings

Population: Individuals eligible for PEP

Intervention: Availability of PEP in community settings (defined as non-healthcare settings; this could include offering of PEP by community-based organizations, community health workers based outside of facilities, mobile units or pharmacies, among other settings)

Comparator: No availability of PEP, or availability only in healthcare settings

Outcomes:

1. Quality of PEP services offered (e.g. adherence to country or international guidelines)
2. Uptake of PEP
3. Timeliness of PEP uptake (time since exposure)
4. Completion of PEP
5. HIV acquisition
6. Linkage to or uptake of appropriate additional services (e.g. PrEP, antiretroviral treatment [ART])
7. Adverse events (e.g. coercion, intimate partner violence, self-harm, psychosocial issues, stigma/discrimination)

2.1.2 | PICO 2: PEP offered by lay health workers or through task sharing

2.2 | Population: Individuals eligible for PEP

Intervention: PEP provided by trained lay health workers, as defined by the WHO as "any health worker who performs functions related to health-care delivery; was trained in some way in the context of the intervention; but has received no formal professional or paraprofessional certificate or tertiary education degree" [5]. We also included studies that focused on task sharing, where PEP was provided by a lower-level provider.

Comparator: PEP provided by trained health workers/higher-level health workers or no provision of PEP

Outcomes:

1. Quality of PEP services offered (e.g. adherence to country or international guidelines)
2. Uptake of PEP
3. Timeliness of PEP uptake (time since exposure)
4. Completion of PEP
5. HIV acquisition
6. Linkage to or uptake of appropriate additional services (e.g. PrEP, ART)
7. Adverse events (e.g. coercion, intimate partner violence, self-harm, psychosocial issues, stigma/discrimination)

Although these PICO questions focused on PEP in community settings and PEP offered by lay health workers, we also included studies comparing different settings where PEP is available (e.g. hospital vs. primary healthcare, hospital vs. pharmacy, etc.) as well as studies that compared PEP offered by different cadres of health workers (e.g. physicians vs. pharmacists, pharmacists vs. nurses, etc.), as our goal was to understand questions around decentralizing services and providing new models of care in community settings.

Studies were included in the effectiveness review if they met the following criteria:

1. Study population included individuals eligible for PEP (according to country or international guidelines).
2. Study design was a randomized trial or comparative observational study (including non-randomized quasi-experimental studies) that compared people who received the intervention described in the PICO question to those who received an intervention described in the PICO comparison group.
3. Measured one or more of the outcomes of interest.
4. Published in a peer-reviewed journal or as a conference abstract between 1 January 2012 (the year when antiretroviral drugs for treatment were recommended in community settings by WHO [2]) and 16 October 2023 (database search date).

If studies combined both PEP and PrEP, or combined both PEP and HIV treatment for the purposes of assessing

"biomedical HIV prevention" more generally, we reported only PEP-specific findings if findings were disaggregated; if findings were not disaggregated, we reported findings but made clear that these were for combined interventions. Studies from any geographic region and any language were included. For studies published in languages other than English, we reviewed the English-language abstract if one was available, or a Google translate version of the abstract if it was in a language not spoken by the study team.

2.3 | Case studies review

Studies were included in the case studies review if they presented primary data examining the implementation of a programme for community-based PEP or provision of PEP by trained lay health workers/task-sharing and provided information on implementation characteristics or outcomes from this programme, but that data did not meet the pre/post or multi-arm criteria for the effectiveness reviews. These studies could be qualitative or quantitative in nature but had to present primary data collection—think pieces and review articles were not included. These could include studies that examined barriers and facilitators to PEP in community settings or by lay health workers/task-sharing, or studies that provided non-comparative outcome data on the PICO outcomes listed above.

2.4 | Values and preferences review

Studies were included in the values and preferences review if they presented primary data (qualitative or quantitative) examining the values and preferences or acceptability of community-based PEP or provision of PEP by trained lay health workers/task-sharing to potential beneficiaries, communities, health workers and other stakeholders. This literature could include studies examining the acceptability of various intervention options covered in the PICO questions above and service delivery preferences, among others. Studies that reported only uptake of PEP or awareness of PEP as a proxy for preferences were not included.

2.5 | Cost review

Studies were included in the cost review if they presented primary data comparing costing, cost-effectiveness, cost-utility or cost-benefit of community-based PEP or provision of PEP by trained lay health workers/task-sharing. Costs could include health sector costs, other sector costs, client/family costs or productivity impacts.

2.5.1 | Search strategy

We used a single search strategy to identify articles using terms for "PEP" and "HIV." This broad search was intended to maximize sensitivity. We searched four online databases (CINAHL, PsycINFO, PubMed and EMBASE) for relevant peer-reviewed publications using the following search terms:

Pubmed: (HIV[Title/Abstract] or HIV[MeSH]) AND (post-exposure prophylaxis [MeSH] OR "postexposure prophylaxis"[Title/Abstract] OR "post-exposure prophylaxis"[Title/Abstract] OR "post exposure prophylaxis"[Title/Abstract] OR PEP[Title/Abstract]))

CINAHL: (MH HIV OR AB HIV OR TI HIV) AND (MH "post-exposure prophylaxis" OR AB "postexposure prophylaxis" OR AB "post-exposure prophylaxis" OR AB "post exposure prophylaxis" OR AB PEP OR TI "postexposure prophylaxis" OR TI "post-exposure prophylaxis" OR TI "post exposure prophylaxis" OR TI PEP)

PsycINFO: (MH HIV OR AB HIV OR TI HIV) AND (MH "post-exposure prophylaxis" OR AB "postexposure prophylaxis" OR AB "post-exposure prophylaxis" OR AB "post exposure prophylaxis" OR AB PEP OR TI "postexposure prophylaxis" OR TI "post-exposure prophylaxis" OR TI "post exposure prophylaxis" OR TI PEP)

EMBASE: (('postexposure prophylaxis':ab, ti OR 'post-exposure prophylaxis':ab, ti OR 'post exposure prophylaxis':ab, ti OR pep:ab, ti) AND hiv:ab, ti)

We also searched conference abstracts from the Conference on Retroviruses and Opportunistic Infections (CROI), the International AIDS Society Conference on HIV Science (IAS) and the International AIDS Conference (IAC). We reviewed the reference lists of several previously conducted reviews [8–10] and of all included studies. Finally, we asked selected experts to propose potentially relevant studies.

2.5.2 | Screening process

Titles, abstracts, citation information and descriptor terms of citations identified through the search strategy were screened by a member of the review team (PTY, RD, CK). Full-text articles were obtained for all selected abstracts and two independent reviewers (CK, RD) assessed all full-text articles for eligibility to determine final study selection. Differences were resolved through consensus.

2.5.3 | Data extraction, management and analysis

Data were extracted independently by two reviewers (CK, RD) using standardized data extraction forms in Excel. Differences in data extraction were resolved through consensus. From each study, we gathered information on citation information (author, year, title, journal, language of article), location, study population, sample size, study design, intervention summary, comparator (when applicable) and study outcomes. For the effectiveness review, risk of bias at the study level was assessed using the Cochrane Collaboration risk of bias tool for randomized trials [11] and the Evidence Project risk of bias tool [12] for comparative observational studies. We also assessed risk of bias at the level of individual outcomes and assessed the overall certainty of the evidence using GRADE [13].

Data were summarized descriptively for each component of the review (effectiveness, case studies, values and preferences, and cost). For the effectiveness review, we planned to conduct a meta-analysis using random-effects models, but did not have enough comparable studies to combine.

3 | RESULTS

Figure 1 presents a PRISMA diagram showing the disposition of citations through the search and screening process [14]. Of 2202 unique citations identified through the search process,

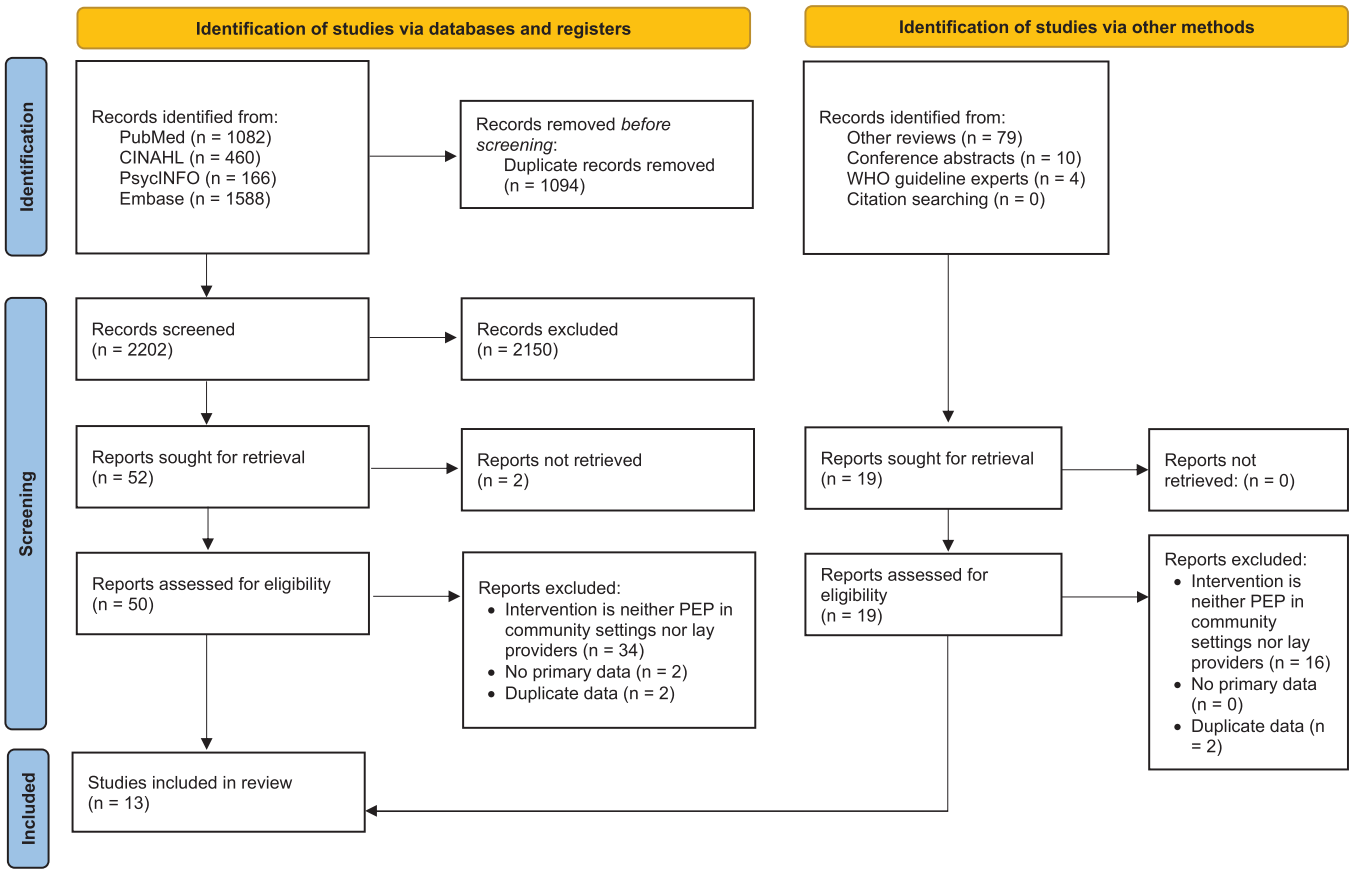

Figure 1. PRISMA flowchart. Disposition of articles through the search and screening process.

13 studies met our inclusion criteria: three effectiveness studies, five case studies, five values and preferences studies (one of which was reported in the same abstract as a case study) and two cost studies (one of which was reported in the same abstract as an effectiveness study).

3.1 | Effectiveness review

One study met the inclusion criteria for the effectiveness review of PEP offered in community settings (Table 1) [15]. The Sustainable East Africa Research in Community Health (SEARCH) SAPPHIRE study, conducted in Kenya and Uganda, offered PEP as part of a "dynamic choice" model of HIV prevention options, which also included PrEP and condoms. The dynamic choice model was delivered in three different settings: in antenatal care (ANC) settings and outpatient departments (OPDs), where PEP was offered by clinical officers and nurses, and in community settings, where PEP was offered by community health workers who facilitated the intervention by clinical officers from the local health centre. "Dynamic choice" refers to people being able to choose and switch between interventions, service locations and service providers. At intervention visits during weeks 4, 12 and 24, participants were asked to select a choice of HIV prevention option (PrEP, PEP, condoms only and no selection), HIV testing modality (oral self-test or clinician-administered rapid antibody) and preferred location for next visit (clinic vs. out-of-facility). At week 24, PEP use and HIV risk (report of sexual partners with HIV or unknown status and/or self-identification as being at risk) for each of the prior six calendar months were assessed via a structured survey. There was risk of bias when comparing across settings, as populations accessing the intervention through community, ANC and OPD settings were substantially different on demographic factors (e.g. gender, age, pregnancy status). This single observational study was judged as providing very low certainty evidence for the PICO question (Supporting information). The study measured the outcome of uptake of PEP over 24 weeks of follow-up and found that the initial choice of PEP for HIV prevention was highest in the community setting (46%) compared to the OPD and ANC settings (9% and 1%, respectively). Selection of PEP over the follow-up study visits remained highest in the community setting over time (23% at week 24); in the ANC and OPD settings, only 3% and 11%, respectively, ever selected PEP.

The SEARCH SAPPHIRE study was also considered to meet the inclusion criteria for the effectiveness review of PEP offered by lay health workers, along with two additional conference abstracts, both reporting on studies conducted in the United States (Table 1).

The first additional study conducted a retrospective chart review of PEP users before and after a programme which

Table 1. Description of studies included in the effectiveness review

Study	Country	PEP setting/intervention	Population	Study design	Sample size
PICO 1: PEP offered in community settings					
Kabami et al., 2022	Kenya and Uganda	PEP offered by CHWs in community settings as part of a dynamic HIV prevention choice model settings	Community	Non-randomized trial	612 community participants
PICO 2: PEP offered by lay health workers/task-sharing					
Kabami et al., 2022	Described above				
Grossman et al., 2020	USA	Pharmacist prescribing PEP in an infectious disease clinic	Individuals referred from an emergency department for non-occupational exposure	Retrospective chart review before/after intervention	24 PEP clients
Lowrey et al., 2020	USA	Pharmacist prescribing free PEP, providing education and conducting a follow-up call	Sexual assault survivors presenting to an emergency department	Retrospective chart review before/after intervention	369 PEP clients

Abbreviations: CHWs, community health workers; PEP, post-exposure prophylaxis.

allowed a pharmacist in an infectious disease clinic to prescribe PEP following a referral from an emergency department; previously, PEP cases were seen in the infectious disease clinic without pharmacist involvement [16]. This observational study had a small sample size (n = 24 PEP users across both arms) and was judged as providing very low certainty evidence for the PICO question (Supporting information). This study measured two primary outcomes: PEP uptake and PEP completion. After the intervention, 16/16 (100%) of eligible clients left the clinic with PEP, compared with 5/8 (62.5%) prior to the intervention. After the intervention, 42% of those who left the clinic with PEP completed the entire PEP course and came to a follow-up appointment, compared to 32% before the intervention (numbers not reported).

The second additional study also conducted a retrospective chart review comparing before and after implementation of a programme that involved pharmacists dispensing free PEP, providing patient education prior to discharge and conducting a follow-up phone call after 3 months for sexual assault survivors in an emergency department [17]. The study measured the outcomes of PEP completion and HIV acquisition, but had a small number of events, and was judged as providing very low certainty evidence for the PICO question (Supporting information). PEP completion was 19.8% (n = 55) with the pharmacist-delivered interventions compared with 4.3% (n = 4) before the intervention (the total number of charts reviewed was 369, but the sample size before and after the intervention was not reported). There were two documented cases of HIV seroconversion before the intervention and none afterwards.

No studies included in the effectiveness review measured the other PICO outcomes: quality of PEP services offered, timeliness of PEP uptake, linkage to or uptake of appropriate additional services or adverse events.

3.2 | Case studies review

Three studies were included in the case studies review of PEP offered in community settings (Table 2). The first study trained health workers from government clinics in Kenya and Uganda on PEP with an option for those trained to offer out-of-facility, community-based medication delivery [18]. Among 124 clients who sought PEP through these clinics, 85% completed PEP and no serious adverse events or HIV seroconversions were reported. Overall, 12% of visits were conducted at out-of-facility community-based sites; 35% of participants had at least one out-of-facility visit. The second study examined police initiation of PEP at police stations for sexual assault survivors in Zambia [19]. Of 207 cases of sexual assault, about half were eligible for PEP (n = 104), but only 25% of these (n = 26) were initiated on PEP by the police. The authors noted that less than half of eligible cases (n = 49) presented during official police working hours, and 33% of eligible survivors who reported during official working hours received PEP, compared to 18% of those who reported on nights or weekends. No adverse events were reported. The third study examined a web-based platform for delivering PEP in China [20]. Of 539 PEP users, nearly all (99%) started PEP within 72 hours of exposure and there were no HIV seroconversions reported.

Two studies were included in the case studies review of PEP offered by lay health workers/task-sharing (Table 2). The first study evaluated PEP delivery by pharmacists in 12 private pharmacies in Kenya [21]. Of 989 clients screened over a 6-month period for PEP, PrEP or sexually transmitted infection (STI) testing, 173 clients were initiated on PEP, and 18% (32/173) of these transitioned to PrEP upon PEP completion. The second study trained 14 nurse non-medical prescribers to offer PEP in nurse-delivered clinics in the UK, compared to the usual offer through a central sexual health hub clinic and

Table 2. Description of studies included in the case studies review

Study	Country	PEP setting/ intervention	Population	Sample size	Results
PICO 1: PEP offered in community settings					
Ayieko et al., 2021	Kenya and Uganda	Community-based delivery	General population	124 PEP initiations	- 124 persons sought PEP; 85% completed PEP, and there were no HIV seroconversions - 12% of all visits were conducted at out-of-facility community-based sites; 35% of participants had ≥1 out-of-facility visit - No serious adverse events were reported
Zama et al., 2015	Zambia	Police stations	Sexual assault survivors	207 cases of sexual assault	- About half of cases were PEP-eligible, and 25% of these were initiated on PEP by the police - Less than half of eligible cases presented during working hours, but eligible cases were more likely to receive PEP if during working hours (33%) than if during non-working hours (18%)
Shan et al., 2023	China	Internet-based service	Mostly men who have sex with men	539 PEP users	Of 539 PEP users who responded to the survey, nearly all (99%) started PEP within 72 hours of exposure and there were no HIV seroconversions reported
PICO 2: PEP offered by lay health workers/task-sharing					
Roche et al., 2023	Kenya	Private pharmacies	General population	989 clients	173 clients were initiated on PEP, and 18% (32/173) of these transitioned to PrEP upon PEP completion
Mensforth et al., 2018	UK	Nurse-delivered clinics	Not reported	27 PEP assessments	- Of 19 PEP prescribing decisions, 18 met local prescribing criteria - Nurse prescribing was described as "comparable, if not better than" doctor prescribing

Abbreviations: PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis.

emergency department, and compared their outcomes with a sample of PEP prescribed by doctors over the same period [22]. In the 6 months after training, 27 PEP assessments were completed by nine nurses across six satellite clinics. Of 27 patient assessments, 19 received PEP, with 18/19 of those prescribing decisions meeting local prescribing criteria.

3.3 | Values and preferences review

One study was identified for the values and preferences review of PEP offered in community settings (Table 3). This study was a cross-sectional survey of 342 sexual and gender minorities visiting collective sex venues in New York City, USA [23]. In open-text survey responses, participants expressed interest in such venues providing a range of free HIV and STI prevention services, including PEP. Although results were not separated for PEP services, participants felt services could be delivered in an acceptable way, although potential barriers included privacy concerns, access to health services in other locations (and thus limited perceived need for community-based services) and negative reactions to the presence of service providers at sex venues.

Four studies were identified for the values and preferences review of PEP offered by lay health workers/task-sharing (Table 3). Two of these were online, cross-sectional surveys of non-randomly selected PEP providers. The first study used an online survey of 214 nurses in Ontario, Canada to assess perspectives on allowing nurses to dispense PEP. Overall, 76.9% of participants indicated they would be supportive of nurse-led PEP under medical directives [24]. The second study was

Table 3. Description of studies included in the values and preferences review

Study	Country	Participants	Study design	Sample size
PICO 1: PEP offered in community settings				
Cai et al., 2023	USA	Sexual and gender minorities	Cross-sectional survey	342
PICO 2: PEP offered by lay health workers/task-sharing				
Clifford-Rashotte et al., 2018	Canada	Nurses	Cross-sectional survey	214
Beanland et al., 2015	Multi-country (South Africa, USA, Lesotho, Armenia and Kenya)	Health workers	Cross-sectional survey	306
Bellman et al., 2022	USA	Pharmacists	Semi-structured qualitative interviews	7
Roche et al., 2023	Kenya	PEP clients and pharmacy providers	Cross-sectional survey	Not reported

Abbreviations: PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infection; USA, United States of America.

Table 4. Description of studies included in the costs review

Study	Country	Setting	Population	Sample size
PICO 1: PEP offered in community settings				
Phillips et al., 2023	Multiple countries in Africa	Community-based availability of PEP	General population	Modelling study
PICO 2: PEP offered by lay health workers/task-sharing				
Grossman et al., 2020	USA	Pharmacists prescribing PEP and facilitating counselling and low or no cost medication access	Patients referred from an emergency department to an infectious disease clinic	24

Abbreviation: PEP, post-exposure prophylaxis.

a multi-country, mixed-methods study to examine values and preferences around PEP to inform prior WHO guidelines [25]. The online survey component was completed by 306 participants from five countries: South Africa (n = 90), the United States (n = 51), Lesotho (n = 16), Armenia (n = 16) and Kenya (n = 15). Of these providers, 65.5% (n = 110) disagreed that 28-day prescribing should only be prescribed by HIV specialists, and 74.1% (n = 126) agreed that they could allow non-HIV specialists to start PEP safely. The third study reported findings from semi-structured qualitative interviews with staff at PEP-prescribing pharmacies in the San Francisco Bay area, USA [26]. Of seven interview participants, all felt the California state bill that allowed pharmacists to dispense PEP was a valuable expansion of services. Finally, the fourth study, also included in the case study review, evaluated a model of PEP delivery (along with PrEP and HIV testing) in private pharmacies in Kenya [21]. Although PEP was not separated from PrEP in the analysis, acceptability was generally high. The majority (70–100%) of clients and providers reported that they liked getting/delivering PrEP/PEP at the pharmacy and that getting/delivering PrEP/PEP at the pharmacy was not hard.

3.4 | Cost review

Two studies were included in the cost review: one for PEP offered in community settings, and one for PEP offered by lay health workers/task-sharing (Table 4). The first study used mathematical modelling to examine a range of scenarios around wider PEP availability in communities in West, East, central and southern Africa [27]. This study estimated a cost of US$16.20 for 3 months of PEP availability, including a 20% additional supply chain cost to cover distribution. In the mathematical models, overall costs were lower with community PEP than with no community PEP in 92% of setting scenarios, with $18.0 million (14% of the overall HIV budget of US$127.8 million per year) savings per year over 50 years as a result of fewer people requiring ART and lower ART-related clinic visits over the long term. Models suggested that community PEP was cost-effective in 90% of setting scenarios and cost-saving (with disability-adjusted life-years averted) in 58% of scenarios. When only examining setting scenarios in which there was a lower uptake of community PEP, it was found to be cost-effective in 92% of setting scenarios. The second study, also included in the effectiveness review, assessed cost

savings associated with a new PEP programme offered by pharmacists in the United States, which included coordinated benefits investigation and low or no-cost medication access [16]. Through this combination of interventions, clients' average out-of-pocket costs for one course of PEP ranged from US$2.25–$7.30 after the pharmacist intervention, compared to US$475.00–$3733.40 before the intervention.

4 | DISCUSSION

This systematic review found that research on expanding PEP access through community delivery or task sharing is limited, but existing research generally suggests positive outcomes, as well as the feasibility and acceptability of these approaches. Currently, many countries lack detailed national policy guidance on PEP [28], and PEP is not widely available outside of hospital settings for healthcare-associated occupational or sexual assault exposures. A previously published systematic review reported that just 14% of eligible people refused PEP [29]. Expanded PEP access could increase coverage of this effective HIV prevention strategy, which remains urgently needed in a world where approximately 1.3 million people acquired HIV in 2023 [30].

While we were interested in PEP delivery by lay health workers, many of the included studies reflected more of a task-sharing approach, where PEP services were provided by pharmacists or other health workers. While there is substantial support for community pharmacist provision of PEP [4], future research with lay health workers, including peers, would be valuable.

We did not include studies examining the PEP in pocket ("PIP") approach, where clients are given a prescription for HIV PEP to self-initiate in case of future high-risk exposures. This approach has generally been offered by trained health workers in non-community settings, so it did not meet our inclusion criteria; however, evidence over many decades suggests it may also hold promise as an additional strategy for widening appropriate access to PEP [31–36]. Indeed, while not offered by trained health workers, the SEARCH trial presented here could be considered an example of a PEP in pocket approach. Studies of PEP in pocket have found it to be feasible and effective [31–33, 35], with individuals appropriately determining when to use PEP [31], and with few [35] to no [31–33] observed HIV seroconversions.

Community-based delivery and task sharing have been successfully used for a range of other HIV services, providing indirect evidence that these strategies should also work for PEP. WHO supports community-based and pharmacy-based delivery of PrEP [3]. For HIV treatment, WHO recommends that trained non-physician clinicians, midwives and nurses can initiate first-line ART, trained and supervised community health workers can dispense ART between regular clinical visits and trained and supervised lay healthcare providers can distribute ART [36]. Both ART and PrEP are more complex to deliver than PEP and require longer-term engagement with the health system. Community-based services and task sharing have also been used for HIV testing, viral hepatitis testing and treatment, harm reduction, contraception and a range of other health services. It is reasonable to assume that provision of PEP through the same strategies would similarly result in improved access and outcomes.

WHO also recommends that HIV self-testing may be used to deliver pre- and post-exposure prophylaxis, including for initiation, re-initiation and continuation for PrEP and initiation and follow-up for PEP [3]. Self-testing could facilitate community delivery and benefit PEP clients, supporting earlier access to PEP in community settings and reducing opportunity costs for clients who would not need to routinely visit health services for follow-up after completion of a course of PEP.

This review has several limitations. Although we conducted a broad search of both peer-reviewed articles and conference abstracts, it is possible that our search missed some relevant studies. Our prespecified PICO outcomes did not include PEP medication tolerability because this review was focused on PEP provision, not regimen selection, although we did look for adverse events. Our search went through October of 2023; since that date, there appear to be limited additional published studies on the PEP strategies we examined. However, one recent study of physician attitudes towards pharmacist-prescribed PEP in the United States found general support for this approach, with greater acceptability among newer trainees compared to established physicians [37].

Future research would be useful to expand this evidence base across a range of country contexts with consideration of the diverse needs of different delivery settings and client populations. In particular, research that shows how PEP can be most effectively provided to populations who may most benefit from it, through creative outreach strategies, and with cost-effectiveness assessments, would be helpful to inform programme decision-making.

5 | CONCLUSIONS

While limited, existing studies provide support for PEP in community settings and by lay health workers or through task sharing. Programmes should be expanded to include community delivery and task-sharing to dispense, distribute, provide and monitor PEP to increase the impact of this underutilized antiretroviral HIV prevention intervention.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHORS' CONTRIBUTIONS

VM, RB, RS, H-MAS, NF and MR conceptualized the review. CEK, PTY and RD developed the study methods and protocols, with feedback from other coauthors. CEK and RD conducted data extraction and formal analysis. CEK wrote the original draft. All authors contributed to writing and editing the review, and gave their assent to submit for publication.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are all publicly available through peer-reviewed journals or conference websites.

REFERENCES

1. Cardo DM, Culver DH, Ciesielski CA, Srivastava PU, Marcus R, Abiteboul D, et al. A case–control study of HIV seroconversion in health care workers after percutaneous exposure. N Engl J Med. 1997;337(2):1485–90.
2. WHO. Guidelines on post-exposure prophylaxis for HIV and the use of co-trimoxazole prophylaxis for HIV-related infections among adults, adolescents and children: recommendations for a public health approach: December 2014 supplement to the 2013 consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Geneva: WHO; 2014.
3. WHO. WHO launched new implementation guidance for simplified and differentiated service delivery of pre-exposure prophylaxis (PrEP). WHO; 2023. https://www.who.int/news/item/26-07-2022-who-launched-new-implementation-guidance-for-simplified-and-differentiated-service-delivery-of-prep. Accessed 21 Jun 2024.
4. Scarnati K, Esser K, Sahloff EG, Duggan J. The role of community pharmacies in providing access to HIV post-exposure prophylaxis (PEP). J Community Health. 2024;49(2):222–28.
5. Kathi HR, Xu LC, Dao A, Lai S, Nicholas Z, Gerriets V. The effect of Senate bill-159 on the provision of HIV pre- and post-exposure prophylaxis in Sacramento, California. J Investig Med. 2023;71(1):38.
6. Nyamuzihwa T, Tembo A, Martyn N, Venter F, Maimin J, Houghton J, et al. The South African community pharmacy sector–an untapped reservoir for delivering HIV services. Front Reprod Health. 2023;5:1173576.
7. WHO. Optimizing health worker roles to improve access to key maternal and newborn health interventions through task-shifting. Geneva: WHO; 2012. https://www.who.int/publications/i/item/9789241504843. Accessed 21 Jun 2024.
8. Zhou L, Assanangkornchai S. Current perspectives on the determinants of acceptability of pre-exposure prophylaxis and nonoccupational post-exposure prophylaxis among people at risk for HIV: a scoping review. Int J Environ Res Public Health. 2022;19(19):12605.
9. Auerbach J. HIV postexposure prophylaxis (PEP): a literature scoping review. Unpublished manuscript presented for WHO/BMGF discussion of PEP, February 2023. 2023.
10. CDC. CDC North American PEP literature review 2015–2022. Unpublished report. 2021.
11. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ. 2019;366:l4898.
12. Kennedy CE, Fonner VA, Armstrong KA, Denison JA, Yeh PT, O'Reilly KR, et al. The Evidence Project risk of bias tool: assessing study rigor for both randomized and non-randomized intervention studies. Syst Rev. 2019;8(1):3.
13. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ. 2008;336(7650):924–26.
14. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
15. Kabami J, Kakande E, Chamie G, Balzer LB, Petersen ML, Camlin CS, et al. Uptake of a patient-centred dynamic choice model for HIV prevention in rural Kenya and Uganda: SEARCH SAPPHIRE study. J Int AIDS Soc. 2023;26(Suppl 1):e26121.
16. Grossman KH. Improving patient access to HIV post-exposure prophylaxis with pharmacist involvement. Open Forum Infect Dis. 2020;7(Suppl. 1):S522.
17. Lowrey K, Kaucher K, Dawson J, Gilliam E. Improvement in HIV screening follow-up with emergency department pharmacist dispensing of post-exposure prophylaxis. J Am Coll Clin Pharm. 2020;3(8):1573–74.
18. Ayieko J, Petersen ML, Kabami J, Mwangwa F, Opel F, Nyabuti M, et al. Uptake and outcomes of a novel community-based HIV post-exposure prophylaxis (PEP) programme in rural Kenya and Uganda. J Int AIDS Soc. 2021;24(6):e25670.
19. Zama MT, Dennis M, Price J, Topp SM. Assessing the feasibility of police initiation of HIV post-exposure prophylaxis for sexual violence survivors in Lusaka, Zambia. BMC Proc. 2015;9(Suppl 4):A3.
20. Shan D, Xue H, Yu F, Zan X, Liu H, Liu J, et al. Understanding the uptake and outcomes of non-occupational postexposure prophylaxis use through an online medical platform in China: web-based cross-sectional study. J Med Internet Res. 2023;25:e42729.
21. Roche S, Omollo V, Mogere P, Asewe M, Gakuo S, Banerjee P, et al. Pharmacy-based PrEP delivery in Kenya: findings from a pilot study extension. CROI; 2023.
22. Mensforth S, Dufty N, Stewart N. Training NMPs to prescribe PEPSE: improved accessibility for all. HIV Med. 2018;19:S109–10.
23. Cai X, Fisher CB, Alohan D, Tellone S, Grov C, Cohall A, et al. Sexual and gender minority individuals' interest in sexual health services at collective sex venues in New York City. AIDS Behav. 2023;27(3):761–71.
24. Clifford-Rashotte M, Fawcett N, Fowler B, Reinhart J, Tan DHS. Assessing the potential for nurse-led HIV pre- and postexposure prophylaxis in Ontario. Can J Nurs Res. 2021;53(2):145–54.
25. Beanland RL, Irvine CM, Green K. End users' views and preferences on prescribing and taking postexposure prophylaxis for prevention of HIV: methods to support World Health Organization guideline development. Clin Infect Dis. 2015;60(Suppl 3):S191–95.
26. Bellman R, Mohebbi S, Nobahar N, Parizher J, Apollonio DE. An observational survey assessing the extent of PrEP and PEP furnishing in San Francisco Bay Area pharmacies. J Am Pharm Assoc. 2022;62(1):370–77.e3.
27. Phillips AN, Bansi-Matharu L, Shahmanesh M, Hargreaves JR, Smith J, Revill P, et al. Potential cost-effectiveness of community availability of tenofovir, lamivudine, and dolutegravir for HIV prevention and treatment in east, central, southern, and west Africa: a modelling analysis. Lancet Glob Health. 2023;11(10):e1648–57.
28. Maisano M, Tran D, Macdonald V, Baggaley RC, Ford N, Johnson CC, et al. A global review of national guidelines of post-exposure prophylaxis for the prevention of HIV. J Int AIDS Soc. 2025;28(1):e26333.
29. Ford N, Irvine C, Shubber Z, Baggaley R, Beanland R, Vitoria M, et al. Adherence to HIV postexposure prophylaxis: a systematic review and meta-analysis. AIDS. 2014;28(18):2721–27.
30. UNAIDS. Fact sheet. 2024. https://www.unaids.org/en/resources/fact-sheet. Accessed 21 Jun 2024.
31. Clifford-Rashotte M, Yoong D, Naccarato M, Pico Espinosa OJ, Fisher K, Bogoch II, et al. Appropriate usage of post-exposure prophylaxis-in-pocket for HIV prevention by individuals with low-frequency exposures. Int J STD AIDS. 2024;35(6):446–51.
32. Alghamdi A, Hempel A, Heendeniya A, Clifford-Rashotte M, Tan DHS, Bogoch II. HIV postexposure prophylaxis-in-pocket: long-term follow-up of individuals with low-frequency, high-risk HIV exposures. AIDS. 2020;34(3):433–37.
33. Tumarkin E, Heendeniya A, Murphy P, Placido T, Tan DHS, Bogoch II. HIV post-exposure prophylaxis-in-pocket ("PIP") for individuals with low-frequency, high-risk HIV exposures. J Acquir Immune Defic Syndr. 2018;78(1):20–22.
34. Fox JM, Lee MJ, Fairhead CL, Ledwaba-Chapman LM, Nori AV, McQuillan O, et al. Self-start HIV postexposure prophylaxis (PEPSE), to reduce time to first dose and increase efficacy. Sex Transm Infect. 2023;99(6):367–72.
35. Schechter M, do Lago RF, Mendelsohn AB, Moreira RI, Moulton LH, Harrison LH; Praca Onze Study Team. Behavioral impact, acceptability, and HIV incidence

among homosexual men with access to postexposure chemoprophylaxis for HIV. J Acquir Immune Defic Syndr. 2004;35(5):519–25.
36. WHO. Consolidated guidelines on HIV prevention, testing, treatment, service delivery and monitoring: recommendations for a public health approach. 2021. https://www.who.int/publications/i/item/9789240031593. Accessed 21 Jun 2024.
37. Scarnati K, Esser KL, Sim JM, Vaidya V, Sahloff E, Duggan J. Physician attitudes towards pharmacist-prescribed HIV post-exposure prophylaxis (PEP): a survey of a state medical association. J Community Health. 2024;50(2):335–43.

SUPPORTING INFORMATION

Additional information may be found under the Supporting Information tab for this article:
Supporting information. GRADE evidence profiles for PICO questions

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COMMENTARY

Implementing the new WHO guidelines on HIV post-exposure prophylaxis: perspectives from five African countries

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Abstract

Introduction: Post-exposure prophylaxis (PEP) is an important component of comprehensive HIV prevention, yet its uptake has been suboptimal globally. In July 2024, the World Health Organization (WHO) updated its global guidance on PEP to include two new recommendations intended to increase timely access to and delivery of PEP. These recommendations specifically aim to expand both *where* PEP can be delivered, to include community settings, and *who* can provide PEP, to include community health workers and task-sharing. The practical realities of adopting new public health guidelines to achieve the intended benefits in most contexts are complex. Articulating these realities is important for identifying what will be required to ensure the feasibility of expanded PEP access in community settings.

Discussion: We provide stakeholder perspectives from five African countries—Kenya, Nigeria, South Africa, Uganda and Zimbabwe—on both barriers to and strategies for implementing the new WHO PEP recommendations. These perspectives are informed by experiences in these countries that were shared at a recent workshop and highlight key themes related to PEP uptake and use: awareness and acceptability; administration and monitoring; policy alignment, including regulatory considerations; logistics; integration of services; stakeholder involvement and capacity building; and linking PEP and PrEP more directly. Running across these themes are the roles of socio-cultural norms and the need for increased resources to pay for implementing the recommendations, including capacity strengthening and monitoring in communities.

Conclusions: While significant challenges exist to expanding PEP access in community settings and through task-sharing, there are examples from our countries of successful efforts to mitigate them by leveraging existing community resources and capacities in innovative ways. Additional efforts will require engagement across multiple stakeholders to address remaining awareness gaps, logistical and regulatory obstacles, and political will. As countries work to update their guidelines and align with the new WHO recommendations, continued collaboration and innovation within and across countries will be essential to realize the full potential of PEP in comprehensive HIV prevention efforts.

Keywords: HIV PEP; post-exposure prophylaxis; HIV prevention; World Health Organization; global guidance; PEP to PrEP

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1 | INTRODUCTION

Despite encouraging reductions in HIV incidence across several countries, significant numbers of new transmissions persist, particularly among key and priority populations [1]. Even in settings where countries have achieved or are nearing the United Nations' (UN) 95–95–95 targets, high levels of testing and antiretroviral therapy (ART) coverage have not been sufficient to achieve the low incidence rates necessary for epidemic control. This highlights the need for enhanced HIV prevention efforts and increased focus on optimizing the uptake of proven efficacious interventions.

The World Health Organization (WHO) recommends several interventions as part of a comprehensive HIV prevention strategy, including condom and lubricant programming, harm reduction for people who inject drugs, voluntary medical male circumcision, pre-exposure prophylaxis (PrEP), provision of ART to eliminate vertical transmission of HIV and post-exposure prophylaxis (PEP). Evidence indicates that providing a range of options and enabling individual choice is crucial for improving the uptake of HIV prevention interventions, which, in many contexts, remains low [2].

PEP, which involves taking antiretroviral medications shortly after potential exposure to HIV to reduce the risk of acquisition, is one such method with relatively low uptake. Although the evidence base for PEP as an efficacious HIV prevention method is limited, it has been accepted globally as sufficient to render PEP an important HIV prevention strategy for various types of exposure [3]. Even with that acceptance, access to and utilization of PEP remain suboptimal, even among healthcare workers in low- and middle-income countries (LIMCs) where the risk of occupational exposure is

high and among the general population in sub-Saharan African countries with high HIV prevalence [4–7].

In response to this gap—and building on the increased attention to and uptake of PrEP, which similarly involves taking antiretroviral medications, but in this case prior to HIV exposure—WHO updated its PEP guidelines in 2024. These guidelines aim to draw attention among policymakers, donors, programme managers, healthcare providers, communities and potential PEP users to the use of PEP. Specifically, these guidelines add two new recommendations: (1) expanding *where* PEP can be provided to include community settings, such as integrated community healthcare facilities and other, non-healthcare facilities and services (e.g. pharmacies, community-based organizations, drop-in centres, mobile clinics and online delivery); and (2) expanding *who* can deliver PEP to include community-based providers, such as pharmacists, nurses, doctors and trained lay and peer health workers, and to encourage task sharing among them [8].

These new recommendations are based on very limited evidence, which WHO acknowledges in both the main guidance document and the annex detailing its evidence review methodology [9]. Only 13 PEP-specific studies related to the new recommendations met WHO's review criteria; about half of these were conducted in non-African, non-LIMCs (i.e. United States, United Kingdom, Canada, China). Other data used to support the recommendations came from studies of expanded delivery of antiretroviral drugs (ARVs) for HIV treatment and for PrEP. Notwithstanding this limited evidence, the Guidelines Development Group believed that the benefits of expanding PEP access in communities far outweighed any harms.

The practical realities of adopting new public health guidelines to achieve such benefits in most contexts are complex [10]. To ascertain the feasibility of implementing the two new PEP recommendations—especially given the limited evidence base supporting them—it is imperative to learn from country experiences with PEP delivery to date, and to identify existing and potential obstacles to and strategies for expanding PEP research, access and uptake in different settings.

2 | DISCUSSION

In this commentary, we consider some existing barriers and potential solutions to PEP scale-up within and across five countries: Kenya, Nigeria, South Africa, Uganda and Zimbabwe. Our discussion is informed by deliberations at a workshop held in June 2024, convened by the South-to-South HIV Prevention Learning Network (SSLN) with stakeholders from these five countries [11]. We focus on key, interrelated themes related to community provision of PEP and task-sharing: awareness and acceptability; administration and monitoring; policy alignment; logistics; integration of services; stakeholder involvement and capacity building; and linking PEP and PrEP.

2.1 | Awareness and acceptability

A significant challenge in PEP implementation is the widespread lack of awareness of PEP as an HIV prevention method among both healthcare providers and potential end-users. Unpublished data from the Kenya Health Information System reported at the SSLN workshop revealed that between January 2022 and March 2024, less than 42% of young people in Kenya exposed to HIV presented for PEP within the required 72 hours due to fear and lack of knowledge. This awareness gap extends to healthcare providers, who often associate PEP primarily with sexual assault cases and occupational exposure. Thus, increasing the availability of PEP through community-based delivery and task-sharing requires increased awareness of PEP among both community members and healthcare staff.

In addition to limited awareness, stigma related to HIV and ARVs remains a substantial barrier to PEP uptake. Concerns about confidentiality and self-stigma are significant challenges in implementing community-based PEP delivery and task-sharing.

To address these issues, we suggest several solutions that emerged from the SSLN workshop and resonate with our experiences, including provider training and sensitization on PEP guidelines; effective branding and repackaging of PEP to increase acceptability, especially among youth; using discreet packaging (e.g. zip lock envelopes or blister packs) to reduce stigma; incorporating recognizable and trusted figures for awareness campaigns; and ensuring the name and messaging (including the distinction between PEP and PrEP) are appealing and relevant to target populations. It is worth noting that, while *rebranding* PEP may be necessary for greater appeal, our consensus is that *renaming* PEP at the policy level is not. Rather, effective branding (e.g. how PEP drugs and their packaging look) and messaging to build awareness of PEP should be the focus of attention.

2.2 | Administration and monitoring

Implementing the new recommendations requires careful consideration of key aspects of PEP administration and monitoring, including HIV testing, PEP prescribing and dosing, and adherence counselling and support inclusive of managing commonly perceived and experienced negative side effects of PEP medications [7]. A broader array of PEP providers will have to be trained in these areas; how such expanded training and retraining will be conducted and funded is a concern. Notwithstanding, countries are moving forward with innovations in these areas. In Uganda, for example, community health workers (CHWs) are being trained to support adherence monitoring and conduct HIV self-testing both pre- and post-PEP, which enables expanded service coverage without overburdening healthcare infrastructure. Additionally, "PEP on Demand" and mobile delivery models are being piloted in South Africa to ensure timely access to PEP even in remote or resource-limited areas. Peer-led adherence support and the introduction of mobile clinics also demonstrate promising results in increasing adherence and providing follow-up support, particularly among youth [11].

2.3 | Policy alignment

Expanding PEP access requires policy changes and considerations. These include updating local and national policies to align with the new WHO recommendations; conducting

comprehensive budget analyses for expanding PEP in community settings; addressing regulatory restrictions on where PEP and associated HIV testing can be delivered and by whom, as well as on which drugs can be used for PEP; and updating healthcare workers' scopes of work.

Relevant extant policies are reflected not only in PEP-specific guidelines and strategies, but also in those addressing the use of ART for both prevention (including PrEP) and treatment [12]. Ideally, such guidelines should be merged and harmonized and should clearly define PEP's role within broader HIV prevention strategies. This requires leveraging existing structures and political will, which may be challenging.

Even with such policy and regulatory challenges, some countries are moving forward. For example, in Nigeria, regulatory requirements have limited PEP delivery to clinical settings, creating access bottlenecks. Policymakers there are working to amend guidelines to authorize community provision and promote PEP as a tool for all high-risk exposures, not only occupational or sexual assault-related cases. Kenya and Uganda also are revising their policies to broaden PEP's availability through CHWs, private pharmacies and drop-in centres, expanding PEP's reach in urban and rural communities alike.

2.4 | Logistics

Effective implementation of community-based PEP requires addressing logistical challenges, including forecasting demand and commodity needs and managing supply chain factors such as procurement, logistics, stock monitoring and distribution, which differ in rural and urban/peri-urban settings. Uganda and Kenya have experienced issues related to stock monitoring and supply chain inefficiencies, which can result in stockouts at community distribution points.

We suggest establishing diversified PEP delivery points—such as youth centres, private pharmacies and mobile clinics—and leveraging digital tools to track inventory and monitor demand. As an example, South African mobile clinics and CHWs now carry small PEP stockpiles, allowing immediate dispensation upon need without requiring patients to travel to centralized health facilities. Further piloting PEP delivery through various channels, including pharmacies, online platforms and vending machines, can improve accessibility.

2.5 | Integration of services

The integration of PEP with other HIV, sexually transmitted infections (STIs), and sexual and reproductive health (SRH) services is crucial for expanding access. This requires leveraging existing community structures for the delivery of multiple prevention methods, including HIV testing/self-testing, and strengthening referral systems between health services.

Nigeria has integrated and trained CHWs for task shifting and sharing along the continuum of care in its HIV treatment and care guidelines. Kenya and Uganda are pursuing integration strategies to link PEP services with STI treatment, emergency contraception and HIV self-testing kits, making PEP more accessible and comprehensive within existing health services. Zimbabwe has adopted a community health approach that integrates PEP into SRH and family planning services within safe spaces, youth drop-in centres and primary healthcare clinics. This one-stop-shop model allows for seamless transitions from emergency PEP use to other preventive measures like PrEP, supporting continuous care for at-risk populations.

2.6 | Stakeholder involvement and capacity building

Successful implementation of the new WHO recommendations requires engaging a wide range of stakeholders and building capacity among healthcare workers and community providers to raise awareness, drive PEP adoption and address cultural barriers. Key aspects of engagement include involving private sector actors, policy implementers, law enforcement agencies, community, traditional and religious leaders; building healthcare workers' capacity to deliver PEP effectively and sensitively; incorporating PEP into HIV prevention demand creation strategies; and addressing social norms and stigma to build community support.

There are examples of efforts in this direction from our countries. In Nigeria, local radio stations and community influencers have been engaged to raise awareness and promote acceptance of PEP; and in Zimbabwe, healthcare providers are receiving training to increase empathy and reduce judgement and stigma towards individuals eligible for PEP. Political support has proven a vital facilitator, as seen in Uganda, where government leaders endorsed PEP as part of the national HIV prevention agenda, opening the door to policy changes that support community-based PEP access. The private sector also plays a pivotal role, with pharmacies in Kenya and South Africa serving as alternative PEP access points, thus decentralizing its provision and increasing accessibility.

In addition to these efforts, we need enhanced monitoring, evaluation and learning, including developing partnerships for community-led monitoring (CLM) [13], among key populations, to ensure services are acceptable and effective.

2.7 | PEP and PrEP linkages

The aim of integrating PEP and PrEP within HIV prevention frameworks and strategies presents both significant opportunities and challenges. By linking these prevention tools, healthcare systems can provide individuals with a more comprehensive HIV prevention pathway, allowing for seamless transitions from emergency PEP usage to ongoing PrEP when appropriate. However, operationalizing this integration in the context of the new WHO recommendations and the emergent access to long-acting injectable PrEP requires adjustments in all the thematic areas discussed above.

One primary challenge is aligning national prevention guidelines with updated WHO recommendations that define PEP's role within broader HIV prevention strategies. Many existing national policies restrict PEP provision to occupational or sexual assault cases, limiting its use as a preventive measure. Another challenge is the lack of clarity in current guidelines about the transition from PEP to PrEP, particularly in settings where different healthcare providers handle each service. For effective implementation, guidelines must streamline the clinical decision-making process for healthcare workers, detailing

when and how to introduce PrEP to individuals completing a PEP course.

To bridge these policy gaps, we suggest integrating WHO guidelines into country-specific policies to clearly define the role of both PEP and PrEP. Our recommendations include updating national protocols to account for the unique needs of different risk profiles and emphasizing patient/user choice. This would involve updating standard operating procedures and prescription protocols to guide healthcare workers in supporting the effective transition from PEP to PrEP. MOSAIC has developed an adaptable PEP template guidelines for countries to review, develop and adapt their existing PEP guidelines to ensure alignment with the new recommendations [14]. The template guideline can be included into the existing PEP guidelines or as an addendum, depending on the country needs.

Training CHWs and other non-traditional providers, such as pharmacists, to dispense PEP and counsel on PrEP offers a pathway to increase coverage and reduce the burden on higher-level healthcare facilities. Uganda and Kenya are already pursuing these strategies, working to integrate CHWs into the continuum of care for PEP and PrEP services. Training modules that cover transition protocols, risk assessment and culturally sensitive communication techniques are crucial. Creating user-friendly risk assessment tools, both digital and manual, can also support healthcare workers in guiding patients through the transition from PEP to PrEP.

Finally, it is important to highlight the role of monitoring and evaluation in ensuring effective PEP-PrEP linkages through enhancing monitoring, evaluation and learning systems, including developing indicators and tools that capture client/user feedback on both interventions; strengthening pharmacovigilance and drug resistance monitoring systems for both PEP and PrEP; and employing CLM for accountability. These measures would help track the success of linkage efforts and identify areas for improvement.

3 | CONCLUSIONS

While there is a pressing need to revitalize PEP as a crucial component of HIV prevention, significant challenges remain in practical implementation, particularly in rolling out PEP in community settings and task-sharing. Expanding timely PEP access will require engagement across multiple stakeholders to meaningfully address awareness gaps, logistical and regulatory obstacles, and political will. It will require leveraging existing community resources and strengths to optimize local solutions. And it will require support for context-specific research and advocacy to ensure that expanded delivery channels provide options and choices to people. Our commentary highlights some good examples of efforts in these directions, but more clearly must be done. As national public health programmes work to update their guidelines and align with the new WHO recommendations, continued collaboration and innovation within and across countries will be essential to realize the full potential of PEP in comprehensive HIV prevention efforts.

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COMPETING INTERESTS

All authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

SM conceptualized the commentary and provided initial notes. JDA developed the first draft of the manuscript with significant inputs from SM. DB, MSH, JM and IM contributed additional inputs to the draft manuscript. All authors reviewed, edited and approved the final manuscript.

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Data sharing is not applicable to this article as no new data were created or analyzed in this study.

REFERENCES

1. Joint United Nations Program on HIV/AIDS. The urgency of now: AIDS at a crossroads. Geneva: Joint United Nations Programme on HIV/AIDS; 2024.
2. Kamya MR, Balzer LB, Ayieko J, Kabami J, Kakande E, Chamie G, et al. Dynamic choice HIV prevention with cabotegravir long-acting injectable in rural Uganda and Kenya: a randomised trial extension. Lancet HIV. 2024;11:e736–45.
3. Mayer KH, Allan-Blitz L-T. Post-exposure prophylaxis to prevent HIV: new drugs, new approaches, and more questions. Lancet HIV. 2023;10(12):e816–e24.
4. Allan-Blitz L-T, Mayer KH. Missed opportunities: a narrative review on why nonoccupational postexposure prophylaxis for HIV is underutilized. Open Forum Infect Dis. 2024;11(8):ofae332.
5. Auerbach JD, Malone S, Forsyth AD. Occupational post-exposure prophylaxis among healthcare workers: a scoping review of factors affecting optimal utilization. J Int AIDS Soc. 2024;27(8):e26341.
6. Ayieko J, Petersen ML, Kaya MR, Havlir DV. PEP for HIV prevention: are we missing opportunities to reduce new infections? J Int AIDS Soc. 2022;25(5):e25942.
7. Liu S, Yuan D, Zhou Y, Fu G, Wang B. Adherence, adverse drug reactions, and discontinuation associated with adverse drug reactions of HIV post-exposure prophylaxis: a meta-analysis based on cohort studies. Ann Med. 2023;55(2):2288309.
8. World Health Organization. Guidelines for HIV post-exposure prophylaxis. Geneva; 2024: Available from: https://www.who.int/publications/i/item/9789240095137. (Accessed 1 November 1, 2024).
9. Kennedy C, Dawit R, Yeh PT; World Health Organization. Guidelines for HIV post-exposure prophylaxis: web annex B: systematic review of findings and GRADE tables. World Health Organization; 2024.
10. Allan-Blitz L-T, Mayer KH. Updated guidelines on HIV post-exposure prophylaxis: continued efforts towards increased accessibility. J Int AIDS Soc. 2024;27:e26393.
11. Insights to Implementation. PEP: the forgotten HIV prevention intervention. Webinar. October 24, 2024; Available from: SSLN/i2i Webinar | PEP The

forgotten HIV prevention intervention | South to South Learning Network (Accessed 1 November, 2024)
12. MOSAIC. Synthesis of Post-Exposure Prophylaxis (PEP) Policies in MOSAIC Countries. Brief. June 2022. Available from: https://www.prepwatch.org/resources/synthesis-of-post-exposure-prophylaxis-pep-policies-in-mosaic-countries/. (Accessed 1 November, 2024).
13. Rambau N, Policar S, Sharp AR, Lankiewicz E, Nsubuga A, Chimhana L, et al. Power, data and social accountability: defining a community-led monitoring model for strengthened health service delivery. J Int AIDS Soc. 2024;27:e26374.
14. MOSAIC. PEP Template Guidelines (English). 6 January 2025. Available from: https://www.prepwatch.org/resources/pep-template-guidelines-english/. (Accessed 11 February 2025).

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COMMENTARY

How plausible is it that PEP would be cost-effective in sub-Saharan Africa?

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Introduction: Post-exposure prophylaxis (PEP) is an efficacious HIV prevention tool when used soon after a potential exposure. Understanding the drivers of cost-effectiveness of PEP in different contexts will likely play a role in determining local policies for providing PEP.
Discussion: The cost-effectiveness of PEP depends upon the likelihood of exposure to HIV, the transmission probability per sexual act and the efficacy of PEP, along with associated costs. The transmission probability per sex act will be greater in the first few acts in a partnership than on average across all acts owing to heterogeneity in the transmission probability between partnerships. In settings with high HIV prevalence and low treatment coverage, appropriately focused PEP is cost-saving. As treatment coverage improves, PEP can remain cost-effective with HIV prevalences above 15% with treatment coverage achieving 90:90:90 treatment targets. At 95:95:95 treatment levels, it is unlikely to be cost-effective. PEP is only cost-effective for the first few sex acts within a partnership. The cost-effectiveness of PEP is sensitive to assumptions about the proportion of the population of partners with unsuppressed HIV, the pattern of mixing of those with unsuppressed virus, the transmission probability per sexual act, PEP efficacy, the costs of PEP and the value attached to preventing HIV acquisition. Where possible local parameters should be used in evaluating PEP cost-effectiveness in our model.
Conclusions: We illustrate the use of simple calculations to define the cost-effectiveness of PEP. In populations where there is a high prevalence of unsuppressed HIV, PEP is likely to be cost-effective but only if used for one off sexual encounters and the first few sex acts within a partnership.

Keywords: cost-effectiveness analysis; HIV; mathematical modelling; post-exposure prophylaxis; sub-Saharan Africa; transmission probabilities

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1 | INTRODUCTION

Despite the lack of randomized controlled trials, it is clear that efficacious antiretroviral treatment shortly after exposure to HIV—post-exposure prophylaxis (PEP)—can prevent HIV acquisition [1]. Unfortunately, this approach to HIV control has been underrecognized, underused and poorly implemented. WHO guidelines from 2024 [2] that recommend community and pharmacy access to PEP aim to make PEP more widely available and more effective. In developing these guidelines, a systematic review of PEP costs and cost-effectiveness generated little evidence [3]. Nonetheless, economic considerations will inform policy decisions about the wider use of PEP, and it is possible from empirical observation of HIV epidemiology and first principles to estimate the likely cost-effectiveness of PEP and in what circumstances its use will be worthwhile.

Initial evidence of the protective effect of PEP was found in a retrospective case-control study with PEP recommended and used to prevent occupational exposure to HIV [4]. This was expanded to use among those exposed to sexual violence, and as more efficacious and less toxic antiretroviral drugs have become available, use has expanded to broader types of HIV exposure. The currently preferred first-line antiretroviral treatment tenofovir, lamivudine and dolutegravir (TLD) is recommended for PEP with a 28-day course.

The cost-effectiveness of PEP was explored in a 1998 study of the US context, where the cost of the regimen was $805 and a cost per Quality Adjusted Life Year threshold of $50,000 was used [5]. PEP was found to be cost-effective for receptive anal intercourse, but not for insertive anal and vaginal intercourse. The only study of the cost-effectiveness of PEP in the context of sub-Saharan Africa, from 2023, explored community availability of TLD for treatment, oral pre-exposure prophylaxis (PrEP) and PEP, and found that in most scenarios, it would be cost-effective at the population level [6].

In this commentary, we show how the cost-effectiveness of PEP can be approximated with simple equations, review the parameters for these equations and illustrate the circumstances in which PEP would and would not be cost-effective.

2 | DISCUSSION

2.1 | Equations describing the cost-effectiveness of PEP

The cost-effectiveness of PEP will be a function of how likely someone using it was actually exposed to HIV, what the likelihood of acquiring HIV from an exposure is, how likely PEP is to avert that acquisition, the costs of PEP and the lifetime costs of HIV acquisition. The likelihood of exposure is a function of the distribution of viral load among contacts and the likelihood of transmission upon exposure is a function of the route of exposure and presence or absence of a range of cofactors.

In assessing the cost-effectiveness of PEP, a useful metric is the number needed to treat (NNT), that is the number of PEP uses to prevent one acquisition of HIV. Normally, the NNT is derived from a specific trial based on the number of incident events averted by the treatment [7]. However, from first principles, a general NNT can be derived from the efficacy of a treatment and the incidence of HIV acquisition, and is given by:

$$NNT = 1/(r.e), \quad (1)$$

where e is the efficacy of PEP and r is the risk of HIV acquisition for a particular unprotected exposure in the absence of PEP.

This risk r can be summarized by the equation:

$$r = P.(1-s).m.\beta, \quad (2)$$

where P is the prevalence of HIV in the sexual partner pool, s is the proportion of people living with HIV (PLHIV) who are virally suppressed, m a term representing an increased (or decreased) chance that a partner is living with HIV and unsuppressed based on patterns of risk behaviour and β represents the transmission probability per act for HIV. We assume there is no transmission from those who are virally suppressed. More details of the complexity summarized by these parameters are presented below.

The cost per HIV acquisition averted C is given by: C = NTT.k, where k is the cost per PEP episode.

The cost per acquisition averted can be compared with the costs of treating an HIV case and the disability-adjusted life-years (DALY) associated with a case to determine whether PEP is cost-saving or cost-effective at a given threshold. The cost per DALY averted A is given by:

$$A = (C-T)/D \quad (3)$$

where T is the lifetime cost of treating someone for HIV and D is the DALYs associated with an HIV acquisition.

The impact in terms of number of HIV acquisitions averted H is given by:

$$H = N.r.e, \quad (4)$$

where N is the number of PEP users, which is determined by the product of the population at risk, the proportion using PEP and the frequency of use per year. Note that impact is not a function of cost or cost-effectiveness, but of the budget impact, which is the product of number of people using PEP and the cost per episode of PEP.

The cost-effectiveness of PEP calculated above is only an approximation, as it does not account for changes in HIV prevalence associated with a PEP programme, or the knock-on benefits from each new person not acquiring HIV averting further acquisitions among their contacts.

2.2 | The prevalence of unsuppressed PLHIV in the partner pool

HIV prevalence by age and sex is estimated by UNAIDS [8]. These prevalence estimates can be combined with estimates for viral suppression among PLHIV from routine clinical data or population-based surveys [9]. Even when treatment coverage is high, there can be moderately high prevalences of unsuppressed PLHIV [10].

2.3 | HIV viral loads and the HIV transmission probability

Empirical data suggest that HIV is not transmitted when the HIV viral load is below 1000 copies per ml [11]. In a review of surveys [8], the average viral load of those unsuppressed was around 10,000 copies per ml. If viral load testing uses a threshold of 1000 copies per ml, most of those with viraemia will be able to transmit, whereas if the more precise thresholds of 50 and 400 which are now sometimes used in clinical management are used, then not all those classified as unsuppressed would be able to transmit the virus. If we define the community viral load as the proportion of the population with an unsuppressed virus (rather than the mean level of viraemia), then the community viral load is the product of the prevalence of HIV and the proportion of unsuppressed PLHIV ($P.(1-s)$ in Equation 2). The average transmission probability per act of HIV-1 measured in retrospective and prospective studies of heterosexual couples is around 1 in a thousand [12–14] with an order of magnitude higher probability for anal intercourse, including among men who have sex with men (MSM) [15]. However, when considering one-time sex acts, particularly with new sexual partners, this average value is misleading [12, 16, 17].

There is heterogeneity in the risk of transmission driven by many variables, including type of sex (receptive and insertive, vaginal and anal), viral load of the partner, the presence of genital ulcer disease, male circumcision status, age and sexual maturity [12–14]. This heterogeneity between partnerships meant that initial studies of HIV transmission found no correlation between the number of sexual exposures within a partnership and HIV transmission [18]. This can be explained by a majority of HIV serodifferent sexual partnerships involving a low risk of transmission per act with only a minority of such partnerships involving a high risk of transmission [16, 17]. The average transmission probability measured from stable partnerships records many acts with no transmission in low-risk partnerships and few acts before transmission in high-risk

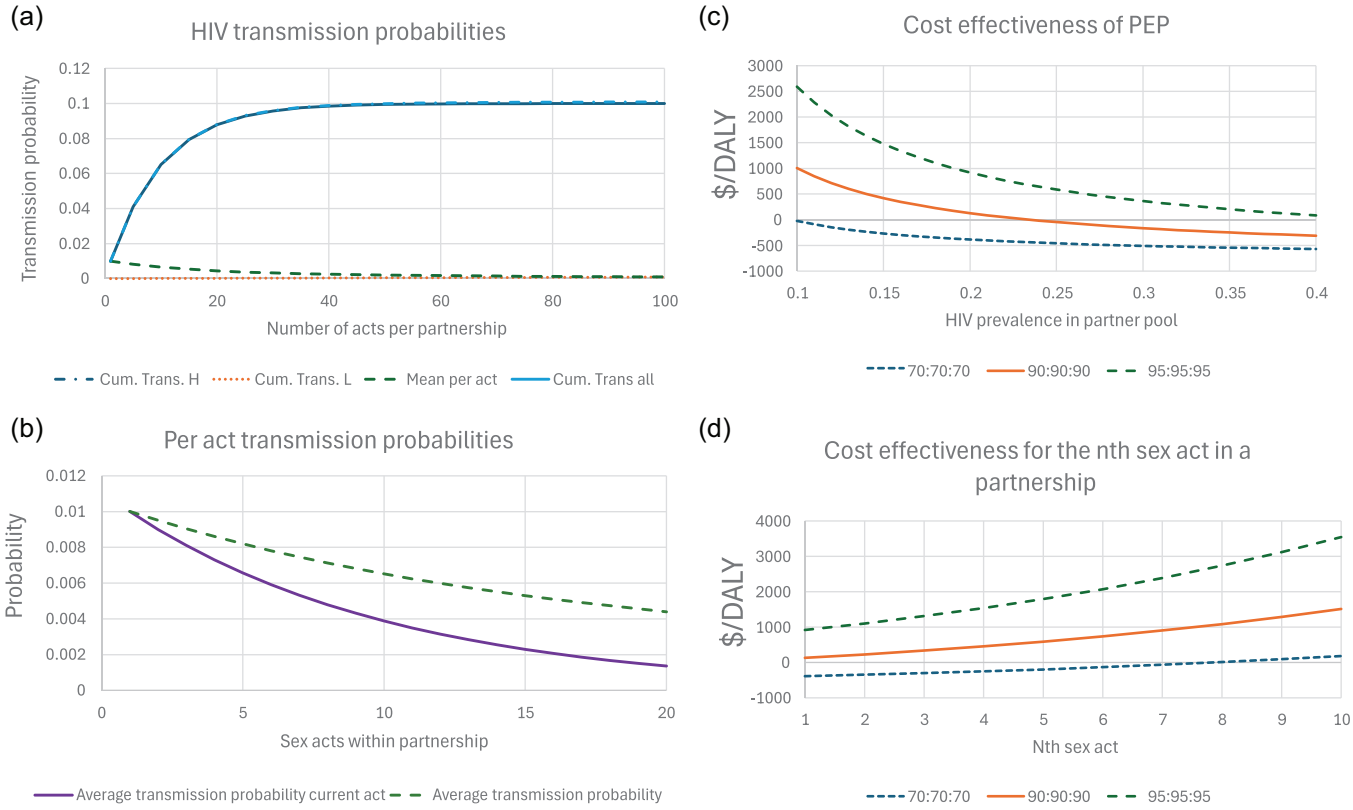

Figure 1. The relationship between unsuppressed HIV virus, the per act HIV transmission probability and the cost-effectiveness of post-exposure prophylaxis PEP. (a) The HIV transmission probability as a function of the number of condomless sexual acts in a partnership when 10% of partnerships have a transmission probability per act of 0.1 and 90% of 0.0001. The transmission probability among the 10% of high-risk partnerships, 90% of low-risk partnerships and all partnerships is shown along with the average transmission probability per act. (b) The average transmission probability per act and the transmission probability in the current act for the *n*th condomless sex act in a partnership is shown when 10% of partnerships have a transmission probability of 0.1 and 90% of 0.0001. (c) The cost-effectiveness of an episode of PEP used after the first condomless sex act in a partnership as a function of HIV prevalence in the partner pool. The cost in dollars per DALY averted is shown when treatment coverage has suppressed virus in 34.3%, 72.9% and 85.7% (in the language of UNAIDS targets 70:70:70, 90:90:90 and 95:95:95). The transmission probability per sex act is 0.010009, the mixing parameter $m = 1.5$, efficacy is 70%, the cost per episode of PEP is $10, the lifetime cost of HIV treatment is $15,0000 and each new HIV acquisition incurs 20 DALYs. (d) The cost-effectiveness of an episode of PEP used in the *n*th condomless sex act within a partnership for three levels of viral suppression.

partnerships, biasing estimates to a lower transmission probability.

Boily and colleagues [13] found transmission probabilities to be greater 0.0087 for females to males and 0.0019 for males to females in low- and-middle-income countries (LMICs). There was much heterogeneity in estimates, with being uncircumcised increasing the probability three- to eight-fold and an early-stage infection increasing risk by nine-fold compared to the asymptomatic stage.

A model of transmission is illustrated in Figure 1a where in 10% of partnerships the transmission probability is 0.1 per act and in 90% of partnerships it is 0.00001 per act. The first act has an average transmission probability 0.01009. The average transmission probability per act falls as acts accumulate, after four acts, the average per act transmission probability is 0.0087, as observed for female-to-male transmission in LMICs, and is 0.0019 after 53 acts as observed for male-to-female transmission in LMICs. Because transmission is occurring early in risky partnerships and not in other partnerships, the average transmission probability falls as acts increase. The average transmission probability per current act across partnerships falls faster than the average across partnerships for cumulative acts (Figure 1b); starting at over 0.01, it is around 0.004 after 10 acts and 0.0014 after 20 acts in the partnership.

2.4 | Patterns of mixing

The likelihood that a one-time sexual contact is with someone living with HIV who has an unsuppressed virus is a function of the proportion of short-lived sexual partnerships among those virally unsuppressed. This depends on not only the fraction of the population that is viraemic but also whether they are more or less likely to be engaged in such partnerships, which depends on the number of such partnerships they form and the pattern of sexual mixing they have with groups seeking PEP. The value m in Equation (2) weights the likelihood that a contact is viraemic. If mixing is random, then

the probability of a new partnership being with someone who is virally unsuppressed is given by $P(1-s).f_v/F$ where $P(1-s)$ is the proportion of the population virally suppressed, f_v is the rate of new partnership formation by those virally suppressed and F is the mean rate at which all people in the partner pool form partnerships.

In addition, there is an influence of how people mix sexually according to social, cultural and demographic variables. It is likely that those virally unsuppressed have characteristics correlated with some of these variables. Patterns of sexual mixing can vary on a scale from assortative (like with like) through random, matching the proportion of partnerships created by a group, to disassortative (like with unlike). Using a parameter, ε, to define the assortativeness of mixing where $\varepsilon = 0$ is assortative mixing and $\varepsilon = 1$ is random mixing, the likelihood a partner being viraemic is $\varepsilon P(1-s)f_v/F$ [17]. This allows us to define m as $m = \varepsilon f_v/F$ since the fraction of the population virally unsuppressed is already included in the numerator of Equation (2).

2.5 | Efficacy of PEP

In the original case-control study where zidovudine was used for PEP, its efficacy was estimated to be 79% [4], in a subsequent study of non-occupational exposure to HIV among MSM in Brazil, efficacy seems to have been 88% [19]. In a review of other clinical studies [1] of 2692 PEP courses, only one seroconversion is recorded in someone with multiple high-risk exposures before and after starting PEP. Efficacy will depend on how soon after exposure PEP is used and whether the course is completed. In our analyses, we assume a PEP efficacy of 70% but also look at the influence of greater or lesser efficacy.

2.6 | Costs

In low-income countries, there have been few studies of the cost of PEP. In a paper modelling, the community availability of TLD for PEP, PrEP and treatment, Phillips and colleagues [6] assumed a cost of PEP of $19 based on 3 months of TLD. This assumed more than 28 days of the drug and did not measure the costs of delivery. In a pilot study of PEP distribution by pharmacists in Kenya, the financial cost of PEP to the provider was $9.34 per client among 162 clients [20].

The costs of treatment vary greatly across countries and depend on the costs that are included, and for a lifetime of treatment, the discount rate is assumed. For ease of illustration, we assume that treatment costs $500 per person per year and is needed for 30 years, adding to $15,000 for a lifetime. The DALYs associated with an HIV acquisition depend upon the age at which the infection is acquired, the years of life lost by those acquiring infection and the disability weight attached to living with HIV.

3 | RESULTS

The cost-effectiveness of PEP when used in the first condomless sex of a partnership is illustrated (Figure 1c) as a function of HIV prevalence for three different treatment levels: 70:70:70, 90:90:90 and 95:95:95. The numbers here represent the percentage of PLHIV diagnosed, the percentage of those diagnosed in a treatment programme and the percentage of those "on treatment" who are virally suppressed. These levels equate, respectively, to 34.3%, 72.9% and 85.7% virally suppressed. PEP is more cost-effective when treatment coverage is lower, being cost-saving when HIV prevalence is 1% and viral suppression is only 34.3%. At 95:95:95, it only becomes cost-effective at the $500 per DALY threshold at 27% prevalence. It should be remembered that the relevant prevalences determining whether PEP is warranted are for the local partner pool, so even if average treatment coverage is high, it might still be low in groups from which partners are selected, such as MSM, sex workers or particular demographic groups.

The cost-effectiveness of PEP declines as it is used over more condomless sex acts in a partnership or in later condomless sex acts in a partnership. Figure 1d illustrates the cost-effectiveness of PEP in the nth sex act in a partnership when HIV prevalence in the partner pool is 20% for the three treatment coverage levels. When 72.9% of PLHIV are suppressed, the cost-effectiveness for the first sex act is $128/DALY but it has risen over $500/DALY by the fifth sex act.

This has implications for the design and messaging around a PEP programme. It is most likely to be cost-effective if PEP is used by those who have had a one off condomless sexual encounter, or very few condomless sex acts with a new partner, and not cost-effective if used occasionally by those in longer-term partnerships. In such partnerships, the use of PEP in the first few unprotected acts could be cost-effective.

Using the equations, one can explore the sensitivity of results to parameter values. For example, anchoring on 20% prevalence, 72.9% viral suppression, m = 1.5, transmission per act = 0.010009, efficacy of 70%, costs of PEP of $10 per episode, lifetime treatment costs of HIV of $15,000 and 20 DALYs incurred for each HIV acquisition, the cost-effectiveness of PEP is $128 per DALY. A decrease in prevalence to 10% changes this to $1006 per DALY, and an increase in prevalence to 30% changes it to −$165/DALY.

Impact is a linear function of the number of people using PEP in the right context. Using the anchor assumptions above, the number of PEP episodes for the first unprotected acts to prevent one HIV acquisition is 1756 (so the cost per acquisition averted is $17,566). PEP use 10,000 times would prevent 5.7 HIV acquisitions.

4 | CONCLUSIONS

It can be seen how the local context of HIV prevalence, sexual mixing, the rapidity with which PEP is accessed, and the costs of PEP, HIV treatment and the burden of an HIV acquisition greatly influence whether PEP is cost-effective. Estimates of unsuppressed virus in potential partners, as illustrated by Joseph et al. [10], could be used by decision-makers to assess the value of a PEP programme.

Our findings diverge from Phillips and colleagues [6], who fitting a complex model to epidemic trends found PEP cost-effective in most scenarios. Our results allow for an explicit exploration of the role of parameters, whereas Phillips and colleagues derive scenarios fitting to quite high levels of HIV

incidence, largely because the data include studies dating back to 2017, while incidence has recently fallen sharply in the region. Their median model estimate for incidence of 0.5% across both sexes is higher than the current UNAIDS estimates for all countries in the region.

In general, high HIV prevalence or low levels of viral suppression in particular partner groups make a PEP programme worthwhile. However, to be cost-effective, such a programme should focus on the first few unprotected sex acts within partnerships. For efficacy and impact, making PEP easily accessible is warranted, but messaging about who will benefit from PEP should focus on one-time sexual encounters and the first few condomless sex acts with new partners.

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COMPETING INTERESTS

GPG is an employee of the Gates Foundation and PG-F has received Grants from the Gates Foundations.

AUTHORS' CONTRIBUTIONS

The commentary was co-conceived by PG-F and GPG. GPG defined and explored the calculations. GPG and PG-F both drafted the commentary.

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DISCLAIMER

The views in this commentary are those of the authors and do not necessarily represent the position of the Gates Foundation.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

REFERENCES

1. Mayer KH, Allan-Blitz L-T. Post-exposure prophylaxis to prevent HIV: new drugs, new approaches, and more questions. Lancet HIV. 2023;10(12):e816–24.
2. World Health Organization. Guidelines for HIV post-exposure prophylaxis. Geneva; 2024.
3. Kennedy C, Dawit R, Yeh PT. Web annex B. Systematic review findings and grade tables. In: Guidelines for HIV post-exposure prophylaxis. Geneva: World Health Organization; 2024.
4. Cardo DM, Culver DH, Ciesielski CA, Srivastava PU, Marcus R, Abiteboul D, et al. A case-control study of HIV seroconversion in health care workers after percutaneous exposure. N Engl J Med. 1997;337:1485–90.
5. Pinkerton SD, Holtgrave DR, Bloom FR. Cost-effectiveness of post-exposure prophylaxis following sexual exposure to HIV. AIDS. 1998;12:1067–78.
6. Phillips AN, Bansi-Matharu L, Shahmanesh M, Hargreaves J, Smith J, Revill P, et al. Potential cost-effectiveness of community availability of tenofovir, lamivudine and dolutegravir for HIV prevention and treatment in east, central, southern, and west Africa: a modelling analysis. Lancet Glob Health. 2023;11:e1648–57.
7. Smeeth L, Haines A, Ebrahim S. Numbers needed to treat derived from meta-analyses – sometimes informative, usually misleading. BMJ. 1999;318:1548–51.
8. UNAIDS. The urgency of now: AIDS at a crossroads. Geneva: Joint United Nations Programme on HIV/AIDS; 2024.
9. Hladik W, Stupp P, McCracken SD, Justman J, Ndongmo C, Shang J, et al. The epidemiology of HIV population viral load in twelve sub-Saharan African countries. PLoS ONE. 18(6):e0275560.
10. Joseph RH, Obeng-Aduasare Y, Achia T, Agedew A, Jonnalagadda S, Katana A, et al. Beyond the 95s: what happens when uniform program targets are applied across a heterogenous HIV epidemic in Eastern and Southern Africa? PLOS Glob Public Health. 2024;4(9):e0003723.
11. Broyles LN, Luo R, Boeras D, Vojnov L. The risk of sexual transmission of HIV in individuals with low-level viraemia: a systematic review. Lancet. 2023;402:464–71.
12. Powers KA, Poole C, Pettifor A, Cohen MS. Rethinking the heterosexual infectivity of HIV-1: a systematic review and meta analysis. Lancet Infect Dis. 2008;8:553–63.
13. Boily M-C, Baggaley RF, Wang L, Masse B, White RG, Hayes R, et al. Heterosexual risk of HIV-1 infection per sexual act: a systematic review and meta-analysis of observational studies. Lancet Infect Dis. 2009;9(2):118–29.
14. Fox J, White PJ, Weber J, Garnett GP, Ward H, Fidler S. Quantifying sexual exposure to HIV within an HIV-1 serodiscordant relationship: development of an algorithm. AIDS. 2011;25:1065–82.
15. Baggaley RF, White RG, Boily MC. HIV transmission risk through anal intercourse: systematic review, meta-analysis and implications for HIV prevention. Int J Epidemiol. 2010;39:11048–1063.
16. Rottingen JA, Garnett GP. The epidemiological and control implications of HIV transmission probabilities within partnerships. Sex Transmit Dis. 2002;29:818–27.
17. Garnett GP, Anderson RM. Factors controlling the spread of HIV in heterosexual communities in developing countries: patterns of mixing between different age and sexual activity classes. Philos Trans Roy Soc Lond B. 1993;342:137–59.
18. Peterman TA, Stoneburner RL, Allen JR, Jaffe HW, Curran JW. Risk of human immunodeficiency virus transmission from heterosexual adults with transfusion-associated infections. JAMA. 1988;259(1):55–8.
19. Schechter M, do Lago RF, Mendlsohn AB, Moreira RI, Moulton LH, Harrison LH. Behavioral impact, acceptability and HIV incidence among homosexual men with access to postexposure chemoprophylaxis for HIV. J Acquir Immune Defic Syndr. 2004;35:519–25.
20. Ekwunife O, Kuo AP, Banerjee P, Kiptinness C, Omollo V, Chen Y, et al. Understanding the cost of pharmacy delivered HIV pre- and post-exposure prophylaxis services in Kenya: findings from a pilot study. Poster. Institute for Disease Modeling Symposium 2024, Seattle, WA.

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SHORT REPORT

Untapped potential of post-exposure prophylaxis in sub-Saharan Africa: a comparative analysis of PEP implementation planning in Kenya, Mozambique, Nigeria, Uganda and Zambia

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Abstract

Introduction: In 2023, over 210,000 new HIV acquisitions occurred in Kenya, Mozambique, Nigeria, Uganda and Zambia. While uptake of oral pre-exposure prophylaxis (oral PrEP) and coverage of voluntary medical male circumcision increased significantly over the past decade, post-exposure prophylaxis (PEP) has received less attention and remains an underused HIV prevention intervention. In 2024, the World Health Organization (WHO) released new guidance emphasizing the need for timely access to PEP, including through community-based channels and task-sharing to mitigate barriers such as stigma and ensure timely access. We conducted a comparative analysis of PEP implementation planning to understand how PEP is currently integrated into HIV prevention programmes, and to identify barriers and opportunities for optimizing the impact of PEP in the method mix.

Methods: We analysed Global Fund country proposals from Grant Cycle 6 (GC6) (2021–2023) and Grant Cycle 7 (GC7) (2024–2026) for five countries in Africa with high HIV burden and established PrEP programmes: Kenya, Mozambique, Nigeria, Uganda and Zambia. To understand how PEP implementation planning evolved across these two cycles, we used quantitative and qualitative analysis to identify trends. We extracted all PEP activities, coding them by focal population and activity type.

Results: We found over a five-fold increase in the number of PEP activities in GC7 compared to GC6, where there were only 10 PEP activities, and an expanded population focus, including people in prisons and pregnant and breastfeeding people. Proposals increasingly emphasized PEP not only as an intervention for occupational and sexual violence exposures but as a vital component of comprehensive HIV prevention strategies. Proposals described strategies for increasing access to PEP through differentiated service delivery models, including community-led and pharmacy-delivered approaches. However, PEP activities were not well defined, with PEP often included in product lists without articulating product-specific activities to address barriers or increase access.

Conclusions: All five countries demonstrated an increased focus on PEP from GC6 to GC7. While this reflects an ambition to expand access to PEP, product-specific activities were not clearly articulated. Practical guidance and tools, as well as focused cross-country learning to support the operationalization of WHO's recommendations, will be critical to increasing access and achieving impact.

Keywords: adolescent girls and young women; combination HIV prevention; differentiated service delivery; key populations; post-exposure prophylaxis; sub-Saharan Africa

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1 | INTRODUCTION

Despite progress in the HIV response in low- and middle-income countries, access to HIV prevention remains inadequate. 1.3 million new HIV acquisitions globally in 2023 demonstrate that not enough people have access to acceptable, effective prevention [1]. Although programmes are increasingly scaling pre-exposure prophylaxis (PrEP),

the focus on post-exposure prophylaxis (PEP) has been limited.

PEP was recommended by the World Health Organization (WHO) for occupational exposures in 2006 and then non-occupational exposures in 2013 [2–5]. WHO released its first PEP-specific guidelines in 2014 and most recently updated them in 2024 [6–8]. WHO's updated guidelines emphasize the need to support timely access to PEP, with recommendations for task-shifting or sharing and community-based delivery.

Despite WHO recommendations, there is limited research on PEP planning and implementation. There is also limited quantitative data available on use and impact, and no data tracked through the Global Fund or The President's Emergency Plan for AIDS Relief (PEPFAR) [9, 10]. Recent modelling estimating the impact of community PEP in Africa assumed current PEP use to be negligible [11]. While there is no data on the total addressable market, studies suggest significant unmet need. One study offering HIV prevention through online pharmacies in Kenya found PEP uptake was over seven times higher than PrEP uptake, despite the focus of demand creation on PrEP [12]. The study also found nearly all clients requested PrEP despite being recently exposed to HIV, suggesting low awareness of PEP [12].

In light of the new WHO guidelines and limited existing research, there is a need to take stock of how PEP has been integrated into prevention programmes. Countries are continuing to invest in PrEP, including differentiated and de-medicalized service delivery. However, without a clear understanding of gaps and needs for PEP implementation, we risk missing an opportunity to maximize the impact of an intervention already widely available and highly affordable.

To assess trends in PEP implementation planning, we analysed Global Fund funding requests in Kenya, Mozambique, Nigeria, Uganda and Zambia. These countries accounted for 16% of new HIV acquisitions and >50% of people who received PrEP globally in 2023 [1, 9]. All five also have growing PrEP programmes—the number receiving PrEP increased by 40% from 2022 to 2023 [1, 9]. Based on increases in funding for PrEP and access to PrEP Matching Funds—an investment from the Children's Investment Fund Foundation (CIFF) to incentivize PrEP scale-up through the Global Fund—we anticipate further PrEP expansion [13, 14]. Understanding PEP implementation planning trends within these high-volume, growing prevention programmes may provide lessons for nascent markets. By focusing on five countries at the leading edge of prevention scale-up, we aimed to identify lessons from PEP implementation planning that can inform HIV programmes more broadly in the region.

2 | METHODS

We analysed publicly available funding requests for Global Fund Grant Cycle 6 (GC6) (2021–2023) and Grant Cycle 7 (GC7) (2024–2026) from Kenya, Mozambique, Nigeria, Uganda and Zambia [10]. Global Fund funding requests outline activities to be funded within the Global Fund allocation, serving as implementation plans for the 3-year grant cycle. Governments develop funding requests through collaborative processes involving civil society, key and vulnerable populations, private sector, donors and technical partners, among others. While the Global Fund constitutes only a portion of overall HIV programming, these requests reflect national priorities and provide a basis for analysing implementation plans through a standard format [15]. The countries included in this analysis were selected based on their large existing PrEP programmes and eligibility for the CIFF-Global Fund PrEP Matching Funds [14].

Quantitative analysis evaluated the frequency of PEP-related activities within prevention modules of each funding request by extracting unique activities that referenced PEP, and coding activities by country and grant cycle. PEP activities were further categorized by type (service delivery, training and sensitization, commodity procurement, demand creation and awareness, policy and advocacy) and population. The data were analysed to obtain a descriptive summary of frequencies, trends, and differences by country and time period. We did not include mentions of PEP in other sections of the country proposals, such as above-allocation requests to focus only on budgeted activities.

This study was a review of publicly available implementation plans and did not involve human subjects research.

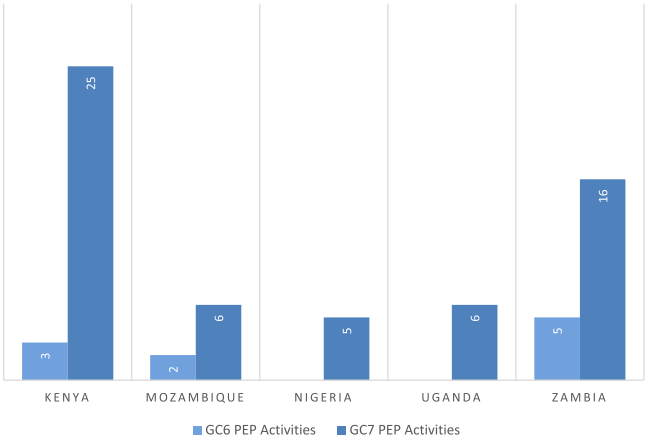

Figure 1. Number of PEP activities in funding requests by country and grant cycle. Abbreviations: GC6, Global Fund Grant Cycle 6; GC7, Global Fund Grant Cycle 7.

3 | RESULTS

There was an increase in the focus on PEP between grant cycles, based on the activity count shown in Figure 1. In GC6, two countries (Nigeria and Uganda) did not include any PEP activities, while the other three countries (Kenya, Mozambique and Zambia) each included fewer than five. Across all five countries, the total number of PEP activities increased from 10 to 58 (over a five-fold increase) from GC6 to GC7, with the greatest increase in Kenya, from three PEP activities in GC6 to 25 in GC7, a nearly eight-fold increase.

Qualitative analysis of PEP activities found a broader population focus in GC7 compared to GC6, shown in Table 1. In GC6, PEP activities were focused within key population (KP) interventions, often within post-violence services in

Table 1. Focal populations for PEP activities by country and grant cycle with example activities

Country	Grant cycle	Populations	Example activity
Kenya	GC6	• KPs: SWs, MSM, PWID, TGs, with an additional specific reference to young KPs • Healthcare workers	"Proposed activities under this intervention include Hepatitis B vaccination for healthcare workers; availability of PEP at all clinics and health centres; and availability of personal protective equipment at the facility level."
	GC7	• KPs: SWs, MSM, PWID, TGs • People in prisons and other closed settings • AYP • Other vulnerable populations: fisherfolk, serodiscordant couples, truckers	"Capacity building of MSM-led organizations on digital prevention approaches to improve demand creation for PrEP and PEP, event-driven and other new prevention technologies."
Mozambique	GC6	• KPs: SWs, MSM	"Offering post-exposure prophylaxis according to national standards."
	GC7	• KPs: SWs, MSM, TGP • People in prisons and other closed settings • AGYW • Other vulnerable populations: Truckers, internally displaced people, seasonal workers	"Screening, testing and treatment of asymptomatic STIs, including periodic serological testing for syphilis infection, delivery of cervical and anal cancer screening and linkages, emergency contraception, and PEP."
Nigeria	GC6	*N/A—No PEP activities in GC6*	
	GC7	• KPs: SWs, MSM, TG, PWID • People in prisons and other closed settings	"Develop national prevention strategies, plans and programmes for access and uptake of HIV prevention tools including PrEP (various modalities) and PEP."
Uganda	GC6	*N/A—No PEP activities in GC6*	
	GC7	• KPs: SWs, PWID • AGYW • Pregnant and breastfeeding people	"The country will also invest in provision of post-violence counselling, referrals and linkages to PEP, clinical investigations, legal services, medical management, clinical care, and psychosocial support."
Zambia	GC6	• KP: SWs, MSM, PWID, TGs • AYP	"Services at one stop centres include: HIV testing, emergency contraceptive, PEP and linkage to legal support for sexual violence victims, medical & surgical care with referral legal services for physically traumatized/assaulted victims, counselling to victims for relationships and psychosocial support."
	GC7	• KPs: SWs, MSM, PWID, TGs • People in prisons and other closed settings • AYP • Pregnant and breastfeeding people • Other vulnerable populations: mobile populations, miners, truck drivers, orphans and vulnerable children, people with disabilities	"Build capacity of prisons HCWs and staff on delivery of prisoner-friendly PrEP and PEP services."

Note: Between grant cycles, there was a notable shift in activity type, moving towards broader integration of PEP into combination prevention packages, as shown in Figure 2. In GC6, PEP activities focused primarily on training, service delivery and commodity procurement. GC7 proposals demonstrated more structured, integrated approaches to implementation planning. For example, activities included key aspects for PEP delivery, such as demand creation, sensitization, and policy and advocacy. In GC7, PEP and PrEP were more frequently mentioned together, with both Kenya and Zambia including PEP alongside nearly every PrEP mention.
Abbreviations: AGYW, adolescent girls and young women; AYP, adolescents and young people; GC6, Global Fund Grant Cycle 6; GC7, Global Fund Grant Cycle 7; KPs, key populations; MSM, men who have sex with men; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; PWID, people who inject drugs; SWs, sex workers; TGs, transgender people.

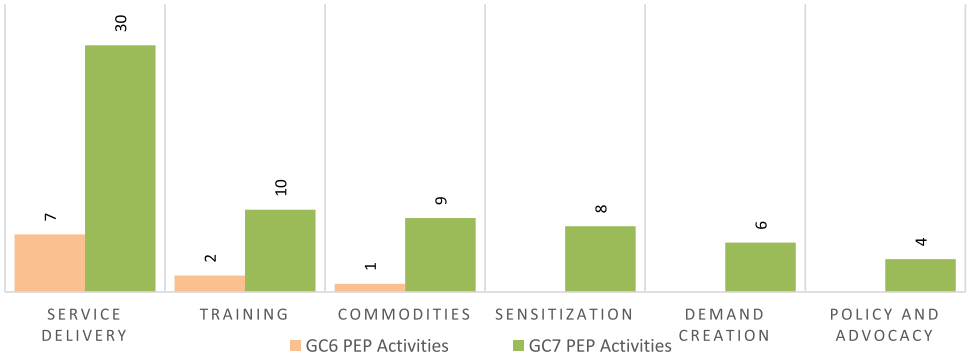

Figure 2. PEP activity type by grant cycle. *Notes*: Service delivery refers to the direct provision or offer of PEP. Training refers to capacity building and/or training provision to providers. Commodities refers to commodity procurement. Sensitization refers to providing information and education and building awareness to lay people, peers and/or healthcare providers who do not offer PEP but would link end users to PEP services. Demand creation refers to activities focused on generating demand for PEP. Policy and advocacy refers to activities to develop policies, strategies, plans or management structures to support PEP delivery. Abbreviations: GC6, Global Fund Grant Cycle 6; GC7, Global Fund Grant Cycle 7.

drop-in centres or one-stop-shops. In GC7, new population groups were included in PEP-related activities. Kenya, Mozambique, Nigeria and Zambia included PEP activities for people in prisons and other closed settings. Uganda and Zambia included PEP for pregnant and breastfeeding people. Kenya, Mozambique and Zambia included PEP activities in prevention packages for a range of "other vulnerable populations," including fisherfolk, serodiscordant couples, truckers and mobile populations. PEP programming in GC7 also had a stronger focus on interventions for adolescent girls and young women or adolescents and young people, with four countries (Kenya, Mozambique, Uganda and Zambia) including these populations in GC7 versus only two in GC6 (Kenya and Zambia). Uganda was the only country that did not include any PEP-related activities in their package of services for men who have sex with men or transgender people in GC7, despite including a range of PrEP-related activities for this population.

4 | DISCUSSION

This analysis aimed to assess Global Fund PEP implementation planning across five countries with large, growing PrEP programmes. We observed a significant increase in the focus on PEP between grant cycles, across three dimensions investigated: number of PEP activities, populations and activity type. In GC7, PEP was treated as one intervention among a growing portfolio of prevention options and was often listed alongside various PrEP products. In contrast, GC6 PEP activities were primarily grouped within packages of care for post-violence services or occupational exposures but not broader prevention packages. Increased focus on PEP alongside other PrEP products suggests that PEP may be benefiting from the growing commitment to expanding choice in prevention. This aligns with emerging themes in the literature—several recent studies investigated preferences or choice of PEP alongside PrEP options [11, 16–18].

Despite the increase in PEP-related activities, few activities addressed product-specific barriers or needs. While some activities referenced linkages between PEP and PrEP at a high level, funding requests did not clearly articulate the role of PEP in prevention packages. This aligns with a recent analysis of PEP policies across eight sub-Saharan African countries, which found gaps and inconsistencies in how PEP is included in guideline and policy documents [19]. No country included the concept of "PEP-in-pocket" or referenced PEP as a prevention option among people with infrequent exposures in their funding requests, suggesting that these concepts have not been translated from research into implementation.

This analysis has key limitations. First, although Global Fund funding requests are developed collaboratively to reflect country priorities, they may not capture the full scope of programming in the country. Interventions funded by governments or other donors may be omitted from Global Fund funding requests to avoid duplication. Second, while funding requests are reviewed and approved by the Global Fund, activities may shift during implementation. This analysis did not evaluate how PEP activities were executed. This analysis also did not assess the budget allocated towards PEP—this is an area for future research. Next, although funding requests used a template that facilitated comparison across countries, some elements of the funding requests were flexible. For example, some countries grouped KP activities in a single module, while others included separate modules for each KP group. Grouping KP activities might result in fewer mentions of PEP but does not necessarily indicate lower prioritization. Finally, there is a critical gap in quantitative data on PEP use and no data available on PEP uptake from GC6 through the Global Fund. In addition, to date, countries have not set PEP targets as part of Global Fund implementation planning. Although PEP is referenced as part of prevention packages in Global Fund guidance, there are no PEP-specific indicators included in the Global Fund's core list of indicators for HIV [20]. In 2023, both PEP and PrEP are listed as "HIV programme essentials" in Global Fund guidance for the first time, requiring countries to outline implementation progress [21]. However, the absence of PEP data presented in GC7 funding requests suggests there may be country-level data gaps and with no Global Fund indicator for PEP use, it is unclear whether this data will be reported in the future.

Similarly, there is no PEP data reported globally through UNAIDS or PEPFAR.

Without further analysis of other variables that impact PEP implementation, including budget, geographical coverage and targets, it is not possible to map the full scope of PEP programming across these countries. Moreover, with major shifts in foreign aid, including PEPFAR funding cuts, we may see greater variance in activities included in funding requests and interventions implemented, as governments prioritize immediate gaps. Even if a greater focus on PEP in funding requests translates to increased funding for PEP in this grant cycle, questions remain on sustainability amidst shrinking global health investments. In this context, PEP access may be more important than ever with treatment disruptions and reduced access to PrEP.

Despite limitations, this analysis highlights several clear implications and recommendations. First, PEP indicators should be included within the minimum set of HIV prevention indicators, guided by WHO's consolidated guidelines on person-centred HIV strategic information, to support improved data visibility [22]. Programmes should also consider setting targets for PEP alongside planning for expanded access through differentiated service delivery, including community-based delivery. Similarly, donors should include PEP indicators and targets in performance monitoring frameworks. While country-specific implementation approaches will be critical, countries should also prioritize rapid evaluation of emerging data from pilots and other studies on the role of PEP within prevention portfolios, considering options like "PEP-in-pocket" as the focus on PEP grows beyond occupational exposures and sexual assault. Finally, with increasingly constrained funding, low-resource strategies for PEP scale-up are more critical than ever. This may include integrating PEP into self-care packages and the use of HIV self-tests to reduce provider burden and policy changes to permit PEP distribution among lower provider cadres.

5 | CONCLUSIONS

All five countries analysed showed an increased focus on PEP in their Global Fund applications. While this reflects the growing ambition to expand access, product-specific needs are not clearly articulated, suggesting the role of PEP within HIV prevention is not yet clearly understood or translated from research to implementation planning. Further evidence generation to define the added value of PEP and its optimal role within the prevention method mix can support countries in increasing access and impact more effectively. While choice-focused, portfolio-based approaches are essential for ensuring person-centred services, it is equally important to identify and address barriers to timely PEP access, as well as to create demand and clearly communicate its benefit. Practical guidance and tools, as well as focused cross-country learning to support the operationalization of WHO PEP recommendations, will be critical to addressing gaps and achieving impact to reduce new HIV acquisitions. Global organizations, such as the Global Fund and PEPFAR, should also consider strengthening data systems on PEP use to better understand need, coverage and impact.

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COMPETING INTERESTS

The authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

DR, AO, AJM, JD and SYJ contributed to the study design, literature search and analysis. KH, TV, JF, HM, EG, MH, CO, CCI, NO, OO, EO, RB, OA, TM, PH, HS, MS, HI and MR contributed to manuscript drafting and review. All authors contributed to the study completion.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available at: https://data.theglobalfund.org/

REFERENCES

1. UNAIDS. AIDSinfo [Internet]. Unaids.org. 2023. Accessed February 28, 2025. https://aidsinfo.unaids.org/
2. Beekmann SE, Henderson DK. Prevention of HIV/AIDS: post-exposure prophylaxis (including healthcare workers). Infect Dis Clin North Am. 2014;28(4):601–13.
3. World Health Organization. Antiretroviral therapy for HIV infection in adults and adolescents: recommendations for a public health approach. Geneva: World Health Organization; 2006.
4. World Health Organization. Responding to intimate partner violence and sexual violence against women: WHO clinical and policy guidelines. Geneva: World Health Organization; 2013.
5. World Health Organization. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Geneva: World Health Organization; 2013.
6. World Health Organization. Guidelines on post-exposure prophylaxis and the use of co-trimoxazole propyhlaxis for HIV-related infections among adults, adolescents and children: recommendations for a public health approach. Geneva: World Health Organization; 2014.
7. World Health Organization. Updated recommendations in first-line and second-line antiretroviral regimens and post-exposure prophylaxis and recommendations on early infant diagnosis of HIV. Supplement to the 2016 consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Geneva: World Health Organization; 2013.
8. World Health Organization. Guideline for HIV post-exposure prophylaxis. Geneva: World Health Organization; 2024.
9. PEPFAR. Panorama Spotlight [Internet]. data.pepfar.gov. Accessed January 10, 2025. https://data.pepfar.gov/library
10. The Data Explorer [Internet]. data.theglobalfund.org. Accessed February 28, 2025. https://data.theglobalfund.org/
11. Phillips AN, Bansi-Matharu L, Shahmanesh M, Hargreaves JR, Smith J, Revill P, et al. Potential cost-effectiveness of community availability of tenofovir, lamivudine, and dolutegravir for HIV prevention and treatment in east, central, southern, and west Africa: a modelling analysis. Lancet Glob Health. 2023;11(10):e1648–57.

12. Kiptinness C, Naik P, Kareithi T, Thuo NB, Rafferty M, Jomo E, et al. Online delivery of HIV prophylaxis services in Kenya: lessons from the ePrEP Kenya pilot study. Poster presented at: 25th International AIDS Conference; July 22–26, 2024; Munich.
13. The Children's Investment Fund Foundation (CIFF) commits US$33 million to break the cycle of HIV transmission [Internet]. Theglobalfund.org. 2023 [cited 2024 Sep 23]. Available from: https://www.theglobalfund.org/en/news/2022/
14. Global Fund. Guidelines: accessing and programming matching funds [Internet]. 2023. Accessed February 28, 2025. https://resources.theglobalfund.org/media/14345/cr_2023-2025-matching-funds_guidance_en.pdf
15. Funding request forms and materials [Internet]. www.theglobalfund.org. Accessed February 28, 2025. https://www.theglobalfund.org/en/applying-for-funding/design-and-submit-funding-requests/funding-request-forms-and-materials/
16. Kakande ER, Ayieko J, Sunday H, Biira E, Nyabuti M, Agengo G, et al. A community-based dynamic choice model for HIV prevention improves PrEP and PEP coverage in rural Uganda and Kenya: a cluster randomized trial. J Int AIDS Soc. 2023;26(12).
17. Koss CA, Ayieko J, Kabami J, Balzer LB, Kakande E, Sunday H, et al. Dynamic choice HIV prevention intervention at outpatient departments in rural Kenya and Uganda. AIDS. 2023;38(3):339–49.
18. Billick MJ, Fisher KN, Myers S, Stan DH, Bofoch II. PEP-in-pocket: long-term follow-up of on demand HIV post-exposure prophylaxis; 2023 February 19–22. Seattle, WA. CROI. Available from: https://www.croiconference.org/abstract/pep-in-pocket-pip-long-term-follow-up-of-on-demand-hiv-post-exposure-prophylaxis/
19. PEPFAR/USAID/MOSAIC. Synthesis of post-exposure prophylaxis (PEP) policies in MOSAIC countries [Internet]. 2022. Available from: https://www.prepwatch.org/resources/synthesis-of-post-exposure-prophylaxis-pep-policies-in-mosaic-countries/
20. Global Fund. Modular framework handbook: allocation period 2023–2025 [Internet]. 2023. Accessed February 28, 2025. https://www.theglobalfund.org/media/4309/fundingmodel_modularframework_handbook_en.pdf
21. Global Fund. HIV Information Note [Internet]. 2022. Accessed February 28, 2025. https://www.theglobalfund.org/media/4765/core_hiv_infonote_en.pdf
22. World Health Organization. Consolidated guidelines on person-centred HIV strategic information: strengthening routine data for impact. Geneva: World Health Organization; 2022.

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RESEARCH ARTICLE

Factors associated with PEP awareness among adolescent girls and young women in Eswatini

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Abstract

Introduction: In Eswatini, HIV incidence among adolescent girls and young women (AGYW), aged 15–24 years, is 10 times that of their male peers. Despite the World Health Organization's 2014 recommendation for post-exposure prophylaxis (PEP) to be available for all HIV exposures, it has been underutilized among youth. PEP is an effective prevention method, and a better understanding of the characteristics, risk factors and behaviours that are associated with PEP awareness, as a precursor to effective use, is needed.

Methods: Using data from the 2022 Eswatini Violence Against Children and Youth Survey, we used logistic regression models to explore the relationships between PEP awareness and a set of hypothesized explanatory variables among AGYW aged 13–24 years who had ever had sex ($N = 2648$). Explanatory variables included socio-demographic characteristics, sexual risk factors and sexual health behaviours.

Results: A slight majority (57.3%) of AGYW who had ever had sex were aware of PEP as an HIV prevention method. PEP awareness increased with age (aOR 1.1, 95% CI 1.0, 1.1) and was higher among AGYW who had a sexual partner whose age was 5 or more years older in the past 12 months (aOR 1.4, 95% CI 1.1, 1.9), those who had ever taken part in an HIV prevention programme (aOR 1.6, 95% CI 1.2, 2.3) and those who had ever heard of pre-exposure prophylaxis (aOR 8.1, 95% CI 6.4, 10.2). Participants who were ever married or partnered (aOR 0.7, 95% CI 0.5, 1.0) and those who engaged in inconsistent condom use with non-spouse/main partner or multiple partners in the past 12 months (aOR 0.8, 95% CI 0.6, 1.00) had lower odds of knowing about PEP in the adjusted model.

Conclusions: We identified sub-optimal PEP awareness among Swazi AGYW who had ever had sex. Our findings suggest that engagement in HIV prevention programmes increased PEP awareness and that knowing about pre-exposure prophylaxis (PrEP) was associated with PEP awareness. Future efforts could include tailored PEP awareness activities and campaigns to resonate with AGYW at elevated risk of HIV and integration of PEP education into routine sexual and reproductive service delivery and school-based HIV curriculum.

Keywords: HIV prevention; adolescent girls and young women; postexposure prophylaxis; Eswatini; Africa; HIV

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1 | INTRODUCTION

Despite progress in addressing the HIV epidemic, we are not on track to end HIV as a public health threat by 2030 [1]. To reach this goal, we must achieve fewer than 370,000 new HIV acquisitions per year by 2025. In 2022, there were 1.3 million new acquisitions, including 210,000 among adolescent girls and young women (AGYW) aged 15–24 years [2, 3]. In sub-Saharan Africa, AGYW account for 63% of HIV acquisitions and are three times more likely to acquire HIV than their male peers [2].

In Eswatini, new HIV acquisitions have declined but incidence among AGYW has fallen less rapidly [4, 5]. Women aged 15–24 are nearly 10 times more likely to acquire HIV than men of the same age (incidence of 1.63 per 1000 vs. 0.17 per 1000, respectively) [5]. This context is challenging as 43% of the population is under 18, and high HIV acquisition rates among AGYW threaten effective epidemic control [6].

Awareness of and access to HIV prevention options for those at risk, especially AGYW, are crucial for reducing new acquisitions. Post-exposure prophylaxis (PEP) for HIV was first introduced in the late 1980s for occupational exposure [7]. In

2014, the World Health Organization updated its guidelines to recommend PEP for all HIV exposures and for all population groups, including adolescents [8].

PEP is currently the only available method that can prevent HIV acquisition following an exposure. An estimated 40% of all new acquisitions in eastern and southern Africa occur among those at medium or low risk [9]. For these lower-risk individuals, PEP may be a more personally relevant and cost-efficient HIV prevention method than daily oral PrEP [10]. PEP, as opposed to condoms, is also a user-controlled prevention method, rather than partner-controlled, and can be used relatively discretely. Both are important features for AGYW, who may struggle to negotiate condom use and who are often at greater risk of sexual violence [11, 12]. A cluster randomized trial in Uganda and Kenya found that, when given a choice in prevention services, 58% of participants chose PEP at one point during the follow-up period and that having this choice contributed to a 27.5% increase in antiretroviral-based prevention coverage [13].

Despite these relative advantages, the limited research to date has found low awareness and use of PEP among youth in sub-Saharan Africa [14, 15]. Initial analysis of the 2022 Eswatini Violence Against Children and Youth Survey found that less than half (40.4%) of AGYW had heard of PEP [16]. Those who had ever experienced any forced or pressured sex had greater PEP awareness (59%). While awareness does not equate to use, multiple theories of health promotion highlight the importance of knowledge or awareness of a particular health behaviour in determining the adoption of that behaviour [17, 18]. In practice, interventions that incorporate awareness-raising methods have also been shown to increase PEP use [19]. This analysis aims to understand the factors associated with PEP awareness among AGYW in Eswatini to inform strategies to raise awareness and, ultimately, increase effective PEP utilization. We hypothesize that PEP awareness may differ based on key socio-demographic characteristics, and that sexual risk factors and health-seeking behaviours may be positively associated with PEP awareness.

2 | METHODS

2.1 | Dataset

We conducted a secondary analysis of select variables from the 2022 Eswatini Violence Against Children and Youth Survey (VACS), a nationally representative cross-sectional, household-based survey conducted from April to August 2022 to assess experiences of violence and HIV risk behaviours and health outcomes among adolescents and young people (aged 13–24 years). Full details of the sampling frame, design, eligibility criteria, recruitment and consenting procedures are available elsewhere [16]. The survey used a three-stage cluster sampling approach, selecting geographic subdivisions as primary sampling units (PSUs). Households within these selected PSUs were listed and pre-screened for eligibility. Twenty to thirty pre-screened households in each PSU were selected and one eligible participant per household was randomly selected to participate in the survey. Eligible participants had to be residents of the selected household. Data were collected through an interview-administered questionnaire covering socio-demographics; experiences of physical, sexual and emotional violence; sexual history and risk-taking behaviours; and service seeking and use.

2.2 | Ethics and consent

This study was approved by the U.S. Centers for Disease Control and Prevention, Columbia University, and Eswatini Health and Human Research institutional review boards (see 45 C.F.R. part 46; 21 C.F.R. part 56) and followed World Health Organization's recommendations on ethics and safety in research on violence against women. Procedures included a youth-friendly consent process. Data collectors received robust training in responding to disclosures of violence including referral procedures for post-violence services. A series of checks were in place to ensure the confidentiality and privacy of participants [20, 21].

2.3 | Measures

2.3.1 | *Outcome variable*

PEP awareness was assessed with the question: "When a person who is HIV-negative takes pills for 28 days after a single exposure to reduce their chances of getting HIV, this is called post-exposure prophylaxis or PEP. Have you heard of PEP before now?". Those who responded "yes" were considered to be aware of PEP, while those responding "no" or "don't know" were considered to be unaware of PEP.

2.3.2 | *Explanatory variables*

Socio-demographic characteristics included age, education level, marital status and HIV status. Age was measured continuously as age at last birthday. Level of education was assessed based on the highest level of school in which the participant was currently enrolled (for those in school) or had completed (for those out of school) and dichotomized into those currently enrolled or who completed primary or less, and those who were enrolled or completed secondary and higher. Marital status was dichotomized as either ever married or living together or never married or living together as if married. Participants who either self-reported a prior positive HIV test or tested positive during the survey-facilitated HIV test were considered HIV positive. Participants who either reported a negative HIV status and refused a survey-facilitated HIV test or who had a negative survey-facilitated HIV test were considered HIV negative.

Sexual risk factors included ever having engaged in transactional sex, having multiple sex partners in the prior 12 months, inconsistent condom use, having experienced sexual violence and having a recent sex partner with unknown HIV status. Participants were asked if they ever entered into a sexual relationship with someone "mainly in order to get things that you need such as money, gifts, or other things that are important to you?". All participants who responded affirmatively were considered to have engaged in transactional sex. Participants were coded as having had multiple sex partners if they reported more than one sexual partner in the 12 months preceding the survey and as having an age-disparate sex partner if any of their three most recent

sexual partners were 5 or more years older than them. Among unmarried participants, inconsistent condom use was coded as never or sometimes using a condom in the past 12 months. Among married/partnered participants, inconsistent condom use was endorsed if the participant had more than one sexual partner (i.e. other sexual partners in addition to their spouse/partner), and never or sometimes used a condom in the past 12 months. Those who endorsed ever experiencing unwanted sexual touching, unwanted forced sex, pressured sex or physically forced sex were considered to have experienced sexual violence. Participants were coded as having had a sex partner with unknown HIV status if they reported not knowing the HIV status of any of their sexual partners in the 12 months prior to the survey.

Sexual health behaviours included HIV testing, sexually transmitted infections (STIs) diagnosis or symptoms, HIV prevention programme participation and access to family planning services. Previous HIV testing was measured by a single question asking participants if they had ever been tested for HIV. Participants were asked if they ever tested positive for a series of STIs (syphilis, gonorrhoea, chlamydia, herpes or genital warts) or if they ever had symptoms of an STI which included unusual discharge, unexplained genital sores or bumps and pain when urinating. Those who reported either a positive STI test or STI symptoms were coded as having had an STI diagnosis or symptom. HIV prevention programme participation was assessed with a single survey item designed in consultation with in-country stakeholders and included a list of all known PEPFAR or Global Fund-funded HIV prevention programmes that primarily supported AGYW. Response options included: Insika ya Kusasa, Likusasa Ngeletfu, Phila Unotse, Stepping Stones and DREAMS on Wheels. Participants who reported having ever taken part in at least one of these programmes were considered to have participated. Participants were asked if they or their most recent sex partner used any method to delay or avoid getting pregnant. Those who indicated the use of male sterilization, female sterilization, intrauterine device, injectable, implant, oral contraceptive pill or diaphragm were considered to have accessed a family planning service given all these methods are provided by a healthcare worker.

Table 1. Descriptive statistics of socio-demographic characteristics, and sexual risk factors and health behaviours among adolescent girls and young women aged 13–24 who had ever had sex in Eswatini, 2022 Eswatini Violence Against Children and Youth Survey (*N* = 2648)

	N (mean/ weighted %)	[95% CI]
Socio-demographic characteristics		
Age (range: 13–24)	2648 (20.5)	[20.4, 20.6]
Secondary or higher schooling	2306 (87.3)	[85.6, 88.9]
Ever married/partnered	347 (12.8)	[11.3, 14.5]
Age disparate[a] relationship (past 12 months)	646 (25.7)	[23.4, 28.0]
HIV-positive status	291 (10.6)	[9.3, 12.1]
Sexual risk factors		
Ever engaged in transactional sex	198 (6.8)	[5.6, 8.2]
Multiple sex partners (past 12 months)	185 (7.4)	[6.3, 8.7]
Inconsistent condom use (past 12 months)	1078 (45.8)	[43.2, 48.4]
Ever experienced sexual violence	331 (13.4)	[11.6, 15.5]
Does not know sexual partner HIV status (past 12 months)	543 (23.1)	[21.0, 25.4]
Sexual health behaviours		
Previously had tested for HIV	2574 (97.0)	[96.0, 97.8]
Ever diagnosed or symptomatic of STI	326 (12.5)	[10.7, 14.6]
Ever taken part in an HIV prevention programme	430 (17.3)	[15.1, 19.7]
Accessed family planning services in past 12 months	751 (31.8)	[29.2, 34.4]
Had heard of PEP	1528 (56.7)	[53.5, 59.8]
Had heard of PrEP	1882 (70.5)	[67.8, 73.1]

Abbreviations: PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infection.
[a]Sexual relationship with someone 5 or more years older.

2.4 | Analytic procedures

This analysis was conducted among a sub-sample of VACS participants and included all respondents who provided consent to participate in the survey, were female and had reported ever having had sex (n = 2648), which was 41% of the total sample. We assessed awareness of PEP and our hypothesized predictors and checked for co-linearity between explanatory variables. We estimated the bivariate relationship between explanatory variables and PEP awareness using Pearson chi-square and t-tests, as appropriate. Finally, we fit a multi-variate logistic regression model to examine the association between PEP awareness and socio-demographic characteristics, sexual risk factors and sexual health behaviours. Adequate model fit was assessed using a version of the Hosmer–Lemeshow test appropriate for complex survey data [22]. Listwise deletion was used to account for missing data which was limited to 0.0–2.3% of items included. All analyses accounted for the VACS complex survey design. All analyses were run in StataNow SE/18.5.

3 | RESULTS

The mean age of AGYW who had ever had sex was 20.5 years with the majority of them having completed or enrolled in secondary school or higher (87.3%) (Table 1). Slightly over 1 in 10 (12.8%) were married or partnered. In the past 12 months, one-quarter (25.7%) had been in a sexual relationship with someone 5 or more years older, and 10.6% were self-reported or tested as HIV positive. A minority, 6.8%, had ever engaged in transactional sex. Just under 1 in 10 (7.4%) had had multiple sex partners and had ever experienced sexual violence (13.4%). Almost half (45.8%) had engaged in inconsistent condom use. About one quarter (27.0%) had a sexual partner of unknown or HIV-positive status in the prior 12 months.

Table 2. Socio-demographic characteristics, and sexual risk factors and health behaviours among adolescent girls and young women aged 13–24 who had ever had sex in Eswatini, by awareness of PEP, 2022 Eswatini Violence Against Children and Youth Survey (*N* = 2648)

		Has heard of PEP						
		No		Yes		Total		
	n	%/mean (SD)	[95% CI]	%/mean (SD)	[95% CI]	%/mean (SD)	[95% CI]	*p*
Socio-demographic characteristics								
Age (range: 13–24)	2644	20.1 (2.6)	[19.9, 20.3]	20.8 (2.4)	[20.7, 21.0]	20.5 (2.5)	[20.4, 20.7]	<0.001
Secondary or higher schooling	2641	84.8	[81.9, 87.3]	89.5	[87.3, 91.4]	87.5	[85.7, 89.0]	0.006
Ever married/partnered	2633	12.1	[10.0, 14.6]	13.3	[11.3, 15.6]	12.8	[11.3, 14.5]	0.466
Age disparate[a] relationship (past 12 months)	2386	23.0	[19.9, 26.3]	27.6	[24.7, 30.7]	25.6	[23.4, 28.0]	0.035
HIV-positive status	2625	9.0	[7.3, 11.0]	11.8	[10.0, 13.9]	10.6	[9.3, 12.1]	0.029
Sexual risk factors								
Ever engaged in transactional sex	2626	6.5	[4.7, 8.7]	7.1	[5.6, 8.9]	6.8	[5.6, 8.3]	0.606
Multiple sex partners (past 12 months)	2391	7.2	[5.6, 9.2]	7.6	[6.1, 9.4]	7.4	[6.3, 8.7]	0.776
Inconsistent condom use (past 12 months)	2366	47.8	[44.4, 51.3]	44.4	[40.8, 48.0]	45.8	[43.2, 48.5]	0.171
Ever experienced sexual violence	2642	13.7	[11.1, 16.8]	13.0	[10.8, 15.7]	13.3	[11.5, 15.4]	0.722
Does not know sexual partner HIV status (past 12 months)	2358	25.6	[22.4, 29.1]	21.3	[18.6, 24.3]	23.1	[21.0, 25.4]	0.048
Sexual health behaviours								
Previously had tested for HIV	2643	94.7	[92.7, 96.3]	98.9	[98.0, 99.4]	97.1	[96.0, 97.9]	<0.001
Ever diagnosed or symptomatic of STI	2644	11.0	[8.5, 14.1]	13.7	[11.4, 16.4]	12.5	[10.7, 14.6]	0.136
Ever taken part in HIV prevention programme	2639	12.3	[9.7, 15.4]	21.1	[18.1, 24.4]	17.3	[15.1, 19.7]	<0.001
Accessed family planning services (past 12 months)	2391	28.4	[24.7, 32.4]	34.2	[30.8, 37.8]	31.8	[29.2, 34.4]	0.027
Ever heard of PrEP	2640	47.5	[43.9, 51.2]	88.1	[85.8, 90.1]	70.5	[67.8, 73.1]	<0.001

Abbreviations: CI, confidence interval; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infection.
[a]Sexual relationship with someone 5 or more years older.

Almost all AGYW (97.0%) had ever tested for HIV and more than 1 in 10 (12.5%) had ever been diagnosed with or symptomatic of an STI. Almost one in five AGYW (17.3%) had taken part in an HIV prevention programme. In the past 12 months, one in three (31.8%) had accessed family planning services. Over half (56.7%) had heard of PEP and the majority (70.5%) had heard of PrEP.

At the bivariate level, PEP awareness increased with age ($p<0.001$), and was greater for those who were enrolled or completed secondary school or higher ($p = 0.006$), were in a sexual relationship in the last 12 months with a partner at least 5 years older ($p = 0.035$), were living with HIV ($p = 0.029$), had previously tested for HIV ($p<0.001$), had ever taken part in an HIV prevention programme ($p<0.001$) and had accessed family planning services in the past 12 months ($p = 0.027$). AGYW who did not know the HIV status of a sexual partner in the past 12 months were less likely to have heard of PEP ($p = 0.048$) (Table 2).

After adjusting for all other demographic characteristics, sexual risk factors and sexual health behaviours, PEP awareness was positively associated with participant's age (aOR 1.1, 95% CI 1.0, 1.1), and engagement in age-disparate sexual relationships in the past 12 months (aOR 1.4, 95% CI 1.1, 1.9). Those who had ever taken part in an HIV prevention programme (aOR 1.6, 95%CI 1.2, 2.3) and those who had ever heard of PrEP (aOR 8.1, 95% CI 6.4, 10.2) had significantly higher odds of having heard about PEP (Table 3). AGYW who were ever married or partnered (aOR 0.7, 95% CI 0.5, 1.0)

Table 3. Adjusted odds ratios of PEP awareness by socio-demographic characteristics, and sexual risk factors and health behaviours among adolescent girls and young women aged 13–24 who had ever had sex in Eswatini, 2022 Eswatini Violence Against Children and Youth Survey (*N* = 2301)

	aOR	95% CI	*p*-value
Socio-demographic characteristics			
Age (range: 13–24)	1.1	[1.0, 1.1]	0.046
Secondary or higher schooling	1.1	[0.8, 1.5]	0.732
Ever married/partnered	0.7	[0.5, 1.0]	0.050
Age disparate[a] relationship (past 12 months)	1.4	[1.1, 1.9]	0.009
HIV-positive status	1.2	[0.8, 1.7]	0.418
Sexual risk factors			
Ever engaged in transactional sex	1.1	[0.7, 1.8]	0.722
Multiple sex partners (past 12 months)	1.1	[0.7, 1.6]	0.744
Inconsistent condom use (past 12 months)	0.7	[0.6, 0.9]	0.004
Ever experienced sexual violence	1.2	[0.8, 1.7]	0.426
Does not know sexual partner's HIV status (past 12 months)	1.0	[0.8, 1.4]	0.884
Sexual health behaviours			
Previously had tested for HIV[a]	1.1	[0.5, 2.9]	0.787
Ever diagnosed or symptomatic of STI	1.2	[0.8, 1.7]	0.346
Ever taken part in HIV prevention programme	1.6	[1.2, 2.3]	0.004
Accessed family planning services (past 12 months)	1.1	[0.8, 1.4]	0.687
Ever heard of PrEP	8.1	[6.4, 10.2]	<0.001
Intercept	0.1	[0.02, 0.31]	<0.001
Model fit, F-adjusted test statistic (p)		0.411 (0.929)	

Abbreviations: CI, confidence interval; PEP, post-exposure prophylaxis; STI, sexually transmitted infection.
[a]Sexual relationship with someone 5 or more years older.

and those who engaged in inconsistent condom use (aOR 0.7, 95% CI 0.6, 0.9) had significantly lower odds of hearing about PEP.

4 | DISCUSSION

The study assessed PEP awareness and its associations with socio-demographic characteristics, sexual risk factors and sexual health behaviours among AGYW in Eswatini who had ever had sex. While PEP awareness does not guarantee effective use, it is a necessary precursor to timely access among those who might benefit. Our results demonstrate that PEP awareness is relatively high among this population (57.3%), compared to lower rates of 24% and 25% among university students in South Africa and Nigeria [14, 15]. A qualitative study in western Kenya found that even those aware of PEP lacked a full understanding of the method [23]. Beyond the African continent, PEP awareness varies. In Australia, 21% of university students knew of PEP and a pooled analysis of men who have sex with men found 60% awareness [24, 25]. Although knowledge among AGYW in Eswatini is higher than in some studies, greater awareness is crucial in a context of persistently high incidence and disproportionate risk. Increased awareness of PEP as an available HIV prevention method must be complemented by accurate knowledge of how to access and use PEP effectively. The VACS study found that only about two-thirds 68.9% of females aware of PEP knew that it must be started within 72 hours [16].

The fully adjusted model indicates that PEP awareness increases with age and is higher among those in age-disparate relationships, who had ever participated in HIV prevention programming and who were aware of PrEP. The relationship between HIV prevention programme participation and PEP awareness is promising, supporting the theory that such programmes enhance knowledge of HIV prevention methods. One notable initiative, the Determined, Resilient, Empowered, AIDS-free, Mentored and Safe (DREAMS) programme, has been implemented in approximately 60% of Eswatini's subregions since 2016 and includes educational content to PEP. This may explain the positive relationship between programme participation and PEP awareness.

Even though we found that, in general, knowledge of PEP was lower than knowledge of PrEP among this population, it was encouraging that PrEP and PEP awareness were positively associated. In Eswatini, counselling on PrEP is provided through a variety of service delivery points including HIV testing services, antenatal care clinics and family planning clinics. At these sites, healthcare workers are often trained to identify clients who might benefit from PrEP, counsel or offer PrEP, and in some cases initiate PrEP and provide ongoing support for PrEP use. These investments in PrEP integration may explain why knowledge of PrEP is greater than knowledge of PEP among this population and underscores the

importance and value of providing HIV prevention counselling that informs clients about all available prevention methods, including both PrEP and PEP, to promote optimal choice. Interestingly, inconsistent condom use among non-spouse or multiple partners was associated with a lower likelihood of PEP awareness, which could benefit from further investigation.

While our bivariate analysis identified positive associations between PEP awareness and school attainment, HIV-positive status, and receipt of HIV testing and family planning services, these associations were not present in the fully adjusted model, suggesting they are attenuated by other factors. Bivariate analyses also indicated a negative relationship between PEP awareness and having a partner with an unknown HIV status, possibly because these participants are less engaged in conversations about HIV and HIV prevention strategies than those who understand their partner's status. Neither the bivariate nor multivariate analyses found evidence of an association between PEP awareness and marital status, engagement in transactional sex, a recent history of multiple sex partners, lifetime experience of sexual violence, or STI diagnosis or symptoms.

Engagement in transactional sex, having multiple recent or concurrent sex partners and having partners with unknown HIV status have all been associated with increased risk of HIV acquisition among AGYW [26–29]. The lack of or negative associations between these factors and PEP awareness identified in both the bivariate and multivariate analyses suggests that PEP awareness-building activities and campaigns may benefit from differentiated PEP-related messages for distinct potential user segments. Key messages could present PEP as an appropriate method for a variety of users including those engaged in transactional sex, those with multiple sex partners, and in sexual relationships with partners with unknown HIV status. Highlighting situations in which PEP might be indicated may help AGYW at risk view PEP as personally relevant and incorporate it as an HIV prevention strategy.

The lack of association between STI diagnosis and treatment in the bivariate and multivariate analyses and between HIV-positive status, previous HIV testing and receipt of family planning services in the multivariate analysis varied from other prior studies which identified HIV testing as a consistent predictor of higher PEP awareness among youth [14, 15]. These findings suggest that there may be missed opportunities to reach potential PEP users who could be addressed by better integrating PEP awareness building into other sexual and reproductive health services such as HIV testing, STI diagnosis and treatment, family planning services and, for AGYW living with HIV, in care and treatment services as a potential prevention option for their HIV-negative partners. Eswatini provides free HIV testing services, that allow youth age 12 and above to access testing services in both community and facility settings without requiring parental consent. This includes supporting HIV self-testing through pharmacies and HIV self-testing booths. Raising awareness of and linkages to PEP through this strong platform may be an efficient and effective strategy to reach youth.

We had hypothesized that those experiencing sexual violence may have a greater awareness of PEP if they sought services and were counselled on, and perhaps provided with, PEP but no such association was observed, perhaps because post-violence service seeking is quite low [16]. These findings suggest that integration of PEP awareness building into violence-prevention approaches and PEP counselling into all post-violence services, given that those who experience physical violence are often at greater risk of sexual violence, may be a priority area of focus to increase PEP awareness among this vulnerable population. Likewise, the lack of association between level of schooling and PEP awareness in the multivariate model may suggest that there is an opportunity to better integrate PEP awareness into existing or future school-health or comprehensive sexuality education curricula.

AGYW-related HIV and other sexual and reproductive health prevention programmes have not been scaled to meet the need [30], and only a relatively modest proportion of this sample reported ever having participated in an HIV prevention programme (17.3%). This means that leveraging other service delivery platforms that reach AGYW such as clinical, pharmacy and education services is a key strategy to expand coverage of PEP education and, ideally, use.

Efforts to increase PEP awareness, knowledge and accessibility in a timely manner could be strengthened by adopting complementary, evidence-based strategies such as community-based access and task-shifting PEP provision to lay health workers or community-led organizations to ensure PEP is easily available and accessible in a timely manner to those who might need it [13, 31]. Initial studies point to the importance not just of awareness but of PEP availability at a variety of community- and facility-based delivery points and PEP support services such as hot-lines [19]. Future research is needed to better understand effective strategies to increase awareness of PEP among young people, and how to translate that awareness into effective use, including formative and mixed-method studies that aim to identify how AGYW prefer to access PEP and be supported in their PEP use.

4.1 | Strengths and limitations

To our knowledge, this is the first study to examine PEP awareness among a nationally representative sample of AGYW in Africa, and the first analysis of PEP awareness in Eswatini. These exploratory findings can inform the design of PEP communication campaigns and other social behaviour change strategies to increase awareness, and use of PEP among this high-need group. They also lay the groundwork for understanding barriers and best practices to increase awareness and uptake of PEP, including future analyses that may identify how patterns of these factors might co-vary to form district segments or audiences that could benefit from tailored PEP-focused messages.

In terms of limitations, this study focused solely on PEP awareness and did not address use. Future research should explore the relationship between awareness and use and mechanisms for improving PrEP uptake. We also could not include all potential predictors of PEP awareness such as discrimination and stigma, which other studies have linked to knowledge of and access to HIV prevention services [32, 33]. This analysis relied on cross-sectional data so associations cannot be interpreted as causal. Although trained data

collectors administered the survey, social desirability bias may have led participants to overreport PEP awareness and/or underreport stigmatized behaviours. Recall bias may have also impacted the accuracy of self-reported behaviours. Lastly, these data are from Eswatini, findings may not be applicable across the region or in other contexts and so should be generalized with caution.

5 | CONCLUSIONS

These findings highlight the suboptimal awareness of PEP among an at-risk population: AGYW who have ever had sex in Eswatini. Enhancing PEP awareness is a critical step to increasing effective use and complements recommendations to expand access to PEP through community distribution and task-shifting. The positive association between HIV prevention programme participation and PrEP awareness underscores the effectiveness of these programmes in building knowledge of HIV prevention methods. However, the negative or null associations between PEP awareness and key socio-demographic characteristics, sexual risk factors and sexual health behaviours, point to (1) gaps in making PEP awareness strategies relevant to those most at-risk of HIV and (2) missed opportunities for integration of PEP education into routine sexual and reproductive health and education services accessed by youth.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHORS' CONTRIBUTIONS

AL: Conceptualization, methodology, writing original draft. SSM: Methodology, formal analysis, writing original draft. ML, SNC, LC and FBA: Methodology, investigation, data curation, project administration, writing review and editing. PM, NNM, SNM, KO, MC, UK, TM and MRA: Writing review and editing. The manuscript underwent a review by all authors, and each approved the final version.

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DATA AVAILABILITY STATEMENT

The public-use dataset from the 2022 Eswatini Violence Against Children and Youth Survey is available via togetherforgirls.org.

REFERENCES

1. UNAIDS. Describing the 'end of AIDS as a public health threat'. Geneva: Joint United Nations Programme on HIV/AIDS; 2023.
2. UNAIDS. The path that ends AIDS: UNIADS Global AIDS Update 2023. Geneva: Joint United Nations Programme on HIV/AIDS: 2023.
3. UNAIDS. Ending inequalities and getting on track to end AIDS by 2030 — A summary of the commitments and targets within the United Nations General Assembly's 2021 Political Declaration on HIV and AIDS. Geneva: Joint United Nations Programme on HIV/AIDS; 2022.
4. Government of the Kingdom of Eswatini. Swaziland HIV Incidence Measurement Survey 2 (SHIMS2) 2016–2017. Final Report. Mbabane: Government of the Kingdom of Eswatini; 2019.
5. Ministry of Health (MOH). Eswatini Population-based HIV Impact Assessment 3 2021 (SHIMS32 2021): Final Report. Mbabane: Ministry of Health; 2023.
6. UNICEF. Country Office Annual Report 2023. Mbabane: UNICEF; 2023.
7. Public Health Service statement on management of occupational exposure to human immunodeficiency virus, including considerations regarding zidovudine postexposure use. MMWR Recomm Rep. 1990;39(Rr-1):1–14.
8. World Health Organization. Guidelines on post-exposure prophylaxis for HIV and the use of co-trimoxazole prophylaxis for HIV-related infections among adults, adolescents and children: recommendations for a public health approach: December 2014 supplement to the 2013 consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Geneva: World Health Organization; 2014.
9. Beyrer C, Tomaras GD, Gelderblom HC, Gray GE, Janes HE, Bekker L, et al. Is HIV epidemic control by 2030 realistic? Lancet HIV. 2024;11(7):e489–94.
10. Maxime Billick K, Tan D, Sapin M, MacFadden D, Bogoch II. HIV PEP-in-Pocket ("PIP") facilities the de-medicalization of HIV prevention. HIV Research for Prevention. Lima, Peru; 2024.
11. Duby Z, Jonas K, McClinton Appollis T, Maruping K, Dietrich J, Mathews C. "Condoms are boring": navigating relationship dynamics, gendered power, and motivations for condomless sex amongst adolescents and young people in South Africa. Int J Sex Health. 2021;33(1):40–57.
12. World Health Organization. Violence against women prevalence estimates, 2018: global, regional and national prevalence estimates for intimate partner violence against women and global and regional prevalence estimates for non-partner sexual violence against women. Geneva: World Health Organization; 2021.
13. Kakande ER, Ayieko J, Sunday H, Biira E, Nyabuti M, Agengo G, et al. A community-based dynamic choice model for HIV prevention improves PrEP and PEP coverage in rural Uganda and Kenya: a cluster randomized trial. J Int AIDS Soc. 2023;26(12):e26195.
14. Ajayi AI, Yusuf MS, Mudefi E, Adeniyi OV, Rala N, Goon DT. Low awareness and use of post-exposure prophylaxis among adolescents and young adults in South Africa: implications for the prevention of new HIV infections. Afr J AIDS Res. 2020;19(3):242–48.
15. Ajayi AI, Ismail KO, Adeniyi OV, Akpan W. Awareness and use of pre-exposure and postexposure prophylaxes among Nigerian university students: findings from a cross-sectional survey. Medicine (Baltimore). 2018;97(36):e12226.
16. Deputy Prime Minister's Office. Violence against children and youth, Kingdom of Eswatini: findings from the Violence Against Children and Youth Survey, 2022 (Final Report). Mbabane: Government of the Kingdom of Eswatini; 2023.
17. Schunk D. Social cognitive theory. American Psychological Association; 2012.
18. Prochaska J, Velicer W. The transtheoretical model of health behavior change. Am J Health Promot. 1997;12(1):38–48.
19. Ayieko J, Petersen ML, Kabami J, Mwangwa F, Opel F, Nyabuti M, et al. Uptake and outcomes of a novel community-based HIV post-exposure prophylaxis (PEP) programme in rural Kenya and Uganda. J Int AIDS Soc. 2021;24(6):e25670.
20. Chiang LF, Kress H, Sumner SA, Gleckel J, Kawemama P, Gordon RN. Violence Against Children Surveys (VACS): towards a global surveillance system. Inj Prev. 2016;22(Suppl 1):i17–22.
21. Centers for Disease Control and Prevention. Critical elements of interviewer training for engaging children and adolescents in global violence research: best practices and lessons learned from the Violence Against Children Survey. Atlanta,

GA: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention; 2017.
22. Archer K, Lemeshow S. Goodness-of-fit test for a logistic regression model fitted using survey sample data. Stata J. 2006;6(1):97–105.
23. Miller L, Otieno B, Amboka S, Kadede K, Odeny D, Odhiambo H, et al. "Something like that": awareness and acceptability of HIV PrEP and PEP among Kenyan adolescents. Int J Behav Med. 2024. Online ahead of print. https://pubmed.ncbi.nlm.nih.gov/38942977/.
24. Warzywoda S, Dyda A, Fitzgerald L, Mullens A, Debattista J, Durham J, et al. A cross-sectional investigation of the factors associated with awareness of PEP and PrEP among Queensland university students. Aust N Z J Public Health. 2024;48(2):100136.
25. Jin J, Sun R, Mu T, Jiang T, Dai L, Lu H, et al. Awareness and use of post-exposure prophylaxis for HIV prevention among men who have sex with men: a systematic review and meta-analysis. Front Med (Lausanne). 2021;8:783626.
26. Low A, Thin K, Davia S, Mantell J, Koto M, McCracken S, et al. Correlates of HIV infection in adolescent girls and young women in Lesotho: results from a population-based survey. Lancet HIV. 2019;6(9):e613–22.
27. Mabaso M, Sokhela Z, Mohlabane N, Chibi B, Zuma K, Simbayi L. Determinants of HIV infection among adolescent girls and young women aged 15–24 years in South Africa: a 2012 population-based national household survey. BMC Public Health. 2018;18(1):183.
28. Santelli JS, Edelstein ZR, Mathur S, Wei Y, Zhang W, Orr MG, et al. Behavioral, biological, and demographic risk and protective factors for new HIV infections among youth in Rakai, Uganda. J Acquir Immune Defic Syndr. 2013;63(3):393–400.
29. Rucinski KB, Mbita G, Atkins K, Majani E, Komba A, Casalini C, et al. Transactional sex and age-disparate sexual partnerships among adolescent girls and young women in Tanzania. Front Reprod Health. 2024;6:1360339.
30. UNAIDS. World AIDS Day 2023 Fact Sheet. Geneva; 2023.
31. World Health Organization. Guidelines for HIV post-exposure prophylaxis. Geneva: World Health Organization; 2024.
32. Velloza J, Khoza N, Scorgie F, Chitukuta M, Mutero P, Mutiti K, et al. The influence of HIV-related stigma on PrEP disclosure and adherence among adolescent girls and young women in HPTN 082: a qualitative study. J Int AIDS Soc. 2020;23(3):e25463.
33. Logie CH, Okumu M, Mwima SP, Kyambadde P, Hakiza R, Kibathi IP, et al. Exploring associations between adolescent sexual and reproductive health stigma and HIV testing awareness and uptake among urban refugee and displaced youth in Kampala, Uganda. Sex Reprod Health Matters. 2019;27(3):86–106.

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RESEARCH ARTICLE

Limited awareness and use of HIV post-exposure prophylaxis among people vulnerable to HIV acquisition in Western Kenya: a cross-sectional analysis

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Abstract

Introduction: HIV post-exposure prophylaxis (PEP) can prevent HIV acquisition and facilitates linkage to pre-exposure prophylaxis (PrEP) for people with ongoing vulnerability. We assessed PEP awareness and use in Western Kenya.

Methods: We used cross-sectional screening/enrolment data from the Multinational Observational Cohort of HIV and other Infections (MOCHI) study. Eligible participants had behavioural vulnerability to HIV and were ages 14–55 years. Participants completed questionnaires on demographics, sexual/behavioural history, and PEP/PrEP awareness and use. Depression was assessed using the Patient Health Questionnaire (PHQ-9) with none/minimal, mild and moderate/severe depression defined as PHQ-9 scores of 0–4, 5–9 and ≥10, respectively. We used multivariable robust Poisson regression with purposeful variable selection to estimate adjusted prevalence ratios (aPRs) and 95% confidence intervals (CIs) for factors associated with PEP awareness.

Results: From December 2021 to May 2023, 398 participants indicated whether they heard of PEP. The median age was 22 years (IQR 19–24), 316/399 (79.2%) were female and 315/389 (81.0%) reported sex work or transactional sex. One hundred fourteen (28.6%) participants had never heard of PEP, of whom 79 (69.3%) had also not heard of PrEP. Among 284 participants who had heard of PEP, 74 (26.1%) did not know where to access it. Seventy-one participants (17.8%) had taken PEP, of whom 17 (23.9%) encountered problems accessing PEP such as unavailability (n = 5) or prohibitive expense (n = 4). In the final model, only <12 years of education (aPR 1.65 [95% CI 1.16–2.34]) and not cohabitating (aPR 2.81 [95% CI = 1.11–7.08]) were associated with never having heard of PEP. Among participants who had heard of PEP, factors associated with not knowing where to access PEP were <12 years of education (aPR 2.20 [95% CI 1.37–3.54]) and depression (mild aPR 1.86 [95% CI 1.17–2.96]; moderate/severe aPR 1.84 [95% CI 1.09–3.09], compared to none/minimal).

Conclusions: Despite enrolling a behaviourally vulnerable group potentially eligible for PEP, we identified substantial gaps in PEP awareness, access and use. Demand generation and improved access to PEP are needed to maximize the impact on reducing HIV incidence. Interventions to improve PEP awareness and access may be most impactful for people with lower education or when coupled with mental health services.

Keywords: post-exposure prophylaxis; pre-exposure prophylaxis; HIV; sexually transmitted infection; health risk behaviours; implementation science

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1 | INTRODUCTION

HIV post-exposure prophylaxis (PEP) is broadly recommended to prevent HIV acquisition after occupational or non-occupational exposures [1–6]. Prompt administration after exposure and completion of an adequate course are crucial to prevent the establishment of persistent infection. Guidelines recommend initiation of a 28-day course of PEP ideally within 24 hours but no later than 72 hours after an HIV exposure [7–10].

PEP provides a prevention option for people who experience unanticipated intermittent HIV exposures, which includes when other methods fail, such as condom breakage or pre-exposure prophylaxis (PrEP) interruptions due to pill fatigue or stockouts. Completing a PEP course is a potential entry point for PrEP (and/or the use of other prevention tools), particularly for individuals anticipating ongoing exposures that have the potential for HIV transmission [11, 12].

PEP has been largely underutilized in the global HIV response [13]. In Kenya, PEP is primarily available in hospitals and HIV clinics and is recommended in local guidelines for individuals without HIV within 72 hours of an exposure that poses a significant risk of HIV transmission [14]. The introduction and increasing use of oral tenofovir-based PrEP in African countries [15] is changing the landscape of HIV prevention, with additional PrEP options on the horizon. Nevertheless, PEP maintains an important and complementary role to PrEP as the only biomedical prevention tool that can be used *after* a potential HIV exposure. Therefore, understanding gaps in PEP awareness and access may inform strategies to maximize impact on reducing HIV incidence.

In this paper, we assessed and characterized PEP awareness and use in people with behavioural vulnerability to HIV in Western Kenya and determined socio-demographic and behavioural factors associated with lack of PEP awareness, access and use.

2 | METHODS

2.1 | Participant recruitment and eligibility

For these analyses, we used cross-sectional data from the screening and enrolment visits at the Kericho and Homa Bay, Kenya sites of the Multinational Observational Cohort of HIV and other Infections (MOCHI; Clinicaltrials.gov NCT05147519). Kericho is located alongside trucking routes with bars and other venues known to be associated with commercial sex work. Homa Bay is a fishing community with bars known to be associated with commercial sex work, a "fish for sex" trade between fishermen and fishmongers, and an established community of men who have sex with men (MSM) [16]. Recruitment occurred in bars, clubs and other venues frequented by populations with high HIV incidence. A community engagement team worked with venue owners to facilitate approaching potential participants and secure on-site space for private briefings. In Homa Bay, the community engagement team also recruited at fish markets. Potential participants were referred to a study site for screening and referrals within social networks were encouraged. Eligible participants were 14–55 years old, not living with HIV, and considered vulnerable to HIV and other sexually transmitted infections (STIs) based on one or more of the following criteria in the previous 24 weeks: (1) documented history of a newly diagnosed STI (confirmed through participant-provided medical record review); (2) self-reported intercourse in exchange for money as a regular source of income; (3) self-reported condomless vaginal or anal intercourse with at least three partners living with HIV or of unknown status; (4) self-reported injection drug use; and (5) self-reported MSM status. Participants were excluded if they had a positive urine pregnancy test, reported participation in an HIV vaccine study with receipt of an active product, or had any condition or substance use that could interfere with their safe participation in the study.

2.2 | Ethical considerations

All participants provided written informed consent in English or Kiswahili prior to any study procedures. Assent and parental consent were required for 14-year-old participants [17]. Illiterate participants were consented with an adult impartial witness present. The study was approved by institutional review boards at the Kenya Medical Research Institute, the Walter Reed Army Institute of Research and all collaborating institutions.

2.3 | Socio-demographic and behaviour data collection and categorization

Participants completed questionnaires related to demographic characteristics and recent behaviours at screening for study eligibility within 7 days of enrolment. Questionnaires were administered primarily via computer-assisted self-interview (CASI).

Demographic characteristics included enrolment site, sex, age, marital status, education level, occupation, weekly household income and the distance from the participant's home to the clinic. Age was dichotomized with a cut-off of 24 years as people under 24 are at an increased risk for HIV acquisition [18]. To maintain consistency with other work from our group [19], weekly household income and distance from the clinic were dichotomized at the 20th percentile. For weekly household income, this allows for comparisons between participants from the poorest households with others. For weekly household income, this allows for comparisons between participants who lived closest to the facility with the remaining participants. These cut-off values allowed us to have adequate sample sizes in each group for regression modelling.

We used questionnaire data to identify members of groups known to have high HIV incidence (e.g. sex workers and MSM), and to classify participants into groups according to HIV risk factors related to PrEP eligibility as defined in the Kenya national guidelines [14]. Participants who reported their primary occupation as a sex worker and/or who reported engaging in transactional sex in the previous 12 weeks were classified as engaging in sex work/transactional sex. Having a partner living with HIV or an unknown HIV status was determined by having one or more partners living with HIV in the previous 12 weeks or if the participant indicated they "don't know" how many partners they had in the previous 12 weeks living with HIV. Participants who reported using condoms in <100% of sex acts (excluding oral sex) were considered as having inconsistent condom use. Alcohol and/or drug use in the previous 12 weeks was ascertained in individual questions and the results were combined into a single item related to alcohol and/or drug use. Participant responses to questions about STI diagnoses in the previous 12 weeks (i.e. gonorrhoea, syphilis, chlamydia, herpes, genital/anal warts or other STI) were combined into a single variable capturing recent STI diagnoses. Depression was assessed using the

Patient Health Questionnaire (PHQ-9) with scores categorized as none/minimal depression (0–4), mild depression (5–9) or moderate/severe depression (10–27) [20].

2.4 | PEP/PrEP data collection and categorization

A CASI questionnaire about PEP/PrEP was administered at enrolment. Participants were first asked true/false questions to assess knowledge about HIV prevention options before being given definitions of PEP and PrEP. PEP was defined for participants as "A method for preventing HIV is called post exposure prophylaxis (PEP). PEP is a medication taken within 72 hours of exposure of HIV. The medication is taken by mouth every day for 28 days. When someone who does not have HIV is exposed to HIV through sex or injection drug use, PEP can work to keep the virus from establishing infection." Immediately following the definition, on the same database screen, participants answered questions about PEP awareness, use, access and adherence. All participants were asked if they had ever heard of PEP, knew of a hospital or clinic where PEP could be accessed, or had ever used or attempted to access PEP. Participants who have ever used or attempted to access PEP were asked if they had ever had problems accessing PEP, how many courses of PEP they had taken and whether they completed their last course of PEP without any missed doses. Participants who indicated they had problems accessing PEP were asked about what problems were encountered. We categorized the number of PEP doses into 0, 1, ≥2 since Kenyan guidelines include recurrent PEP use as an eligibility criterion for PrEP [14]. Participants who indicated they had missed one or more doses during their last course of PEP were asked about the reasons for the missed dose(s) and how many doses were missed. All participants were given the opportunity to respond don't know or refuse to answer or skip any question. Don't know answers were recoded as no and refuse to answer responses were recoded as missing.

Similarly, PrEP was defined for participants before they answered questions related to PrEP awareness, use, access, adherence, and concerns and preferences regarding PrEP options. PrEP was defined for participants as "A method for preventing HIV is called pre-exposure prophylaxis, or PrEP. PrEP is a medication taken to prevent HIV acquisition. Currently it is in the form of a pill taken every day or on demand when needed. When someone who does not have HIV is exposed to HIV through sex or injection drug use, PrEP can work to keep the virus from establishing infection. When taken consistently, daily oral PrEP has been shown to reduce the risk of HIV acquisition by up to 92% and up to 86% when taken on-demand." PrEP awareness and use was previously examined [19]; therefore, limited PrEP analyses are presented.

2.4.1 | Outcome definitions

We defined three PEP-related outcomes to highlight implementation gaps. PEP awareness was defined by an affirmative response to the question, "Have you ever heard of PEP?" Among participants who heard of PEP, knowledge of where to access PEP was defined by an affirmative response to the question, "Do you know of a clinic or hospital in this area where PEP is available?" Lastly, among participants who heard of PEP, PEP use was defined by reporting one or more PEP courses in response to the question, "How many times have you taken a treatment course for PEP?" If a participant answered that they had taken PEP but previously indicated that they had never heard of PEP, the participant was reclassified as having heard of PEP. Participants who refused to answer or who were missing responses were classified as not reporting knowing where to access PEP or as not having reported PEP use.

2.5 | Statistical analyses

The analytic population included all participants enrolled at the Kenyan sites who had a valid response to the question, "Have you ever heard of PEP?". Descriptive analyses included counts and percentages for all variables and were stratified by outcome. We used Poisson regression with robust standard errors [21] to compute prevalence ratios (PRs) and adjusted prevalence ratios (aPRs) with 95% confidence intervals (CIs) to examine factors potentially associated with each PEP-related outcome. For each outcome, we examined unadjusted models and an adjusted final model implementing purposeful variable selection [22, 23]. The purposeful variable selection process included three steps. First, we fit an adjusted model with all independent variables that were significant in their respective unadjusted models at the $p<0.25$ level. Second, using this initial adjusted model, we retained variables based on significance ($p<0.1$) in the adjusted model or confounding with other variables included in the adjusted model. A variable was retained based on confounding if the coefficient on any other independent variable changed by more than 20% when it was removed from the model. Variables not retained in this step were excluded from the final adjusted model. Finally, any independent variables not included in the initial adjusted model were added to the final model one at a time to determine if they became significant ($p<0.15$) in the presence of other independent variables. If any new variables were added to the model in this final stage, they were also assessed based on significance and confounding. Missingness in the independent variables was addressed using complete case analysis. *P*-values <0.05 were considered statistically significant and *p*-values <0.10 were considered suggestive of an association. All analyses were conducted using RStudio, version 2023.09.1 [24].

3 | RESULTS

3.1 | Participant characteristics

Of 485 people screened for study eligibility, 407 were enrolled, 399 attempted the PEP/PrEP questionnaire and 398 responded to the question "Have you ever heard of PEP?". The analysed population was primarily female (n = 316, 79.4%; Table 1) with a median age of 22 years (IQR 19–24 years). In the 12 weeks prior to enrolment, the majority of participants reported inconsistent condom use (n = 282, 73.6%), partners with HIV or unknown HIV status (n = 278, 73.4%), transactional sex or sex work (n = 315, 81.0%), alcohol and/or drug use before sex (n = 233, 60.2%) and symptoms of depression (n = 228, 59.7%; Table 1). Forty-three (10.9%) men reported

Table 1. Participant characteristics, overall and by awareness, knowledge of where to access and ever having used HIV post-exposure prophylaxis

Characteristic	Overall *n* (Column %) *N* = 398	Heard of PEP		Knew where to access PEP[a]		Ever used PEP[a]	
		Yes *n* (Row %) *n* = 284 (71.4)	No *n* (Row %) *n* = 114 (28.6)	Yes *n* (Row %) *n* = 210 (73.9)	No *n* (Row %) *n* = 74 (26.1)	Yes *n* (Row %) *n* = 71 (25.0)	No *n* (Row %) *n* = 213 (75.0)
Study site							
Kericho	181 (45.5)	120 (66.3)	61 (33.7)	73 (60.8)	47 (39.2)	24 (20.0)	96 (80.0)
Homa Bay	217 (54.5)	164 (75.6)	53 (24.4)	137 (83.5)	27 (16.5)	47 (28.7)	117 (71.3)
Sex							
Male	82 (20.6)	63 (76.8)	19 (23.2)	49 (77.8)	14 (22.2)	12 (19.0)	51 (81.0)
Female	316 (79.4)	221 (69.9)	95 (30.1)	161 (72.9)	60 (27.1)	59 (26.7)	162 (73.3)
Age							
≤24 years	317 (79.6)	224 (70.7)	93 (29.3)	157 (70.1)	67 (29.9)	46 (20.5)	178 (79.5)
>24 years	81 (20.4)	60 (74.1)	21 (25.9)	53 (88.3)	7 (11.7)	25 (41.7)	35 (58.3)
Marital status							
Not cohabitating or married	361 (90.9)	252 (69.8)	109 (30.2)	184 (73.0)	68 (27.0)	67 (26.6)	185 (73.4)
Cohabitating or married	36 (9.1)	31 (86.1)	5 (13.9)	25 (80.6)	6 (19.4)	4 (12.9)	27 (87.1)
Missing	1	1	0	1	0	0	1
Education level							
<12 years of education	209 (52.6)	139 (66.5)	70 (33.5)	87 (62.6)	52 (37.4)	34 (24.5)	105 (75.5)
≥12 years of education	188 (47.4)	144 (76.6)	44 (23.4)	122 (84.7)	22 (15.3)	37 (25.7)	107 (74.3)
Missing	1	1	0	1	0	0	1
Weekly household income[b]							
≤1000 Kenyan shillings	133 (33.5)	85 (63.9)	48 (36.1)	53 (62.4)	32 (37.6)	22 (25.9)	63 (74.1)
>1000 Kenyan shillings	264 (66.5)	198 (75.0)	66 (25.0)	156 (78.8)	42 (21.2)	49 (24.7)	149 (75.3)
Missing	1	1	0	1	0	0	1
Distance from facility							
≤3 km	95 (24.1)	76 (80.0)	19 (20.0)	67 (88.2)	9 (11.8)	22 (28.9)	54 (71.1)
>3 km	299 (75.9)	204 (68.2)	95 (31.8)	141 (69.1)	63 (30.9)	49 (24.0)	155 (76.0)
Missing	4	4	0	2	2	0	4
Ever heard of HIV pre-exposure prophylaxis							
No	120 (30.4)	41 (34.2)	79 (65.8)	21 (51.2)	20 (48.8)	8 (19.5)	33 (80.5)
Yes	275 (69.6)	241 (87.6)	34 (12.4)	188 (78.0)	53 (22.0)	63 (26.1)	178 (73.9)
Missing	3	2	1	1	1	0	2
Inconsistent condom use[c,d]							
No	101 (26.4)	77 (76.2)	24 (23.8)	55 (71.4)	22 (28.6)	17 (22.1)	60 (77.9)
Yes	282 (73.6)	199 (70.6)	83 (29.4)	149 (74.9)	50 (25.1)	54 (27.1)	145 (72.9)
Missing	15	8	7	6	2	0	8
Partners with HIV or unknown HIV status[b]							
No	101 (26.6)	78 (77.2)	23 (22.8)	60 (76.9)	18 (23.1)	16 (20.5)	62 (79.5)
Yes	278 (73.4)	196 (70.5)	82 (29.5)	140 (71.4)	56 (28.6)	53 (27.0)	143 (73.0)
Missing	19	10	9	10	0	2	8
Transactional sex or sex work[b]							
No	74 (19.0)	59 (79.7)	15 (20.3)	52 (88.1)	7 (11.9)	10 (16.9)	49 (83.1)
Yes	315 (81.0)	220 (69.8)	95 (30.2)	155 (70.5)	65 (29.5)	61 (27.7)	159 (72.3)
Missing	9	5	4	3	2	0	5

(*Continued*)

Table 1. (Continued)

Characteristic	Overall *n* (Column %) *N* = 398	Heard of PEP Yes *n* (Row %) *n* = 284 (71.4)	Heard of PEP No *n* (Row %) *n* = 114 (28.6)	Knew where to access PEP[a] Yes *n* (Row %) *n* = 210 (73.9)	Knew where to access PEP[a] No *n* (Row %) *n* = 74 (26.1)	Ever used PEP[a] Yes *n* (Row %) *n* = 71 (25.0)	Ever used PEP[a] No *n* (Row %) *n* = 213 (75.0)
Self-reported sexually transmitted infection[b]							
No	339 (88.5)	243 (71.7)	96 (28.3)	174 (71.6)	69 (28.4)	61 (25.1)	182 (74.9)
Yes	44 (11.5)	32 (72.7)	12 (27.3)	28 (87.5)	4 (12.5)	10 (31.2)	22 (68.8)
Missing	15	9	6	8	1	0	9
Alcohol and/or drug use before sex[b]							
No	154 (39.8)	119 (77.3)	35 (22.7)	90 (75.6)	29 (24.4)	26 (21.8)	93 (78.2)
Yes	233 (60.2)	157 (67.4)	76 (32.6)	114 (72.6)	43 (27.4)	43 (27.4)	114 (72.6)
Missing	11	8	3	6	2	2	6
Depression[e]							
None/minimal	154 (40.3)	110 (71.4)	44 (28.6)	87 (79.1)	23 (20.9)	32 (29.1)	78 (70.9)
Mild	130 (34.0)	86 (66.2)	44 (33.8)	57 (66.3)	29 (33.7)	20 (23.3)	66 (76.7)
Moderate/severe	98 (25.7)	77 (78.6)	21 (21.4)	57 (74.0)	20 (26.0)	17 (22.1)	60 (77.9)
Missing	16	11	5	9	2	2	9

Note: At study entry, participants completed comprehensive socio-behavioural questionnaires primarily by computer-assisted self-interview, including a dedicated questionnaire about HIV post-exposure prophylaxis (PEP) and pre-exposure prophylaxis (PrEP). Among 398 answered the question about whether they had ever heard of PEP. Among the 284 participants who had ever heard of PEP, 284 (100%) answered the question about knowing where to access PEP and all 284 (100%) were included in the PEP use outcome. For the overall study population, column percentages were calculated for each characteristic with missing values excluded from the denominator. Row percentages were calculated for each characteristic in analyses stratified by the outcomes of (1) having heard of PEP, (2) knowing where to access PEP and (3) ever having taken PEP.

Abbreviation: PEP, HIV post-exposure prophylaxis.

[a]Denominators for row percentages are the number of participants in the row who reported having heard of PrEP and had a non-missing response to the outcome question (knows where to access PEP or has taken PEP).

[b]1000 Kenyan shillings was approximately equal to 7 USD at the time of survey administration.

[c]Question asked about behaviours in the 12 weeks prior to enrolment.

[d]Inconsistent condom use was defined as participants reporting condom use in fewer than 100% of all vaginal or anal sex.

[e]None/minimal depression was defined as PHQ-9 score 0–4, mild as 5–9 and moderate/severe as ≥10.

sex with other men in the 12 weeks prior to enrolment; 21 of whom reported a primary occupation as a sex worker and/or engaging in transactional sex in the 12 weeks prior to enrolment.

3.2 | PEP/PrEP awareness, knowledge and access

The majority of participants had heard of PEP (*n* = 284, 71.4%, Table 1 and Figure 1) and PrEP (*n* = 275, 69.6%). However, 114 (28.6%) participants had never heard of PEP, of whom 79 (69.3%) had also never heard of PrEP. One participant reported not having heard of PEP but also reported having taken one course of PEP; this participant was reclassified as having heard of PEP. While the majority of participants correctly indicated that there is a medicine that can be taken after sex for 28 days to prevent HIV (*n* = 295, 74.5%; Table 2) or that there is a pill that can be taken every day to prevent HIV (*n* = 270, 68.4%), a large proportion incorrectly thought a vaccine can prevent HIV (*n* = 193, 48.6%).

Two hundred ten (73.9%, Table 1) participants who had ever heard of PEP indicated they knew where PEP was avail-

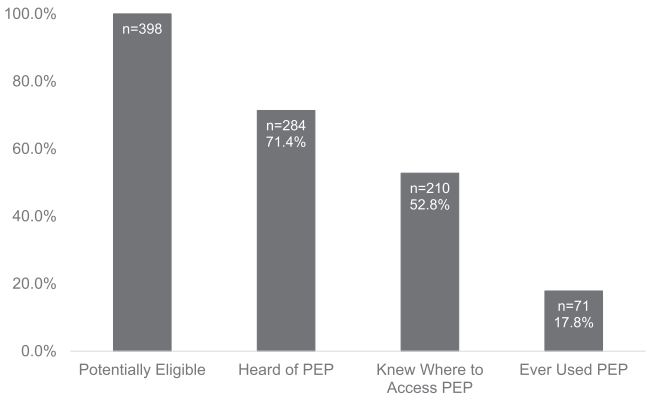

Figure 1. Number and percentage of participants who, at enrolment, are potentially eligible for PEP, heard of PEP, knew where to access PEP and ever used PEP. All percentages are out of the total number of participants who are potentially eligible for PEP (*n* = 398).

Table 2. HIV prevention knowledge, overall and by awareness, knowledge of where to access and ever having used HIV post-exposure prophylaxis

		Heard of PEP		Knew where to access PEP		Ever used PEP	
	Total	Yes	No	Yes	No	Yes	No
	n (Column %)	*n* (Row %)	*n* (Row %)	*n* (Row %)	*n* (Row %)	*n* (Row %)	*n* (Row %)
Knowledge question	*N* = 398	*n* = 284	*n* = 114	*n* = 210	*n* = 74	*n* = 71	*n* = 213
True or False: There is a medicine that can be taken after sex for 28 days to prevent HIV infection.							
False	16 (4.0)	10 (62.5)	6 (37.5)	7 (70.0)	3 (30.0)	2 (20.0)	8 (80.0)
True	295 (74.5)	239 (81.0)	56 (19.0)	183 (76.6)	56 (23.4)	66 (27.6)	173 (72.4)
Don't know	85 (21.5)	33 (38.8)	52 (61.2)	19 (57.6)	14 (42.4)	3 (9.1)	30 (90.9)
Missing	2	2	0	1	1	0	2
True or False: There is a pill that can be taken every day to prevent HIV infection.							
False	38 (9.6)	30 (78.9)	8 (21.1)	23 (76.7)	7 (23.3)	7 (23.3)	23 (76.7)
True	270 (68.4)	213 (78.9)	57 (21.1)	164 (77.0)	49 (23.0)	61 (28.6)	152 (71.4)
Don't know	87 (22.0)	39 (44.8)	48 (55.2)	23 (59.0)	16 (41.0)	3 (7.7)	36 (92.3)
Missing	3	2	1	0	2	0	2
True or False: There are pills that can be taken to prevent HIV infection							
False	43 (10.9)	34 (79.1)	9 (20.9)	26 (76.5)	8 (23.5)	8 (23.5)	26 (76.5)
True	217 (54.9)	174 (80.2)	43 (19.8)	137 (78.7)	37 (21.3)	51 (29.3)	123 (70.7)
Don't know	135 (34.2)	75 (55.6)	60 (44.4)	46 (61.3)	29 (38.7)	12 (16.0)	63 (84.0)
Missing	3	1	2	1	0	0	1
True or False: There is a vaccine that can prevent HIV infection.							
False	68 (17.1)	53 (77.9)	15 (22.1)	41 (77.4)	12 (22.6)	9 (17.0)	44 (83.0)
True	193 (48.6)	153 (79.3)	40 (20.7)	121 (79.1)	32 (20.9)	49 (32.0)	104 (68.0)
Don't know	136 (34.3)	78 (57.4)	58 (42.6)	48 (61.5)	30 (38.5)	13 (16.7)	65 (83.3)
Missing	1	0	1	0	0	0	0

Note: At study entry, participants completed comprehensive socio-behavioural questionnaires primarily by computer-assisted self-interview, including a series of true-false questions to test participant knowledge about HIV post-exposure prophylaxis (PEP) and pre-exposure prophylaxis (PrEP). For the overall study population, column percentages were calculated for each response to a knowledge question with missing values excluded from the denominator. Row percentages were calculated for each response to a knowledge question in analyses stratified by the outcomes of (1) having heard of PEP (n = 398), (2) knowing where to access PEP among participants who have heard of PEP (n = 284) and (3) ever having taken PEP among participants who have heard of PEP (n = 284).
Abbreviation: PEP, HIV post-exposure prophylaxis.

able, and 71 (25.0%) participants who had heard of PEP reported having taken PEP. Among participants who had taken PEP, 33 (46.5%, Table 3) reported having taken two or more courses of PEP and 16 (22.5%) reported having problems accessing PEP. Participant-reported access problems included PEP was not available (n = 5, 38.5%), PEP was too expensive (n = 4, 30.8%) and the participant was unable to consistently travel to pick up the medications (n = 4, 30.8%). One participant reported having taken or attempting to access PEP and also reported taking zero courses of PEP, yet this participant did not report problems accessing PEP. Sixteen (22.9%) participants who reported PEP use indicated they missed doses the last time they took a course of PEP. Reasons for missed dose(s) included no longer feeling the medication was needed (n = 5, 33.3%), receiving fewer than 28 doses (n = 4, 25.0%) and experiencing unwanted symptoms (n = 3, 20.0%).

3.3 | Factors associated with PEP awareness and access

Factors associated with not having heard of PEP included completing fewer than 12 years of education (aPR 1.65 [95% CI 1.16–2.34], p = 0.005; Table 4) and marital status (Not

Table 3. HIV post-exposure prophylaxis use, access and adherence

	Participants who had ever used HIV PEP $N = 71$ (Column %)
Have you had problems accessing PEP?	
No	55 (77.5)
Yes	16 (22.5)
What problems did you have accessing PEP? ($n = 16$)	
Medication was not available	5 (38.5)
The medications are too expensive to consistently purchase	4 (30.8)
I am unable to consistently travel to pick up the medications	4 (30.8)
Missing	3
Number of courses of PEP	
1 course of PEP	38 (53.5)
2 or more courses of PEP	33 (46.5)
The last time you took PEP, did you complete the 28 doses of PEP without any missed doses?	
No	16 (22.9)
Yes	54 (77.1)
Missing	1
What was the reason for missed doses?	
Did not remember to take the medication	1 (6.7)
Stopped medication due to unwanted symptoms	3 (20.0)
No longer felt I needed the medication	5 (33.3)
Don't know	1 (6.7)
Participant defined other reasons for missed doses of PEP ($n = 5$)	5 (33.3)
Boyfriend threw the medications away after realizing it was PEP	1 (20.0)
Received fewer than 28 doses	4 (80.0)
Missing	1
Since completing PEP, how frequently do you find yourself using condoms?	
Never	2 (2.8)
More frequently	54 (76.1)
About the same	4 (5.6)
Less frequently	9 (12.7)
I'm still taking PEP	2 (2.8)

Note: Among 71 participants who reported that they had ever taken HIV post-exposure prophylaxis (PEP), further questioning was conducted to characterize their PEP use, access to PEP and adherence to PEP.
Abbreviation: PEP, HIV post-exposure prophylaxis.

cohabitating/married vs. cohabitating/married: aPR 2.81 [95% CI 1.11–7.08], $p = 0.029$). There was some evidence of an association between not having heard of PEP and inconsistent condom use in the previous 12 weeks (aPR 1.50 [95% CI 0.98–2.30], $p = 0.063$). In the initial purposeful variable selection process, both site and transactional sex were also retained in the final adjusted model. However, neither variable was significant even at the 0.25 level and each was only retained in the model due to a high degree of collinearity with each other, resulting in large changes to the coefficient on one variable when the other variable is excluded from the model, so both were excluded as non-significant and the purposeful variable selection process was repeated only including the other 10 variables.

Among participants who reported hearing of PEP, factors associated with not knowing where to access PEP included completing fewer than 12 years of education (aPR 2.20 [95% CI 1.37–3.54], $p = 0.001$; Table 5) and depression (mild aPR 1.86 [95% CI 1.17–2.96], $p = 0.009$; moderate or severe aPR 1.84 [95% CI 1.09–3.09], $p = 0.021$). There was some evidence that participants with a self-reported STI in the previous 12 weeks were more likely to know where to access PEP (aPR 0.41 [95% CI 0.15–1.13], $p = 0.086$).

Factors associated with being less likely to have used PEP among participants who reported hearing of PEP included age 24 years or younger (aPR 1.34 [95% CI 1.02–1.75], $p = 0.032$), marital status (Not cohabitating/married vs. cohabitating/married aPR 0.75 [95% CI 0.60–0.95], $p = 0.016$; Table 6) and engagement in transactional sex or sex work (aPR 0.77 [95% CI 0.63–0.94], $p = 0.009$). Though they were not significantly associated with having used PEP in the adjusted model, study site, distance from healthcare facility, sexual partners with HIV or unknown HIV status in the previous 12 weeks and depression were also included in the final model due to confounding with other independent variables included in the model.

Sensitivity analyses were conducted to determine the impact of outcome definitions and missingness on the results. There were no significant changes in the results based on either the inclusion/exclusion of missing responses in the analyses or if PEP use was defined based upon "Have you ever taken or attempted to access PEP?" or "How many times have you taken a treatment course of PEP?".

4 | DISCUSSION

Despite enrolling participants who reported behaviours associated with vulnerability to HIV, we found that more than a quarter of participants had never heard of PEP and many more did not know where to access it. While PEP awareness in this study was suboptimal, it was higher than expected considering that previous studies had reported PEP awareness in Africa between 20% and 56.7% [25–28]. Our study was conducted in an area that has hosted many prior HIV-related studies, particularly at the Kericho site, so the enrolled population may have been exposed to increased HIV prevention messaging as a result. Regardless, substantial gaps in PEP awareness were identified. Furthermore, there were substantial gaps in knowledge about PEP/PrEP options with almost

Table 4. Poisson regression analyses of factors potentially associated with never having heard of HIV post-exposure prophylaxis

Characteristic	Never heard of PEP[a] *n* (row %)	Unadjusted prevalence ratio (95% CI)	*p*-value	Adjusted prevalence ratio (95% CI)	*p*-value
Study site					
Kericho	57 (34.5)	**1.48 (1.06–2.07)**	**0.022**		
Homa Bay	43 (23.4)	Reference			
Sex					
Male	13 (19.4)	Reference			
Female	87 (30.9)	1.59 (0.95–2.67)	0.080		
Age					
≤24 years	81 (29.3)	1.13 (0.74–1.73)	0.582		
>24 years	19 (26.0)	Reference			
Marital status					
Not cohabitating or married	96 (30.5)	**2.59 (1.02–6.60)**	**0.046**	**2.81 (1.11–7.08)**	**0.029**
Cohabitating or married	4 (11.8)	Reference		Reference	
Education level					
<12 years of education	66 (34.6)	**1.61 (1.12–2.29)**	**0.009**	**1.65 (1.16–2.34)**	**0.005**
≥12 years of education	34 (21.5)	Reference		Reference	
Weekly household income					
≤1000 Kenyan shillings	38 (33.6)	1.28 (0.91–1.79)	0.15		
>1000 Kenyan shillings	62 (26.3)	Reference			
Distance from healthcare facility					
≤3 km	14 (17.9)	Reference			
>3 km	86 (31.7)	**1.77 (1.07–2.93)**	**0.027**		
Inconsistent condom use[b]					
No	19 (22.6)	Reference		Reference	
Yes	81 (30.6)	1.35 (0.87–2.09)	0.175	1.50 (0.98–2.30)	0.063
Partners with HIV or unknown HIV status[b]					
No	22 (23.7)	Reference			
Yes	78 (30.5)	1.29 (0.86–1.94)	0.226		
Transactional sex or sex work[b]					
No	11 (16.7)	Reference			
Yes	89 (31.4)	**1.89 (1.07–3.32)**	**0.028**		
Self-reported sexually transmitted infection[b]					
No	89 (29.0)	Reference			
Yes	11 (26.2)	0.90 (0.53–1.55)	0.711		
Alcohol and/or drug use before sex[b]					
No	29 (21.5)	Reference			
Yes	71 (33.2)	**1.54 (1.06–2.25)**	**0.023**		
Depression[c]					
None/minimal	40 (27.6)	Reference			
Mild	42 (35.6)	1.29 (0.90–1.85)	0.163		
Moderate or severe	18 (20.9)	0.76 (0.47–1.24)	0.268		

Note: Poisson regression with robust standard errors was used to calculate prevalence ratios and 95% confidence intervals for the association between pre-specified participant characteristics and never having heard of PEP. Unadjusted modelling was performed for each characteristic of interest and purposeful variable selection was used to identify participant characteristics for inclusion in the final adjusted model. Results significant at the 5% level are presented in bold font.

Abbreviations: CI, confidence interval; PEP, HIV post-exposure prophylaxis.

[a]Since complete case analysis (n = 349) was used to deal with missingness, the counts and percentages will not match those in Table 1.

[b]Question asked about behaviours in the 12 weeks prior to enrolment.

[c]None/minimal depression was defined as PHQ-9 score 0–4, mild as 5–9 and moderate/severe as ≥10.

Table 5. Poisson regression analyses of factors potentially associated with not knowing where to access HIV post-exposure prophylaxis, among participants who had ever heard of it

Characteristic	Does not know where to access PEP[a] *n* (row %)	Unadjusted prevalence ratio (95% CI)	*p*-value	Adjusted prevalence ratio (95% CI)	*p*-value
Study site					
Kericho	42 (38.9)	**2.38 (1.53–3.71)**	**<0.001**	1.40 (0.84–2.35)	0.198
Homa Bay	23 (16.3)	Reference		Reference	
Sex					
Male	11 (20.4)	Reference			
Female	54 (27.7)	1.36 (0.77–2.41)	0.294		
Age					
≤24 years	58 (29.7)	**2.29 (1.11–4.73)**	**0.025**	1.51 (0.72–3.18)	0.275
>24 years	7 (13.0)	Reference		Reference	
Marital status					
Not cohabitating or married	59 (26.9)	1.35 (0.64–2.85)	0.435		
Cohabitating or married	6 (20.0)	Reference			
Education level					
<12 years of education	47 (37.6)	**2.59 (1.60–4.20)**	**<0.001**	**2.20 (1.37–3.54)**	**0.001**
≥12 years of education	18 (14.5)	Reference		Reference	
Weekly household income					
≤1000 Kenyan shillings	28 (37.3)	**1.76 (1.17–2.64)**	**0.007**		
>1000 Kenyan shillings	37 (21.3)	Reference			
Distance from healthcare facility					
≤3 km	7 (10.9)	Reference		Reference	
>3 km	58 (31.4)	**2.87 (1.38–5.95)**	**0.005**	1.85 (0.88–3.93)	0.107
Inconsistent condom use[b]					
No	18 (27.7)	Reference			
Yes	47 (25.5)	0.92 (0.58–1.47)	0.733		
Partners with HIV or unknown HIV status[b]					
No	16 (22.5)	Reference			
Yes	49 (27.5)	1.22 (0.75–2.00)	0.426		
Transactional sex or sex work[b]					
No	7 (12.7)	Reference			
Yes	58 (29.9)	**2.35 (1.14–4.85)**	**0.021**		
Self-reported sexually transmitted infection[b]					
No	62 (28.4)	Reference		Reference	
Yes	3 (9.7)	0.34 (0.11–1.02)	0.054	0.41 (0.15–1.13)	0.086
Alcohol and/or drug use before sex[b]					
No	25 (23.6)	Reference			
Yes	40 (28.0)	1.19 (0.77–1.83)	0.439		

(*Continued*)

half of participants thinking there is an existing HIV vaccine and more than 25% unaware that PEP was available. When considering participants who were aware of PEP, more than 40% did not know where it was available and more than 20% of participants who tried to access PEP reported having experienced access problems.

Previous work has found that barriers to PEP implementation include low awareness of PEP as an HIV prevention tool among people vulnerable to HIV [29, 30], difficulties in the healthcare system to handle non-occupational PEP requests, lack of confidence among healthcare providers to prescribe PEP [29], concerns about confidentiality and/or discomfort

Table 5. (Continued)

Characteristic	Does not know where to access PEP[a] *n* (row %)	Unadjusted prevalence ratio (95% CI)	*p*-value	Adjusted prevalence ratio (95% CI)	*p*-value
Depression[c]					
None/minimal	20 (19.0)	Reference		Reference	
Mild	27 (35.5)	**1.87 (1.13–3.07)**	**0.014**	**1.86 (1.17–2.96)**	**0.009**
Moderate or severe	18 (26.5)	1.39 (0.79–2.43)	0.249	**1.84 (1.09–3.09)**	**0.021**

Note: Poisson regression with robust standard errors was used to calculate prevalence ratios and 95% confidence intervals for the association between pre-specified participant characteristics and not knowing where to access PEP, among those who have heard of PEP. Unadjusted modelling was performed for each characteristic of interest and purposeful variable selection was used to identify participant characteristics for inclusion in the final adjusted model. Results significant at the 5% level are presented in bold font.
Abbreviations: CI, confidence interval; PEP, HIV post-exposure prophylaxis.
[a]Since complete case analysis (n = 249) was used to deal with missingness, the counts and percentages will not match those in Table 1.
[b]Question asked about behaviours in the 12 weeks prior to enrolment.
[c]None/minimal depression was defined as PHQ-9 score 0–4, mild as 5–9 and moderate/severe as ≥10.

disclosing HIV status [29, 30], potential side effects and lack of access to PEP [29]. In spite of Kenyan guidelines for PrEP indicating that recurrent use of PEP is one eligibility criterion for PrEP [14], we found that participants lack knowledge of PEP as a prevention tool, consistent with previous findings. Other findings consistent with previous work include low PEP awareness and a lack of knowledge about where to access PEP. Furthermore, our finding that some participants were not given a full course of PEP is an indication supporting previous work that providers may not be confident prescribing PEP. Provider confidence in prescribing PEP is not well-documented, especially in sub-Saharan Africa. However, several studies surveying U.S. providers report low provider confidence in prescribing PEP and/or PrEP, regardless of their years of experience or age [31–33]. Having lower education levels was associated with both a lack of PEP awareness and a lack of knowledge of where to access PEP among participants who had heard of PEP. Our finding that having lower education levels was associated with a lack of PEP awareness is consistent with this previous research from geographically diverse study locations [34–38]. Few studies have examined the association between socio-demographic characteristics or behaviours and knowledge of where to access PEP. However, previous work has found that knowledge of where to access PEP is low [39, 40]. Among participants who were aware of PEP, being younger and being married were associated with an increased prevalence of never taking PEP. These gaps represent opportunities for improved programming related to PEP as a biomedical HIV prevention tool for participants with occasional exposure to HIV, highlighting the importance of targeted messaging for younger people and people with lower socio-economic status.

The relationship between depression and HIV prevention/care engagement is not well understood. While some studies have reported that depression is not associated with HIV care and prevention-related outcomes [41, 42], many studies report that experiencing depressive symptoms is associated with lower adherence to HIV medication regimens, lower engagement in HIV-related healthcare, and worse health outcomes in people living with HIV and with reduced adherence to HIV prevention regimens and an increased likelihood of acquisition in people living without HIV [43–51]. In our study, depression was associated with both never taking PEP and not knowing where to access PEP among participants who had heard of PEP. While depressive symptoms may be associated with any number of factors related or unrelated to a possible HIV exposure, this finding highlights the importance of addressing mental health in the context of HIV prevention for people who engage in behaviours that may increase the risk of HIV exposure.

Enrolment of participants with behavioural vulnerability to HIV allowed us to measure PEP-related outcomes in a population that was likely eligible for PEP/PrEP. However, these analyses should be interpreted in the context of several limitations. The MOCHI study was powered to study HIV incidence and may have been underpowered to assess all potential factors associated with PEP-related outcomes. Future work in larger cohorts should examine these relationships in detail. Questionnaires assessed participant demographic characteristics at enrolment and behavioural characteristics within the previous 12 weeks, but questions about PEP use did not identify a time frame, complicating the analysis and interpretation of PEP use and eligibility. Participants were provided a definition of PEP immediately before being asked whether they had ever heard of PEP; while the definition was intended to clarify the question, some participants may have reported hearing of PEP based only on the definition they had just been provided. Additionally, the definitions of PEP and PrEP may have included terms that were unfamiliar or confusing to participants. Lastly, questionnaire data may be susceptible to biases related to recall, self-report and social desirability.

5 | CONCLUSIONS

Despite enrolling people behaviourally vulnerable to HIV, we identified substantial gaps in PEP awareness, knowledge and uptake. These gaps included a lack of awareness of PEP and PrEP, a lack of knowledge about where to access PEP and problems accessing PEP. Participants with lower education levels have lower awareness of PEP, whereas younger par-

Table 6. Poisson regression analyses of factors potentially associated with never having taken HIV post-exposure prophylaxis, among participants who had ever heard of it

Characteristic	Never used PEP[a] *n* (row %)	Unadjusted prevalence ratio (95% CI)	*p*-value	Adjusted prevalence ratio (95% CI)	*p*-value
Study site					
Kericho	85 (78.7)	1.13 (0.98–1.31)	0.097	1.21 (0.96–1.53)	0.098
Homa Bay	98 (69.5)	Reference		Reference	
Sex					
Male	44 (81.5)	Reference			
Female	139 (71.3)	0.87 (0.75–1.02)	0.091		
Age					
≤24 years	151 (77.4)	**1.31 (1.03–1.65)**	**0.025**	**1.35 (1.04–1.76)**	**0.023**
>24 years	32 (59.3)	Reference		Reference	
Marital status					
Not cohabitating or married	157 (71.7)	**0.83 (0.70–0.97)**	**0.023**	**0.75 (0.60–0.95)**	**0.015**
Cohabitating or married	26 (86.7)	Reference		Reference	
Education level					
<12 years of education	93 (74.4)	1.03 (0.88–1.19)	0.745		
≥12 years of education	90 (72.6)	Reference			
Weekly household income					
≤1000 Kenyan shillings	53 (70.7)	0.95 (0.80–1.12)	0.520		
>1000 Kenyan shillings	130 (74.7)	Reference			
Distance from healthcare facility					
≤3 km	42 (65.6)	Reference		Reference	
>3 km	141 (76.2)	1.16 (0.96–1.41)	0.132	1.14 (0.92–1.40)	0.235
Inconsistent condom use[b]					
No	50 (76.9)	Reference			
Yes	133 (72.3)	0.94 (0.80–1.10)	0.447		
Partners with HIV or unknown HIV status[b]					
No	56 (78.9)	Reference		Reference	
Yes	127 (71.3)	0.90 (0.78–1.05)	0.197	0.88 (0.71–1.09)	0.239
Transactional sex or sex work[b]					
No	46 (83.6)	Reference		Reference	
Yes	137 (70.6)	**0.84 (0.73–0.98)**	**0.025**	**0.78 (0.64–0.94)**	**0.010**
Self-reported sexually transmitted infection[b]					
No	162 (74.3)	Reference			
Yes	21 (67.7)	0.91 (0.71–1.18)	0.477		
Alcohol and/or drug use before sex[b]					
No	81 (76.4)	Reference			
Yes	102 (71.3)	0.93 (0.80–1.08)	0.363		
Depression[c]					
None/minimal	73 (69.5)	Reference		Reference	
Mild	59 (77.6)	1.12 (0.94–1.33)	0.217	1.16 (0.98–1.37)	0.085
Moderate or severe	51 (75.0)	1.08 (0.90–1.30)	0.426	1.14 (0.95–1.36)	0.168

Note: Poisson regression with robust standard errors was used to calculate prevalence ratios and 95% confidence intervals for the association between pre-specified participant characteristics and never having taken PEP, among those who have heard of PEP. Unadjusted modelling was performed for each characteristic of interest and purposeful variable selection was used to identify participant characteristics for inclusion in the final adjusted model. Results significant at the 5% level are presented in bold font.

Abbreviations: CI, confidence interval; PEP, HIV post-exposure prophylaxis.

[a]Since complete case analysis (n = 249) was used to deal with missingness, the counts and percentages will not match those in Table 1.

[b]Question asked about behaviours in the 12 weeks prior to enrolment.

[c]None/minimal depression was defined as PHQ-9 score 0–4, mild as 5–9 and moderate/severe as ≥10.

ticipants have lower PEP utilization than older participants, and participants with depression have both lower PEP utilization and knowledge of where to access PEP than participants without depression. Therefore, targeting outreach efforts to populations with lower education levels and including mental healthcare in HIV prevention programming may help alleviate some of the PEP awareness and uptake barriers.

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COMPETING INTERESTS

The authors have no conflicts of interest to disclose.

AUTHORS' CONTRIBUTIONS

MLR, GS, JK and TAC developed the concept and designed the analysis plan with input at various points from AY, JG, HQ, BG, MCT, RB, DL, CA, CC, MY and FS. CA, RB and DL collected and managed the data at the site. GS, AY and NB conducted the statistical analyses. GS wrote the first draft of the manuscript with critical input from all co-authors. All authors edited the manuscript and provided final approval for submission.

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DISCLAIMER

Material has been reviewed by the Walter Reed Army Institute of Research. There is no objection to its presentation and/or publication. The opinions or assertions contained herein are the private views of the author, and are not to be construed as official, or as reflecting true views of the Department of the Army or the Department of Defense.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

REFERENCES

1. Public health service statement on management of occupational exposure to human immunodeficiency virus, including considerations regarding zidovudine postexposure use. Can Dis Wkly Rep. 1990;16 Suppl 2:4–13.
2. 1998 guidelines for treatment of sexually transmitted diseases. Centers for Disease Control and Prevention. MMWR Recomm Rep. 1998;47(Rr-1):1–111.
3. World Health Organization & International Labour Organization. Post-exposure prophylaxis to prevent HIV infection: Joint WHO/ILO guidelines on post exposure prophylaxis (PEP) to prevent HIV infection; 2007. Available from: https://apps.who.int/iris/handle/10665/43838. Accessed 4 January 2023.
4. Smith DK, Grohskopf LA, Black RJ, Auerbach JD, Veronese F, Struble KA, et al. Antiretroviral postexposure prophylaxis after sexual, injection-drug use, or other nonoccupational exposure to HIV in the United States: recommendations from the U.S. Department of Health and Human Services. MMWR Recomm Rep. 2005;54(Rr-2):1–20.
5. Announcement: updated guidelines for antiretroviral postexposure prophylaxis after sexual, injection-drug use, or other nonoccupational exposure to HIV—United States, 2016. MMWR Morb Mortal Wkly Rep. 2016;65(17):458.
6. World Health Organization. Guidelines on post-exposure prophylaxis for HIV and the use of co-trimoxazole prophylaxis for HIV-related infections among adults, adolescents and children: recommendations for a public health approach. December 2014 supplement to the 2013 consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Available from: http://apps.who.int/iris/bitstream/handle/10665/145719/9789241508193_eng.pdf;jsessionid=B7FB145BE4BB8300E0120A65EFDD5D0E?sequence=1. Accessed 23 December 2022.
7. World Health Organization. Consolidated guidelines on HIV prevention, testing, treatment, service delivery and monitoring: recommendations for a public health approach. 2021. Available from: https://www.who.int/publications/i/item/9789240031593. Accessed 23 December 2022.
8. Gandhi RT, Bedimo R, Hoy JF, Landovitz RJ, Smith DM, Eaton EF, et al. Antiretroviral drugs for treatment and prevention of HIV infection in adults: 2022 recommendations of the International Antiviral Society-USA Panel. JAMA. 2022;333(7):609–28.
9. European AIDS Clinical Society (EACS). Guidelines Version 11.1; October 2022. Available from: https://www.eacsociety.org/media/guidelines-11.1_final_09-10.pdf. Accessed 27 December 2022.
10. Guidelines for HIV post-exposure prophylaxis. Geneva: World Health Organization; 2024.
11. Jain S, Krakower DS, Mayer KH. The transition from postexposure prophylaxis to preexposure prophylaxis: an emerging opportunity for biobehavioral HIV prevention. Clin Infect Dis. 2015;60(Suppl 3):S200–204.
12. O'Byrne P, Orser L, Vandyk A. Immediate PrEP after PEP: results from an observational nurse-led PEP2PrEP study. J Int Assoc Provid AIDS Care. 2020;19.
13. Ayieko J, Petersen ML, Kamya MR, Havlir DV. PEP for HIV prevention: are we missing opportunities to reduce new infections? J Int AIDS Soc. 2022;25(5):e25942.
14. Kenya HIV Prevention and Treatment Guidelines. Kenya: National AIDS & STI Control Program, Ministry of Health Kenya; 2022.
15. World Health Organization. Global state of PrEP. Available from: https://www.who.int/groups/global-prep-network/global-state-of-prep Accessed 27 December 2022.
16. UNICEF. Homa Bay, teenage girls face high risk of HIV and unintended pregnancy. 2020.
17. (KEMRI) NAaSCPNKMRI. Guidelines for conducting adolescent HIV sexual and reproductive health research in Kenya. 2015.
18. UNAIDS. UNAIDS Data. 2022.
19. Romo ML, Schluck G, Kosgei J, Akoth C, Bor R, Langat D, et al. Pre-exposure prophylaxis implementation gaps among people vulnerable to HIV acquisition: a cross-sectional analysis in two communities in western Kenya, 2021–2023. J Int AIDS Soc. 2024;27(11):e26372.
20. Kroenke K, Spitzer R, Williams J. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001;16(9):606–13.
21. Zou G. A modified Poisson regression approach to prospective studies with binary data. Am J Epidemiol. 2004;159(7):702–6.
22. Bursac Z, Gauss CH, Williams DK, Hosmer DW. Purposeful selection of variables in logistic regression. Source Code Biol Med. 2008;3:17.
23. Hosmer D, Lemeshow S, Sturdivant R. Applied logistic regression. 3rd ed. John Wiley & Sons, Inc; 2013.
24. RC Team. R: a language and environment for statistical computing. Vienna: Foundation for Statistical Computing; 2023.

25. Christian C, Kabami J, Kwarisiima D, Beinamatsiko B, Nakato H, Khakshi JW, et al. Feasibility and preliminary effectiveness of integrating HIV prevention into an adolescent empowerment and livelihood intervention at youth clubs in rural Uganda. AIDS Care. 2023;35(1):41–7.
26. Eshun SN, Tampah-Naah AM, Udor R, Addae D. Awareness and willingness to use pre-exposure prophylaxis (PrEP) and post-exposure prophylaxis (PEP) among sexually active adults in Ghana. HIV AIDS Rev. 2023;22(4):329–36.
27. Abdallah AG, Olayo RN, Cholo WO, Kapanga RR. Prevalence and demographic determinants of HIV pre-exposure and post-exposure prophylaxis use in Khwisero sub-county, Kenya. Afr J Empir Res. 2024;5(3):676–84.
28. Bahikire D, Nanyingi M, Atuhairwe C, Matama C, Ninsiima LR, Bbuye M. Risk perception and usage of non-occupational post-exposure prophylaxis among fisherfolk in Ggulwe parish on the shores of Lake Victoria in central Uganda. Frontiers in Public Health, Sec Infect Dis: Epidemiol Prev. 2023;11:1116317.
29. Ayieko J, Petersen ML, Kabami J, Mwangwa F, Opel F, Nyabuti M, et al. Uptake and outcomes of a novel community-based HIV post-exposure prophylaxis programme in rural Kenya and Uganda. J Int AIDS Soc. 2021;24(6):e25670.
30. Kakande ER, Ayieko J, Sunday H, Biira E, Nyabuti M, Agengo G, et al. A community-based dynamic choice model for HIV prevention improves PrEP and PEP coverage in rural Uganda and Kenya: a cluster randomized trial. J Int AIDS Soc. 2023;26(12):e26195.
31. John SA, Quinn KG, Pleuhs B, Walsh JL, Petroll AE. HIV post-exposure prophylaxis (PEP) awareness and non-occupational PEP (nPEP) prescribing history among U.S. healthcare providers. AIDS Behav. 2020;24(11):3124–31.
32. Vora AS, Marroquin M, Rosenthal SL, Broker P, Jetelina K, Tiro JA, et al. Residents and fellows' confidence in prescribing pre-exposure prophylaxis (PrEP). Acad Pediatr. 2023.
33. Kisteneff A, Gill S, O'Connell K, Edwards J, Lo B, Derber C. HIV post exposure prophylaxis in the emergency department: barriers and missed opportunities. Ann Emerg Med. 2020;76(4S):S129.
34. Lin SY, Lachowsky NJ, Hull M, Rich A, Cui Z, Sereda P, et al. Awareness and use of nonoccupational post-exposure prophylaxis among men who have sex with men in Vancouver, Canada. HIV Med. 2016;17(9):662–73.
35. Hou J, Wu Y, Xie L, Meng S, Fu R, Zheng H, et al. Post-exposure prophylaxis: an underutilized biomedical HIV prevention method among gay, bisexual and other men who have sex with men in China. AIDS Care. 2020;32(12):1573–80.
36. Sousa LRM, Elias HC, Fernandes NM, Gir E, Reis RK. Knowledge of PEP and PrEP among people living with HIV/AIDS in Brazil. BMC Public Health. 2021;21:1573-1580.
37. Prati G, Zani B, Pietrantoni L, Scudiero D, Perone P, Cosmaro L, et al. PEP and TasP awareness among Italian MSM, PLWHA, and high-risk heterosexuals and demographic, behavioral, and social correlates. PLoS One. 2016;11(6):e0157339.
38. Sun Y, Li G, Lu H. Awareness and use of nonoccupational HIV post-exposure prophylaxis and factors associated with awareness among MSM in Beijing, China. PLoS One. 2021;16(8):e0255108.
39. Ajayi AI, Yusuf MS, Mudefi E, Adeniyi OV, Rala N, Goon DT. Low awareness and use of post-exposure prophylaxis among adolescents and young adults in South Africa: implications for the prevention of new HIV infections. Afr J AIDS Res. 2020;19(3):242–48.
40. Ajayi AI, Ismail KO, Adeniyi OV, Akpan W. Awareness and use of pre-exposure and postexposure prophylaxes among Nigerian university students: findings from a cross-sectional survey. Medicine (Baltimore). 2018;97(36):e12226.
41. Stockton MA, Gaynes BN, Hosseinipour MC, Pettifor AE, Maselko J, Mphonda SM, et al. Association between depression and HIV care engagement outcomes among patients newly initiating ART in Lilongwe, Malawi. AIDS Behav. 2021;25:826–35.
42. Yotebieng KA, Fokong K, Yotebieng M. Depression, retention in care, and uptake of PMTCT service in Kinshasa, the Democratic Republic of Congo: a prospective cohort. AIDS Care. 2017;29:285–9.
43. Bradley MV, Pereira LF, Cohen MAA. HIV testing and prevention. In: Bourgeois JA, Cohen MAA, Makurumidze G, editors. HIV psychiatry: A practical guide for clinicians. Switzerland AG: Springer Nature; 2022. p.23–43.
44. McKinnon KM, Alves-Bradford J-M, Cournos F. HIV and serious mental illness. In: Bourgeois JA, Cohen MAA, Makurumidze G, editors. HIV psychiatry: A practical guide for clinicians. Switzerland AG: Springer Nature; 2022. p.289–308.
45. Shubber Z, Ford N. Adherence to HIV post-exposure prophylaxis for children/adolescents who have been sexually assaulted: a systematic review of barriers, enablers, and interventions. Child Abuse Negl. 2021;116(1):104143.
46. Ramirez-Avila L, Regan S, Giddy J, Chetty S, Ross D, Katz JN, et al. Depressive symptoms and their impact on health-seeking behaviors in newly-diagnosed HIV-infected patients in Durban, South Africa. AIDS Behav. 2012;16:2226–35.
47. Mendez NA, Mayo D, Safren SA. Interventions addressing depression and HIV-related outcomes in people with HIV. Curr HIV/AIDS Rep. 2021;18:377–90.
48. Abebe W, Gebremariam M, Molla M, Teferra S, Wissow L, Ruff A. Prevalence of depression among HIV-positive pregnant women and its association with adherence to antiretroviral therapy in Addis Ababa, Ethiopia. PLoS One. 2022;17(e0262638).
49. Kemp CG, Pence BW, Velloza J, Concepcion T, Moitra M, Iroezindu M, et al.; the AFRICOS Study Group. Cumulative exposure to depressive symptoms and all-cause mortality among adults with HIV in Kenya, Nigeria, Tanzania, and Uganda. AIDS. 2024;38(8):1228–36.
50. Concepcion T, Velloza J, Kemp CG, Bhat A, Bennett IM, Rao D, et al. Perinatal depressive symptoms and viral non-suppression among a prospective cohort of pregnant women living with HIV in Nigeria, Kenya, Uganda, and Tanzania. AIDS Behav. 2023;27:783–795.
51. Dear NF, Esber A, Iroezindu M, Bahemana E, Kibuuka H, Maswai J, et al. the AFRICOS study group. Routine HIV clinic visit adherence in the African cohort study. AIDS Res Ther. 2022;19:1.

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RESEARCH ARTICLE

Characteristics of individuals who received post-exposure prophylaxis and HIV seroconversion in Malawi: an analysis of national routine HIV testing data

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Abstract

Introduction: In Malawi, where HIV prevalence remains high at 6.7%, post-exposure prophylaxis (PEP) has been implemented as one of the HIV prevention strategies. However, there is limited data on the characteristics of PEP users and HIV seroconversion. Using national routine HIV testing services (HTS) programme data, we described the demographic characteristics and risk of exposure to HIV for HTS clients reporting PEP use and determined HIV seroconversion rates among those with baseline HIV-negative results.

Methods: We conducted a descriptive cross-sectional study of individuals aged 2 years and older accessing HTS who reported PEP use. A subset was included in a retrospective cohort to determine HIV seroconversion rates. The risk of exposure to HIV was classified as high, ongoing, low and not assessed. HTS encounters data were extracted from a national HTS data repository. Some HTS clients had multiple HTS encounters. Descriptive statistics were reported for the study populations and Poisson regression model with an offset was used to estimate HIV seroconversion rates.

Results: Between November 2022 and July 2023, there were 21,298 HTS encounters where PEP use was reported any time prior. Of the 21,298 encounters, 1847 (8.7%) HTS clients with a baseline HIV-negative status were included in the cohort study component. The median follow-up time was 30 days (interquartile range 30–61). Of the 1847 HTS clients, 1055 (57.1%) were males and 928 (50.2%) were aged 20 and 29 years. A total of 329 (17.8%) HTS clients reported a high-risk HIV exposure event in the past 3 months, 581 (31.5%) had an ongoing risk of exposure to HIV, 892 (48.3%) had low risk of exposure to HIV and 45 (2.4%) assessment was not done. Overall, five individuals seroconverted, yielding a seroconversion rate of 2.08 (0.87–4.99) per 100 person-years.

Conclusions: The majority of PEP users were young adults and males. A sizeable proportion had an ongoing risk of exposure to HIV. The HIV seroconversion rate was high. Targeted efforts should focus on promoting condom use, encouraging partner testing and expanding access to PEP for those with ongoing HIV exposure.

Keywords: post-exposure prophylaxis; HIV seroconversion; HIV testing service; young adult; HIV infection; HIV risk

Additional information may be found under the Supporting Information tab of this article.

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1 | INTRODUCTION

HIV acquisition remains a significant public health concern in sub-Saharan Africa (SSA). Approximately 25.9 million people were living with HIV (PLHIV) in SSA in 2023, which accounted for 67% of the world's PLHIV [1]. Malawi, one of the SSA countries, has one of the highest numbers of PLHIV. As of 2023, the national adult HIV prevalence was estimated at 6.7%, with around 1 million PLHIV. While Malawi has made significant progress towards the UNAIDS 95-95-95 targets—95% of PLHIV knew their status, 91% of those diagnosed received sustained antiretroviral therapy (ART) and 87% of those on ART achieved viral suppression—Malawi reported over 12,000 new PLHIV in 2023 [1]. Reducing HIV acquisitions requires a multi-faceted approach, integrating prevention strategies such as post-exposure prophylaxis (PEP),

pre-exposure prophylaxis (PrEP), expanding access to voluntary medical male circumcision and promoting consistent condom use [2].

PEP is recommended by the World Health Organization (WHO) to prevent new acquisitions, particularly for individuals at high risk of HIV transmission after exposure [3]. PEP is a short-term antiretroviral treatment that reduces the risk of HIV acquisition after exposure to HIV-infected blood. PEP has an estimated 80% effectiveness in preventing HIV acquisition if initiated within 72 hours of exposure, and the entire 28-day course is completed [3]. However, delayed initiation, incomplete adherence, and repeated high-risk exposures have raised concerns about its effectiveness, particularly in resource-limited settings like Malawi [4].

In 2016, the Malawi HIV programme aligned its PEP regimen with the standard first-line ART regimen for adults and children [5]. The 2022 national HIV guidelines for PEP service include a baseline HIV test—contingent on the availability of testing services—to confirm negative status, provision of a 30-day supply of PEP and adherence assessment at 30 days. Follow-up HIV tests are recommended at 3 and 6 months. Data collection on PEP is limited to initiation, with no dedicated tools for follow-up after the completion of the regimen, leading to a lack of data on HIV seroconversion [6].

In 2021, the Malawi HIV programme introduced a scannable integrated HIV testing register using ScanForm, an artifical intelligence (AI)-powered technology to digitize and analyse handwritten data, developed by Quantitative Engineering Design (QED.ai) [7]. The integrated HIV testing register also serves as a proxy PEP follow-up tool to capture information about previous HIV test results, time since the last HIV test, previous PEP use and time since the last PEP use. Despite the implementation of the integrated HIV testing register, the data has not yet been evaluated to understand the characteristics of PEP users and assess HIV seroconversion rates among individuals who access HIV testing services (HTS). Therefore, this study analysed the data to (1) describe the demographic characteristics and risk of exposure to HIV among HTS clients who reported PEP use; and (2) determine HIV seroconversion rates among HTS clients with a baseline HIV-negative test result who reported previous PEP use.

2 | METHODS

2.1 | Study design

We conducted a descriptive cross-sectional study to profile HTS individuals aged 2 years and older who reported PEP use in Malawi, with a subset of these HTS clients included in a retrospective cohort to determine HIV seroconversion rates. We used national HTS programme data collected between November 2022 and July 2024.

2.2 | Setting

2.2.1 | PEP services and HTS

PEP services are offered in health facilities, some of which have one-stop centres that provide comprehensive services comprising medical treatment, social welfare, law enforcement and counselling to victims of sexual or gender-based violence [8]. Eligibility for PEP is determined based on the risk of exposure to HIV. Adults and children (ages < 12 years and below) who experience potential risk of exposure to HIV through occupational (e.g. needlestick injuries in healthcare settings) or non-occupational events (unprotected consensual sexual intercourse, sexual assault or sharing needles) are considered for PEP. The assessment includes evaluating the timing of the exposure, with PEP being most effective when initiated within 72 hours. Children receive distinct legal and social services from adults.

Clients who are eligible for PEP are referred for a baseline HIV test—if testing services are available—to confirm negative status before PEP initiation. The Malawi HIV programme implements a 3-test algorithm for HTS for adults and children (Figure S1) [9]. All clients are counselled on voluntary and confidential testing, emphasizing their right to opt out without affecting access to other healthcare services. Informed consent is obtained from all HTS clients before testing. At each HTS session, regardless of PEP needs, a self-reported history is documented, including the risk of exposure to HIV, HIV testing history (previous HIV test results and dates) and any prior antiretrivial (ARV) use, such as PEP, PrEP and ART. The risk of exposure to HIV is classified as high risk, ongoing risk, low risk or not assessed. "High risk of exposure to HIV" refers to a potential high-risk HIV exposure event within the last 3 months (e.g. sexual assault, unprotected consensual sexual intercourse), while "ongoing risk of exposure to HIV" includes clients whose partners are HIV positive or on ART and HIV-exposed infants (children aged < 2 years old born to HIV-positive women). Clients who do not have high or ongoing risk of exposure to HIV are classified as having low risk. After HIV testing, clients receive post-test counselling, which includes referral to ART, PEP or PrEP services.

PEP-eligible individuals with an HIV-negative result or unknown HIV status are initiated on PEP and receive a complete 30-day PEP regimen, with a strong emphasis on adherence. The standard PEP regimen consists of weight-based combinations: ABC/3TC + DTG for individuals weighing <30 kg (mainly children) and TDF/3TC/DTG for those weighing ≥30 kg [6]. An alternative regimen is an AZT/3TC-based regimen used across all weight categories. Follow-up visits are scheduled at 30 days post-PEP initiation for adherence assessment and condom provision, and at 3 and 6 months for HIV testing to confirm the absence of HIV acquisition. In cases of sexual assault, emergency contraception is also provided.

2.3 | Data collection for PEP and HTS

PEP initiations are documented in an improvised PEP register, but no dedicated monitoring and evaluation (M&E) tool captures follow-up testing data. HTS data is captured in paper-based HIV testing registers that are scannable with ScanForm, which are featured in the WHO strategic information guidelines to strengthen routine data for impact [10]. To enhance data quality, the ScanForm system has built-in data validation checks that automatically identify and flag anomalies. The

anomalies are disseminated through an online portal, with direct notifications sent to the relevant facilities for timely correction [11]. The resulting non-identifiable client-level electronic data is stored in a central data repository and integrated with DHIS2.

In accordance with Malawi MoH reporting guidelines, preliminary statistics are automatically generated weekly, and comprehensive monthly reports are shared with programme leadership by the fifth of each month. A dedicated dashboard provides HTS staff with real-time access to performance metrics, including PEP data. The ScanForm technology improves HTS quality and M&E by generating reports highlighting data quality errors, missing information and violations of the 3-test algorithm. As of July 2024, the ScanForm technology was rolled out in 74% (730/982) of the health facilities in Malawi.

2.4 | Data sources

HTS data were extracted from the ScanForm HTS dataset, a central repository containing HTS records collected between November 2022 and July 2024 across Malawi. Each encounter in the dataset represented an individual instance of HIV testing, and some clients had multiple encounters during the study period.

2.5 | Inclusion and exclusion criteria

We analysed two datasets. The first dataset, a cross-sectional study component included all HTS encounters of individuals aged 2 years and older who reported PEP use at some point in their life. The second dataset, a cohort study, was designed to estimate HIV seroconversion. We constructed the HTS cohort using self-reported PEP use history and HIV testing data, specifically the time since the last HIV test and previous test results. Since HIV testing data are recorded as individual HTS encounters rather than longitudinal client records, we implemented steps to establish a cohort of unique HTS clients (1) who returned for a follow-up HIV test after recently completing PEP and (2) had no evidence of HIV acquisitions before PEP initiation and during PEP. This involved excluding the following HTS encounters:

1. Non-negative previous HIV test results;
2. Baseline HIV test occurred more than 35 days before PEP initiation;
   (time between baseline test and PEP initiation was too long, more than a month)
3. Baseline HIV test occurred more than 7 days after PEP initiation;
   (suggests that the full PEP course was not completed)
4. Date of last PEP use was greater than 65 days ago;
   (new high-risk events could have occurred since completing PEP)
5. Follow-up HIV test was performed more than 95 days after PEP initiation.
   (new high-risk events could have occurred since completing PEP)

2.6 | Statistical data analysis

Descriptive statistics were used to report the characteristics of HTS clients included in the cross-sectional study and cohort study components. Categorical variables were summarized using counts and proportions, while continuous variables were analysed using medians with interquartile range (IQR).

Using cross-sectional data, we compared the characteristics and HIV test results between HTS clients who reported PEP use and those who did not. In the cohort analysis, we evaluated participant characteristics and HIV seroconversion. Follow-up time was calculated as the interval between the previous baseline HIV-negative test result and the follow-up HIV test performed within 95 days after PEP initiation. Overall and gender-specific HIV seroconversion rates were estimated using a Poisson regression model with an offset to account for varying follow-up durations. HIV seroconversion rates, along with 95% confidence intervals (CI), were presented.

2.7 | Ethical considerations

The study was approved by the National Health Sciences Committee in Malawi (protocol #: 23/12/4275). The committee waived the need for the client's informed consent because the study used routine programmatic data and did not include personal identifiers.

3 | RESULTS

3.1 | Characteristics and HIV test results of clients included in the cross-sectional study component

Between November 2022 and July 2024, a total of 4,710,601 HTS encounters were recorded in HIV testing registers across 730 health facilities in Malawi and included in the cross-sectional study component (Table 1). Of these, 21,298 (0.5%) encounters involved clients who reported PEP use. PEP users were more likely to be male, have tested HIV negative, be categorized as having "high HIV-risk exposure" and have partners with unknown HIV status or HIV-positive partners on ART ($p<0.001$).

Among HTS encounters with PEP use, 13,595 (63.8%) were for males. Half of HTS encounters involving clients reporting PEP use were aged 20–29 years (n = 10,933, 51.3%), followed by those aged 30–39 years (n = 5888, 27.7%). The median time since the last PEP was 213 days (IQR 30–365). The risk of exposure to HIV among PEP users was: 7941 (37.3%) were classified as having a low risk of HIV exposure, 6301 (29.6%) had ongoing risk and 6382 (40%) had high risk. Regarding partners' HIV status, 8854 (41.6%) of HTS encounters were for clients who reported having an HIV-negative partner, 8156 (38.3%) for clients who did not know their partner's HIV status and 1319 (6.2%) for clients whose partners were HIV positive and on ART, 75 (0.4%) for clients with HIV-positive partners who were not on ART and 39 (0.2%) for clients with HIV-positive partners with unknown ART status.

Table 1. Characteristics and HIV results of clients for each encounter of HTS in Malawi by reported PEP use, November 2022–July 2024

	Total	Reported PEP use		Did not report PEP use		
	N	*n*	%	*n*	%	*p*-values
Total	4,710,601	21,298		4,689,303		
Sex						<0.001
Male	1,479,979	13,595	63.8	1,466,384	31.3	
Female	3,228,919	7694	36.1	3,221,225	68.7	
Unknown	1703	9	<1	1694	<1	
Age at HTS (years)						
2–12	418,271	841	4.0	417,430	8.9	<0.001
13–19	819,027	1174	5.5	817,853	17.4	
20–29	2,006,062	10,933	51.3	1,995,129	42.5	
30–39	910,944	5888	27.7	905,056	19.3	
40–49	341,038	2020	9.5	339,018	7.2	
50–59	115,454	350	1.6	115,104	2.5	
60+	99,805	92	0.43	99,713	2.1	
Previous HIV test result						<0.001
Never tested	823,657	193	0.9	823,464	17.6	
HIV positive[a]	55,646	93	0.4	55,553	1.2	
HIV negative	3,827,589	20,972	98.5	3,806,617	81.2	
Invalid/inconclusive missing	3709	40	0.19	3669	0.1	
Median time (days) since the previous HIV test (IQR)	365 (152–730)	183	(61–365)	365	(152–730)	
Median time (days) since the last PEP (IQR)	–	213	(30–365)	–		
Classification of client's risk of exposure to HIV						<0.001
Low risk	3,193,525	7941	37.3	3,185,584	67.9	
Ongoing risk	786,150	6301	29.6	779,849	16.6	
High HIV-risk exposure event in the last 3 months	318,654	6382	40.0	312,272	6.7	
Not assessed	412,272	674	3.1	411,598	8.8	
HTS access point						
Facility	4,316,205	19,715	92.6	4296.490	91.6	
Community	394,396	1583	7.4	392,813	8.4	
Partner's HIV status						
Negative	3,043,582	8854	41.6	3,034,728	64.7	
HIV status unknown	630,949	8156	38.3	622,793	13.3	
HIV positive, on ART	202,337	1319	6.2	201,018		
HIV positive, not on ART	7774	75	0.4	7699	0.2	
HIV positive, ART status unknown	3375	39	0.2	3336	01	
No partner	822,577	2855	13.4	819,722	64.7	
HIV test result given to the client						
HIV positive	91,190	426	2.0	90,764	1.9	
HIV negative	4,536,307	20,644	96.9	4,515,663	96.3	
Inconclusive/invalid	83,104	228	1.1	82,876	1.8	

Abbreviations: ART, antiretroviral therapy; IQR, interquartile range; HTS, HIV testing services.
[a]Clients returned for confirmatory tests.

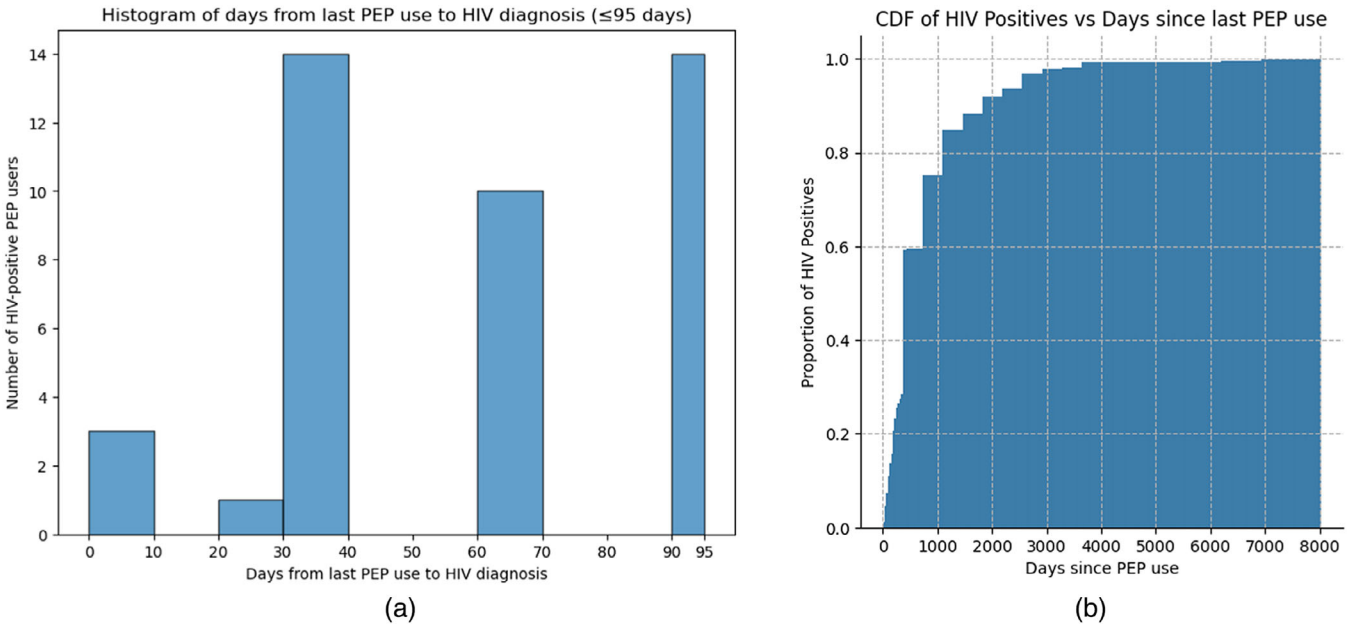

Figure 1. (A) Histogram of days from last PEP use to HIV diagnosis (≤95 days) among HIV-positive clients who reported PEP use. (B) Cumulative distribution function time between last PEP use and HIV diagnosis among all HIV-positive clients who reported PEP use (*n* = 426) between November 2022 and July 2024. Abbreviations: CDF, cumulative distribution function; PEP, post-exposure prophylaxis.

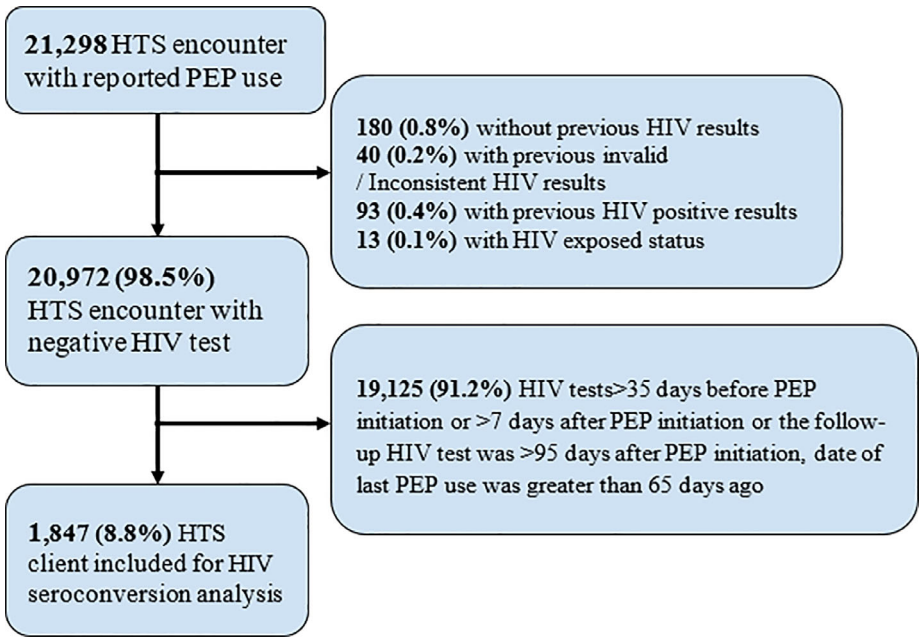

Figure 2. Flowchart of clients who reported PEP use in Malawi between November 2022 and July 2024.
Note: HIV-exposed status applies to children aged 2 years who had a previous rapid HIV-positive test result. Abbreviations: HTS, HIV testing services; PEP, post-exposure prophylaxis.

3.2 | HIV-positive tests

The overall confirmed HIV positivity rate among clients who had ever used PEP was 2%, with 426 testing HIV positive. The HIV-positive clients were clustered around 30, 60 and 90 days since the last PEP use, with very few positives reporting less than 30 days since the last PEP use (Figure 1A). Of the 426 HIV-positive individuals, 10% were diagnosed within 95 days after the last PEP use (Figure 1B).

3.3 | HTS cohort for PEP

Of the 21,298 HTS encounters where clients reported PEP use, we excluded 326 (1.5%) encounters: 180 (0.8%) without a previous HIV status, 40 (0.2%) with invalid/inconsistent HIV status, 93 (0.4%) with previous HIV-positive results and 13 (0.1%) were for children aged 2 years who had previous rapid HIV test (HIV-exposed status) (Figure 2). Among the remaining 20,972 (98.5%) HTS encounters with negative HIV test results, 19,129 (91.2%) encounters were further excluded based on the following criteria: HIV tests were performed more than 35 days before PEP initiation or more than 7 days after PEP initiation or time since last PEP was more than 65 days, date of last PEP use was more than 65 days and follow-up HIV testing occurred beyond 95 days post-PEP initiation. A cohort of 1847 (8.8%) HTS clients met the inclusion criteria: baseline HIV-negative results and a follow-up HIV test within 95 days of PEP initiation.

3.4 | Characteristics and HIV seroconversion among HTS clients included in the cohort study component

Among 1847 HTS clients included in the cohort analysis, 1055 (57.1%) were male (Table 2). Half (n = 927, 50.2%) was aged 20–29 years, followed by those aged 30–39 years (n = 460, 24.9%), while 292 (15.8%) were under 20 years. The median time since the previous HIV test was 30 days (IQR: 30–61), while the median time since the last PEP use was 3 days (IQR: 1–30). Nearly half of the clients (n = 892, 48.3%) were classified as having a low HIV risk. However, 581 (31.6%) reported ongoing HIV risk, 329 (17.8%) reported a high HIV-risk event within the last 3 months and risk assessment was not conducted for 45 (2.4%). Regarding partner's HIV status, 752 (40.7%) HTS clients reported having an HIV-negative partner, 625 (33.8%) indicated their partner's HIV status was unknown, 106 (5.8%) reported having an HIV-positive partner and 364 (19.7%) reported having no partners.

There was no association between sex and HIV exposure categories (Table 3). However, significant associations were found between age group and partner's HIV status with the client's classification of HIV exposure. Children aged 2–12 years were more frequently categorized as having a low risk of exposure to HIV (n = 78, 69.6%), while 12 (10.7%) had ongoing risk and 21 (18.8%) had a recent high HIV-risk event in the last 3 months. The majority of individuals who reported having an HIV-negative partner or no partner were frequently classified as having low risk (n = 566, 75.3% and n = 263, 72.3%, respectively). In contrast, individuals with partners whose HIV status was unknown or HIV positive were more often classified as having high or ongoing risk.

A total of five individuals seroconverted, yielding a seroconversion rate of 2.08 (0.87–4.99) per 100 person-years: two males (1.42 [0.34–5.67] per 100 person-years) and three females (3.02 [0.97–18.05] per 100 person-years). Of the individuals who seroconverted, one reported a high-risk event in the past 3 months, three had ongoing HIV exposure and one was categorized as low exposure. Regarding partner HIV status, two did not know their partner's HIV status, one had an HIV-positive partner on ART, one had no partner and one had a partner who was HIV negative.

Table 2. Characteristics of HTS cohort clients who reported PEP use, November 2022–August 2024

	N	%
Sex		
Male	1055	57.1
Female	792	42.9
Age at HTS (years)		
2–12	112	6.1
13–19	180	9.8
20–29	928	50.2
30–39	460	24.9
40–49	127	6.9
50+	40	2.2
Median time (days) since the previous HIV test (IQR)	30.0	(30–61)
Median time (days) since the last PEP (IQR)	3.0	(1–30)
Classification of client's risk of exposure to HIV		
Low risk	892	48.3
Ongoing risk	581	31.5
High HIV-risk exposure event in the last 3 months	329	17.8
Risk assessment not done	45	2.4
Access point for HTS		
Facility	1789	96.9
Community	58	3.1
Partners HIV status		
Negative	752	40.7
HIV status unknown	625	33.8
HIV positive, on ART	100	5.4
HIV positive, not on ART	5	0.3
HIV positive, ART status unknown	1	0.1
No partner	364	19.7

Abbreviations: ART, antiretroviral therapy; HTS, HIV testing service; IQR, interquartile range; PEP, post-exposure prophylaxis.

4 | DISCUSSION

This study is the first globally to use a large-scale national routine programme data to describe characteristics of HTS clients who reported PEP use and their HIV seroconversion rates. The use of nationally representative, real-world data strengthens the relevance of the study and provides unique insights into national PEP implementation. Both the cross-sectional and cohort components of this study showed that the majority of HTS clients who reported PEP use at any time prior were aged 20–29 years, with a higher proportion being male, and a sizeable proportion having substantial ongoing HIV exposure. In the cohort analysis, HTS clients with ongoing HIV exposure were those with unknown partner HIV status

Table 3. HIV exposure category by characteristics of clients with baseline HIV test who reported PEP use, November 2022–July 2024

	Classification of risk of exposure to HIV					
	Total	High HIV-risk exposure event last 3 months	Ongoing risk	Low risk	Risk assessment not done	Chi-square
Sex						0.200
Male	1055 (57.1%)	192 (58.5%)	346 (59.6%)	488 (54.7%)	29 (64.4%)	
Female	792 (42.9%)	137 (41.6%)	235 (40.5%)	404 (45.3%)	16 (35.6%)	
Age group						<0.001
2–12	112 (6.1%)	21 (18.8%)	12 (10.7%)	78 (69.6%)	1 (0.9%)	
13–24	692 (37.5%)	130 (18.8%)	213 (30.8%)	333 (48.1%)	16(2.3%)	
25–49	1003(54.3)	174 (17.3%)	338(33.7%)	463 (46.2%)	28 (2.8%)	
50+	40 (2.2%)	4 (10%)	18 (45%)	18 (45%)	0 (0.0%)	
Partner's HIV status						<0.001
Unknown	625 (33.8%)	190 (30.4%)	372 (59.5%)	55 (30.4%)	8 (1.3%)	
Positive not on ART	5 (0.3%)	0 (0.0%)	3 (60.0%)	2 (0%)	0 (0%)	
Positive	1 (0.1%)	0 (0.0%)	1 (100%)	0 (0.0%)	0 (0.0%)	
ART Unknown						
Positive on ART	100 (5.4%)	12 (12.0%)	80 (80.0%)	6 (6.0%)	2 (2.0%)	
Negative	752 (40.7%)	69 (9.2%)	88 (11.7%)	566 (75.3%)	29 (3.9%)	
No partner	364 (19.7%)	58 (15.9%)	37 (10.2%)	263 (72.3%)	6 (1.6%)	

and those with HIV-positive partners. The study found a high HIV seroconversion of 2% per year. The findings have several implications for the national PEP programme.

Similar to other studies [12–15], the majority of the PEP users were young adults and males. In SSA, including Malawi, young adults are at elevated risk of HIV exposure due to increased sexual activity, often involving multiple or older partners [16]. The heightened risk awareness may drive more young adults to seek PEP following potential exposures such as condom slippage or breakage, sexual assault and unprotected consensual sexual intercourse. The gender disparity in PEP access may stem from structural and socio-cultural barriers, including financial constraints, and stigma surrounding sexual violence disclosure despite women generally having higher health-seeking behaviour [17, 18]. Women who experience sexual assault—especially from intimate partners—may not seek care [19]. Integrating PEP education and awareness campaigns with broader sexual and reproductive health services may empower young women to understand and access PEP.

Our study found that 4% of HTS clients who reported PEP use were children aged 2–12 years. Although this study did not collect specific details on HIV exposure, previous research highlights child sexual assault as a significant issue in Malawi [20, 21]. Additionally, anecdotal reports from facilities with one-stop centres (those with a high number of child PEP users) reported that child sexual assault was the most common HIV exposure. In the past two decades, the Government of Malawi has collaborated with international organizations to combat violence against children, encourage reporting of sexual violence and establish national referral pathways connecting communities, law enforcement, social support networks and health facilities [22]. Given the significant number of children accessing PEP, scaling up educational campaigns on child sexual abuse prevention and strengthening national referral pathways to encourage prompt reporting are warranted.

The study identified a seroconversion rate of 2% per year, with five individuals seroconverting. While comparable to other studies [23, 24], the HIV seroconversion is relatively higher. Most studies on PEP, particularly among healthcare workers (occupational PEP), report low seroconversion rates, often less than 1% [25, 26]. In non-occupational PEP use, seroconversion rates vary from 1% to 2.9% [27, 28], influenced by factors such as adherence to PEP regimens,

ongoing HIV exposure and lack of proper follow-up. Although PEP initiation timing and adherence were not determined, most individuals who seroconverted had ongoing HIV exposure (unknown partner HIV status or HIV-positive partner), emphasizing the need for enhanced prevention measures, including condom use, partner HIV testing and transitioning from PEP to PrEP for those at continued risk [29–31].

Forty-one percent of PEP users reported having HIV-negative partners, with 75% classified as low risk, which contrasts with typical HIV risk profiles for individuals seeking PEP. There are two possible explanations for the discrepancy. First, underreporting of high-HIV risk exposures, such as concurrent condomless partnerships or undisclosed sexual networks—may have resulted in misclassification of participants' HIV risk status. People may underreport these events due to stigma and undesirable aspects [32, 33]. Second, PEP may have been initiated due to high HIV exposure events (e.g. occupational incidents or sexual assault), while subsequent risk assessment reflected the participants' current low status rather than the prior high-risk exposure that prompted PEP use.

Reporting PEP uptake, HIV exposure and completion rates in the Malawi HIV programme is challenging due to the lack of standardized tools. The HIV testing register data used in this study tracked whether clients had previously received PEP during HIV testing encounters, which was designed to monitor HTS client return rates. However, effective monitoring of PEP use remains an unmet need. Implementing a standardized PEP register that document HIV exposures, along with baseline and follow-up testing results, would improve client tracking, enhance continuity of care, and ultimately help reduce seroconversion rates.

The study findings should be interpreted considering the following limitations. First, the prevalence of "ever used PEP" was calculated based on the HTS encounters, where some people may have received HTS multiple times, potentially leading to an overestimate. Second, reliance on self-reported previous HIV testing history and use of PEP, which is subject to recall bias and misreporting, risks inaccurate estimation of ever-used PEP. Third, the estimation of the HIV incidence may be influenced by the exclusion criteria, which may affect generalizability. Fourth, selection bias may affect the results, as HTS clients who returned for follow-up HIV testing might differ from those who did not, potentially leading to an overestimation or underestimation of the true seroconversion rates. Lastly, some clients who were included in the HIV seroconversion analysis might have already acquired HIV but tested HIV negative before starting PEP, hence overestimating the observed seroconversion rates. Despite these limitations, the study accurately reflects current practices in PEP programme implementation and highlights critical areas for improvement.

5 | CONCLUSIONS

Our findings show a high HIV seroconversion rate among PEP users. The majority of PEP users were male, suggesting a potential gap in reaching women. Younger individuals also represented a large proportion of PEP users. Many continued to engage in high HIV-risk exposure behaviours, underscoring the need to promote condom use, partner HIV testing, PrEP access, alongside other evidence-based safer sex strategies. PEP M & E tools are essential for effectively monitoring PEP uptake, adherence and seroconversion rates. Further research is necessary to understand the type of risk of exposure to HIV better.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

LG, WW, HT and TC designed the study. WW, ZZ, AD and DB conducted data analysis. HT, TC and AJ interpreted the data. HT, LG, WW and TC wrote a draft paper. All authors reviewed and approved the final paper.

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DISCLAIMER

The content is solely the responsibility of the authors and does not necessarily represent the official views of the Malawi Ministry of Health and the donors.

DATA AVAILABILITY STATEMENT

The dataset used in this study is available from the corresponding author upon reasonable request.

REFERENCES

1. The urgency of now: AIDS at a crossroads. Geneva: Joint United Nations Programme on HIV/AIDS; 2024.
2. World Health Organization. Prevention. Department of Global HIV, Hepatitis and Sexually Transmitted Infections Programmes; 2024.
3. Kennedy C, Dawit R, Yeh P. Web annex B. Systematic review findings and GRADE tables. In: Guidelines for HIV post-exposure prophylaxis. Geneva: World Health Organization; 2024.
4. Ford N, Irvine C, Shubber Z, Baggaley R, Beanland R, Vitoria M, et al. Adherence to HIV postexposure prophylaxis: a systematic review and meta-analysis. AIDS. 2014;28(18):2721–27. doi: 10.1097/QAD.0000000000000505
5. Malawi Ministry of Health. Clinical management of HIV in children and adults: Malawi integrated clinical HIV guidelines. 2nd edition. 2014. Available from: https://dms.hiv.health.gov.mw/link/3xmvrbm0
6. Malawi Ministry of Health and Population. Malawi guidelines for clinical management of HIV in children and adults. 5th edition. 2022. Available from: https://dms.hiv.health.gov.mw/link/ih4m1z0g
7. ScanForm: scalable data collection and analysis from handwritten documents. By Quantitative Engineering Design (QED.ai). 2023. Available from: https://scanform.qed.ai
8. Mulambia Y, Miller AJ, MacDonald G, Kennedy N. Are one-stop centres an appropriate model to deliver services to sexually abused children in urban Malawi? BMC Pediatr. 2018;18(1):145.
9. HIV, syphilis and hepatitis B integrated rapid testing and counselling guidelines and standard operating procedures. Malawi Ministry of Health; 2023.
10. Consolidated guidelines on person-centred HIV strategic information: strengthening routine data for impact. Geneva: World Health Organization; 2022.

11. QED.ai. ScanForm [Internet]. [cited 2024 Oct 10]. Available from: https://about.scanform.qed.ai/
12. Castoldi L, Berengan MM, Both NS, Fortes VS, Pinheiro TV. HIV post-exposure prophylaxis in vulnerable populations: a retrospective longitudinal study in a public health outpatient clinic in Rio Grande do Sul, Brazil, 2015–2018. Epidemiol Serv Saúde. 2021;30(2):e2020646.
13. Carneiro da Silva F, Magno L, Antônio de Souza Teles Santos C. Prescription of HIV post-exposure prophylaxis in emergency care units and return for follow-up appointments in specialized services in Salvador, Brazil, 2018: a cross-sectional study. Epidemiol Serv Saúde. 2024;33:e2023642. doi: 10.1590/S2237-96222024V33E2023642.en
14. Onyedum CC, Chukwuka C, Iyoke CA, Omotola OF. HIV postexposure prophylaxis (PEP) in a Nigerian tertiary health institution. J Int Assoc Physicians AIDS Care (Chic). 2011;10(3):171–75.
15. Kouanfack C, Meli H, Cumber SN, Bede F, Nkfusai CN, Ijang PY, et al. Non-occupational HIV post-exposure prophylaxis: a 10-year retrospective review of data following sexual exposure from Yaoundé Central Hospital, Cameroon. Int J MCH AIDS. 2019;8(2):138–45.
16. Wilson CN, Sathiyasusuman A. Associated risk factors of STIs and multiple sexual relationships among youths in Malawi. PLoS One. 2015;10(8):e0134286.
17. Abrahams N, Jewkes R. Barriers to post exposure prophylaxis (PEP) completion after rape: a South African qualitative study. Cult Health Sex. 2010;12(5):471–84.
18. Goparaju L, Praschan NC, Warren-Jeanpiere L, Experton LS, Young MA, Kassaye S. Stigma, partners, providers and costs: potential barriers to PrEP uptake among US women. J AIDS Clin Res. 2017;8(9):730. doi: 10.4172/2155-6113.1000730
19. Dickson KS, Boateng ENK, Adzrago D, Addo IY, Acquah E, Nyarko SH. Silent suffering: unveiling factors associated with women's inability to seek help for intimate partner violence in sub-Saharan Africa (SSA). Reprod Health. 2023;20(1):110.
20. Mason C, Kennedy N. Sexual abuse in Malawi: patterns of disclosure. J Child Sex Abus. 2014;23(3):278–89.
21. Mulambia Y, Miller AJ, MacDonald G, Kennedy N. Are one-stop centres an appropriate model to deliver services to sexually abused children in urban Malawi? BMC Pediatr. 2018;18(1):145.
22. Government of Malawi. National Referral Pathways Guidance Notes. 2020. Available at: https://intdev.tetratecheurope.com/wp-content/uploads/2022/02/7.-Referral-Pathways-Booklet-English.pdf
23. Roland ME, Myer L, Martin LJ, Maw A, Batra P, Arend E, et al. Preventing human immunodeficiency virus infection among sexual assault survivors in Cape Town, South Africa: an observational study. AIDS Behav. 2011;16(4):990–98.
24. Carries S, Muller F, Muller FJ, Morroni C, Wilson D. Characteristics, treatment, and antiretroviral prophylaxis adherence of South African rape survivors. J Acquir Immune Defic Syndr. 2007;46(1):68–71.
25. Shiao JS, Guo YL, McLaws M-L. Risk of seroconversion estimated from a percutaneous injury reporting system. Occup Environ Med. 2011;68(Suppl 1):A103–A103.
26. Abubakar S, Iliyasu G, Dayyab FM, Inuwa S, Tudun Wada RA, Sadiq NM, et al. Post-exposure prophylaxis following occupational exposure to HIV and hepatitis B: an analysis of a 12-year record in a Nigerian tertiary hospital. J Infect Prev. 2018;19(4):184–89.
27. Pierce AB, Yohannes K, Guy R, Watson KM, Armishaw J, Price B, et al. HIV seroconversions among male non-occupational post-exposure prophylaxis service users: a data linkage study. Sex Health. 2011;8(2):179–83.
28. Schechter M, do Lago RF, Mendelsohn AB, Moreira RI, Moulton LH, Harrison LH, et al.; Praca Onze Study Team. Behavioral impact, acceptability, and HIV incidence among homosexual men with access to postexposure chemoprophylaxis for HIV. J Acquir Immune Defic Syndr. 2004;35(5):519–25.
29. Leal L, Torres B, León A, Lucero C, Inciarte A, Diaz-Brito V, et al. Predictive factors for HIV seroconversion among individuals attending a specialized center after an HIV risk exposure: a case–control study. AIDS Res Hum Retroviruses. 2016;32(10–11):1016–21.
30. O'Byrne P, MacPherson P, Orser L. Nurse-led HIV PEP program used by men at high risk for HIV seroconversion. J Assoc Nurses AIDS Care. 2018;29(4):550–59.
31. Nugent D, Gilson R. Where next with preexposure prophylaxis? Curr Opin Infect Dis. 2017;30(1):44–9.
32. O'Sullivan LF. Challenging assumptions regarding the validity of self-report measures: the special case of sexual behavior. J Adolesc Health. 2008;42(3):207–8.
33. Catania JA, Gibson DR, Chitwood DD, Coates TJ. Methodological problems in AIDS behavioral research: influences on measurement error and participation bias in studies of sexual behavior. Psychol Bull. 1990;108(3):339–62.

SUPPORTING INFORMATION

Additional information may be found under the Supporting Information tab for this article:
Figure S1: 3-test diagnostic algorithm for HIV in Malawi

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RESEARCH ARTICLE

Poor post-exposure prophylaxis completion despite improvements in post-violence service delivery in 14 PEPFAR-supported sub-Saharan African countries, 2018–2023

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Abstract

Introduction: Sexual violence (SV) affects millions globally and has a well-documented bidirectional association with HIV. Post-exposure prophylaxis (PEP) is a critical, yet often underutilized, HIV prevention tool in post-SV care. Despite its potential impact to reduce HIV transmission, SV care remains an overlooked service delivery point for HIV prevention. The U.S. Centers for Disease Control and Prevention (CDC), as part of the President's Emergency Plan for AIDS Relief (PEPFAR), supports PEP provision within broader post-violence care (PVC) services. Understanding PEP utilization is crucial for optimizing service delivery and HIV prevention efforts.

Methods: Using Monitoring Evaluation and Reporting data from fiscal years 2018–2023, we conducted a descriptive analysis of clients who received PVC and SV services through CDC-supported programming in 14 sub-Saharan African countries.

Results: From 2018 to 2023, the annual number of clients receiving any PVC, and specifically SV, services increased by 233% (in 2018, *n* = 206,764; in 2023, *n* = 689,349) and 163% (in 2018, *n* = 42,848; in 2023, *n* = 112,838), respectively. Fewer than half of SV clients completed PEP (38% in 2018, *n* = 16,103; 31% in 2023, *n* = 35,118). Across all years combined, most SV clients (female: 185,414; male: 59,618) were aged 15–19 years. The age band and sex with the lowest proportion of clients completing PEP were males aged 15–19 (4%, *n* = 2296).

Conclusions: The findings underscore a critical gap between the scaling of SV services and the completion of PEP within violence response programmes. Innovative implementation science approaches may help to identify and address barriers inhibiting effective PEP delivery and uptake within PVC service delivery programmes. Enhancing PEP uptake and completion can support mitigating the bidirectional relationship between violence and HIV acquisition, particularly among vulnerable populations like adolescents and young adults. Low PEP coverage also reflects missed opportunities, particularly among adolescent girls and young women, who experience disproportionate rates of HIV acquisition.

Keywords: Africa; HIV prevention; HIV; intimate partner violence; post-exposure prophylaxis; sexual violence

Additional information may be found under the Supporting Information tab of this article.

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1 | INTRODUCTION

Violence is the intentional use of physical force or power, threatened or actual, against oneself or against a group or community that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment or deprivation [1, 2]. Globally, it is estimated that one in four ever-married/partnered adolescent girls experiences physical and/or sexual violence (SV) from an intimate partner once in their lifetime [2]. In sub-Saharan Africa (SSA), the prevalence of experiencing lifetime intimate partner violence (IPV) is 33% [2].

The United States Centers for Disease Control and Prevention (U.S. CDC) defines sexual violence as sexual activity with consent that is not obtained or freely given [1]. Globally, SV has been shown to have a bidirectional positive association with HIV [2–4]. The impact of SV on HIV is seen across the clinical cascade. Across six high-burden countries in SSA, women exposed to physical and/or sexual IPV in the past 12 months were 3.2 times more likely to have acquired HIV [5]. Several violence against children (boys and girls) have described the associations between SV and HIV, including the ability of survivors of violence to negotiate prevention methods [6–8]. Studies have shown that those who can negotiate prevention methods have a lower risk of HIV acquisition [6–8].

Post-exposure prophylaxis (PEP) refers to the medications (3-drug regimen) given to prevent the transmission of HIV following a potential exposure [9, 10]. The World Health Organization (WHO) and the U.S. CDC recommend that persons who experience SV receive PEP within 72 hours (28-day course) to prevent HIV acquisition [9]. The United States President's Emergency Plan for AIDS Relief (PEPFAR), the most significant bilateral funder of HIV prevention and treatment programmes worldwide (more than 50 countries), makes a substantial investment in violence prevention and response programming [6, 11, 12]. This includes funding for violence prevention and response to more than 20 countries in SSA [12]. PEPFAR-supported health facilities provide a minimum package of services for SV survivors, which includes care for injuries, rapid HIV testing with referral to care and treatment (as appropriate), PEP, sexually transmitted infection (STI) screening/testing, STI prophylaxis and treatment, emergency contraception and counselling [9, 11, 13].

Despite the expansion and investment in violence service provision in U.S. CDC/PEPFAR-supported countries, the coverage of PEP use among SV survivors in this context has rarely been explored in low-resource settings [9, 14–16]. Furthermore, despite WHO guidance for the use of PEP in cases of sexual assault, this remains an understudied field, especially within SSA [9, 14, 17, 18]. PEPFAR's mandated annual reporting on services provides a resource for analysing trends and geographic variations in PEP coverage. This study is the first description of PEP utilization within the U.S. CDC's PEPFAR-supported violence service delivery programmes in SSA.

2 | METHODS

PEP data was available from 29 PEPFAR-supported countries. For this analysis, we restricted the analysis to data from U.S. CDC/PEPFAR-supported countries in SSA. We analysed PEPFAR's Monitoring, Evaluation, and Reporting (MER) data on post-violence service provision from October 2018 to September 2023 (fiscal years) across 14 SSA countries. This system semiannually captures aggregate programme data and information on the minimum package of post-violence services provided in post-violence clinical settings within PEPFAR-supported sites. Fifteen SSA countries were excluded from the data due to incomplete data for several years. We included only data reported by U.S. CDC-supported implementing partners from the 14 countries with data for all or nearly all included years (Cameroon, Cote d'Ivoire, Democratic Republic of Congo, Eswatini, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Nigeria, Rwanda, Tanzania, Uganda and Zambia). The primary variable of interest was the number of persons receiving post-violence clinical care categorized by age group, sex and among individuals who experienced SV, completion of PEP (yes/no) [12, 13].

Data also includes the categorization of type of assault: (1) physical and emotional violence (yes/no) and (2) SV (yes/no). To avoid double-counting, services for an individual who has experienced both sexual and physical and/or emotional violence are only counted under the SV indicator. Those who did not experience SV are counted under the physical and/or emotional violence indicator as appropriate. PEP completion is counted when an individual who has experienced sexual assault receives post-rape care and a client initiates PEP and self-reports completing the entire course of treatment according to international guidance and returns for a follow-up visit [9, 13]. Data on the number of clients initiating and not completing PEP were unavailable and not included in this analysis. All facilities providing the minimum package of services are required to have all providers trained on the provision of post-violence care (PVC), including PEP. The numbers of clients eligible for PEP and offered but declined PEP are not captured. Additionally, clients may have received PEP and completed the course without reporting back to the clinic. We performed a descriptive analysis using Microsoft Excel.

2.1 | Ethical review

PEPFAR MER data are covered by a protocol reviewed by the U.S. CDC, deemed not research, and conducted consistent with applicable federal law and U.S. CDC policy (45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq). Only aggregated data with no personal identifying information were used for this analysis; hence there was no need for informed consent by the clients.

3 | RESULTS

From 2018 to 2023, the total client encounters for annually receiving PVC services increased by 233% in the 14 countries, from 206,764 in 2018 to 689,349 in 2023 (Figure 1 and Table S1). Three East African countries, Kenya (n = 1,171,259), Tanzania (n = 644,574) and Uganda (n = 414,031), reported the highest volume of PVC services delivered at U.S. CDC-supported facilities. During this same period, the total volume of SV services increased by 163%, from 42,848 in 2018 to 112,838 in 2023 (Figure 1, Table 1 and Table S1). Four East African countries, Ethiopia (n = 43,363), Kenya (n = 101,519), Tanzania (n = 100,621) and Uganda (n = 137,595), reported the highest volume of SV services delivered. The number of U.S. CDC-supported facilities providing the minimum service package for PVC increased from 2818 in 2018 to 5220 in 2023 (Table 1). Three countries (Cote d'Ivoire, Lesotho and Mozambique) saw an adverse change in the number of sites providing PVC services. Rwanda was the only country to maintain a constant number of sites providing PVC services. In contrast, the others all had a

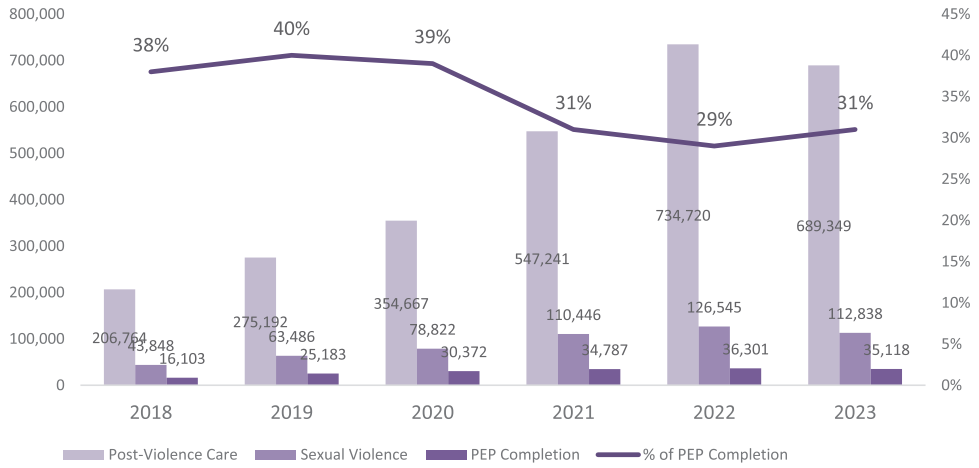

Figure 1. Annual proportion of PEP completion among clients who received post-violence care and sexual violence services in 14 countries supported by U.S. CDC/PEPFAR, 2018–2023. *Sexual violence = denominator for percentage.

Table 1. Number of sites providing the minimum package of post-violence care service in 14 countries supported by U.S. CDC/PEPFAR, 2018–2023

Country	2018		2019		2020		2021		2022		2023		
	All sites (*n*)	Minimum package (*n*, %)	All sites (*n*)	Minimum package (*n*, %)	All sites (*n*)	Minimum package (*n*, %)	All sites (*n*)	Minimum package (*n*, %)	All sites (*n*)	Minimum package (*n*, %)	All sites (*n*)	Minimum package (*n*, %)	Change (*n*)
Cameroon	344	6 (1.7)	362	10 (2.8)	301	61 (20.3)	144	110 (76.4)	453	101 (22.3)	495	71 (14.3)	65
Cote d'Ivoire	1344	158 (11.8)	1458	107 (7.3)	974	145 (14.9)	1345	138 (10.3)	572	188 (32.9)	588	133 (22.6)	−25
DRC	345	35 (10.1)	357	52 (14.6)	349	50(143)	349	37 (10.6)	380	48 (12.6)	382	39 (10.2)	4
Eswatini	140	30 (21.4)	140	2014.3)	274	16 (5.8)	180	34 (18.9)	174	48 (27.6)	115	35 (30.4)	5
Ethiopia	1131	177 (15.6)	1113	234(21.0)	1184	23519.8)	703	268 (38.1)	1746	328 (18.8)	1859	292 (15.7)	115
Kenya	1457	534 (36.7)	1440	634 (44.0)	1857	713 (38.4)	1416	965 (68.1)	1396	1162 (83.2)	1408	1172 (83.2)	638
Lesotho	111	–	123	–	122	35(28.7)	102	45 (44.1)	99	44 (44.4)	99	32 (32.3)	−3
Malawi	123	–	522	10 (1.9)	538	15(2.8)	582	46 (7.9)	582	57 (9.8)	589	60 (10.2)	50
Mozambique	1006	517 (51.4)	1025	576 (56.2)	1546	43027.8)	1655	415 (25.1)	1703	442 (26.0)	1722	440 (25.6)	−77
Nigeria	1560	306 (19.6)	1742	307 (17.6)	1241	372 (30.0)	1426	426 (29.9)	1421	496 (34.9)	1426	472 (33.1)	166
Rwanda	303	25 (8.3)	299	26 (8.7)	280	25 (8.9)	300	27 (9.0)	271	25 (9.2)	264	25 (9.5)	0
Tanzania	3224	463 (14.4)	3304	613(18.6)	2167	583 (26.9)	2209	862(39.0)	2078	1042 (50.1)	2102	1050 (50.0)	587
Uganda	1650	566 (34.3)	1752	732 (41.8)	1762	764 (43.1)	1860	857 (46.1)	1801	869 (48.3)	2052	870 (42.4)	304
Zambia	1099	1 (0.1)	1128	1 (0.1)	1134	1 (0.1)	1336	152 (11.4)	1212	490 (40.4)	1303	529 (40.6)	528
Total	13,837	2818	14,765	3322	13,729	3445	13,607	4382	13,888	5340	14,404	5220	2402

Note: From 2018 to 2023, the number of SV clients completing PEP decreased, with fewer than half completing PEP in 2018 (37%, *n* = 16,103) and in 2023 (31%, *n* = 35,118) (Table 2). More than half of the countries (DRC, Eswatini, Ethiopia, Kenya, Malawi, Rwanda, Tanzania and Uganda) reported that fewer than 50% of SV clients completed PEP over the 6 years.
Abbreviation: DRC, Democratic Republic of the Congo.

net increase in the number of facilities providing services (Table 2).

4 | DISCUSSION

Our study demonstrates a significant expansion in PVC service delivery (a 163% increase from 2018 to 2023) in these countries. The total number of sites providing PVC services and the total number of clients reported to have sought services show significant growth during the 6-year study period. However, our findings also highlight two key areas of concern: the disproportionately low PEP completion rate among women aged 40–44 and poor PEP completion rates among adolescent boys and young men. Over the study period, the percent change in PEP completion decreased by 7 percentage points. This may suggest poor PEP completion within SSA's CDC/PEPFAR-supported PVC service delivery programmes. However, given the limitations of the data, it is difficult to characterize the change.

We also found that while adolescents make up a large proportion of SV clients, their PEP completion rates are low. This represents a missed opportunity for prevention among a population at high risk for HIV, as women aged 15 years and older account for 61% of all people living with HIV in 2022, with those aged 15–24 years at the highest risk of HIV acquisition [5]. A combination of factors such as quality and availability of services, enabling policies, knowledge of the importance of PVC services, and social attitudes and norms may have played a significant part in service uptake [5].

The findings highlight the poor understanding of PEP initiation and completion among SV clients across the 14 CDC/PEPFAR countries. More than half of the countries in this analysis reported less than 50% PEP completion among those eligible for PEP services. Globally, there are low completion rates of PEP with wide variations, such as in the United States (27.4%), Barcelona (29.0%), Brussels (60.0%) and South Africa (58.5%). However, all indicate suboptimal completion, leaving persons at risk of HIV [16, 19–21]. Barriers to PEP completion are many and include side effects of the drugs, fear of blame for the sexual assault, lack of social support, psychological trauma related to SV and limited knowledge about the importance of completing the entire course of PEP [14, 17, 19]. These findings on PEP completion suggest that more investments in psychological support and adherence counselling for survivors of SV might lead to better outcomes for both adherence and completion [23–25]. One systematic review and meta-analysis also pointed to higher adherence rates seen in low-income settings (53.2%, 95% CI 43.5–62.9%) compared with high-income countries (33.3%, 95% CI 26.0–40.6%) ($p<0.01$) [17]. Such differences have been explained to be due to different attitudes towards HIV and medications, and as such, continued investments in addressing other barriers to PEP completion may lead to higher completion rates [22–24]. Despite fewer Adolescent Girls and Young Women (AGYW) aged 15–24 years acquiring HIV in SSA compared to a decade ago, many still face a substantial risk of acquiring HIV [5, 25], as shown by the large number of young female and male clients seeking SV services in this study. The transmission rate of HIV varies depending on the modality of sexual contact; receptive anal exposure carries the highest risk (0.8–3.0%), followed by receptive vaginal exposure (0.1–0.5%) and oral sex (0.0001–0.01%) [19].

Particularly troubling is the low PEP completion among adolescent boys, highlighting the need for tailored violence prevention and destigmatization efforts. Men and boys often experience severe stigma around experiences of SV in the community and when seeking PVC services. Furthermore, PVC services are usually tailored and designed around the needs of women and heteronormative standards. The findings emphasize the urgent need and demand for PVC services that meet the needs of men and boys.

Low PEP completion is not only a missed opportunity to prevent HIV in the aftermath of SV but also represents a larger opportunity for further intervention and support, including introducing other biomedical options for their longer-term health needs such as family planning and Pre-Exposure Prophylaxis (PrEP). Engagement with survivors at the point of PEP completion may present a critical moment to begin to mitigate the cascading effects of violence, given the well-established link between experiencing violence and HIV risk behaviours.

This study has several strengths: a large-scale country analysis (14 SSA) with 6-year trend data, standardized data collections, focus on an understudied area, and programmatic relevance to improve HIV and PVC services.

This study has several limitations. First, we only included data from CDC-supported facilities through the PEPFAR programme in the selected countries. Thus, we may not represent all persons seeking SV/PVC services in SSA or in PEPFAR programmes supported by other agencies. Second, our data does not account for those clients who experienced sexual assault but were not eligible for PEP initiation (due to late presentation and/or high ongoing risk). This might mean we are underestimating PEP completion by excluding clients not eligible for PEP in the denominator. Third, procedures for recording visits and PEP provision and availability varied across settings. Not all facilities could verify PEP completion by clients, which may have resulted in an underestimation of completion. Fourth, given the high prevalence of HIV in some countries, it is possible that some clients were not eligible for PEP due to their HIV status. Fifth, our data does not allow us to capture the overlap of those clients who may have experienced physical/emotional violence in addition to SV at the same time. Finally, while post-violence clinical service provision may appear to be increasing, this does not necessarily mean that PEP initiation and completion would increase, as effective violence prevention programmes may simultaneously have been implemented over this period.

5 | CONCLUSIONS

This study underscores the critical gap between scaling SV clinical services and PEP completion within violence programmes. Enhancing PEP awareness and uptake is essential to implementing successful violence programmes and may help mitigate HIV acquisition, particularly among vulnerable populations like adolescents and young adults. Training of healthcare providers on the eligibility requirements and appropriate

Table 2. Percentage of all sexual violence clients who completed PEP in 14 countries supported by CDC/PEPFAR, 2018–2023

Country	2018			2019			2020			2021			2022			2023		
	PEP (*n*)	SV (*n*)	Proportion (%)	PEP (*n*)	SV (*n*)	Proportion (%)	PEP (*n*)	SV (*n*)	Proportion (%)	PEP (*n*)	SV (*n*)	Proportion (%)	PEP (*n*)	SV (*n*)	Proportion (%)	PEP (*n*)	SV (*n*)	Proportion (%)
Cameroon	85	86	98.8	45	186	24.2	283	424	66.7	521	817	63.8	462	809	57.1	415	625	66.4
Cote d'Ivoire	351	647	54.3	209	261	80.1	399	497	80.3	540	617	87.5	571	801	71.3	800	872	91.7
DRC	233	463	50.3	222	486	45.7	164	220	74.5	261	432	60.4	508	953	53.3	386	822	47.0
Eswatini	160	677	23.6	104	882	11.8	182	327	55.7	253	481	52.6	365	846	43.1	115	781	14.7
Ethiopia	1398	3311	42.2	2499	5832	42.8	1853	6025	30.8	2509	7511	33.4	3224	10,625	30.3	3258	10,059	32.4
Kenya	3417	7493	45.6	4371	8815	49.6	5541	11,081	50.0	7796	20,655	37.7	6827	29,623	23.0	6402	23,852	26.8
Lesotho	0	0	0.0	0	0	0.0	132	172	76.7	252	420	60.0	304	385	79.0	275	393	70.0
Malawi	0	0	0.0	53	99	53.5	704	1265	55.7	902	1522	59.3	831	1734	47.9	814	1653	49.2
Mozambique	2330	3944	59.1	2779	4500	61.8	2539	4121	61.6	3021	5252	57.5	4458	8087	55.1	5005	8516	58.8
Nigeria	2067	3143	65.8	3745	5742	65.2	5112	6447	79.3	3529	5181	68.1	3081	5920	52.0	1561	2646	59.0
Rwanda	1702	5782	29.4	1411	8284	17.0	2264	7692	29.4	2241	7394	30.3	2547	7227	35.2	2065	6896	29.9
Tanzania	2030	5867	34.6	3907	9040	43.2	5330	18,419	28.9	6100	27,451	22.2	4234	22,488	18.8	4810	17356	27.7
Uganda	1818	9713	18.7	5132	17,721	29.0	4265	18,988	22.5	5233	29,186	17.9	5640	30,982	18.2	5380	31005	17.4
Zambia	512	1722	29.7	706	1638	43.1	1604	3144	51.0	1629	3527	46.2	3249	6065	53.6	3832	7362	52.1
Total	16,103	42,848	37.6	25,183	63,486	39.6	30,372	78,822	38.5	34,787	110,446	31.5	36.301	126.545	28.6	35.118	112.838	31

Note: Across all years combined, SV clients were young people aged 15–19 (female: 46%, 185,414; male: 41%, 59,618). However, those with the lowest proportion to have completed PEP were 15–19 for males (4%, *n* = 2296) and 40–44 for females (25%, *n* = 2212) (Table 3). Males across all years, except those aged 40–44 (female: 25%; male: 27%), had lower proportions completing PEP than females.

Abbreviations: DRC, Democratic Republic of the Congo; PEP, % post-exposure prophylaxis completed; PEPFAR, President's Emergency Plan for AIDS Relief; SV, sexual violence.

Table 3. Proportion of all sexual violence clients who completed post-exposure prophylaxis by age band and by sex in 14 countries supported by U.S. CDC/PEPFAR, 2018–2023[a]

Years	Sexual violence		Post-exposure prophylaxis		Percent of SV clients who completed PEP	
	Female *n* (%)	Male *n* (%)	Female *n* (%)	Male *n* (%)	Female %	Male %
<10	37,123 (9)	15,197 (10)	20,784 (12)	2423 (13)	56	16
10–14	61,030 (15)	22,359 (15)	32,863 (20)	2002 (11)	54	9
15–19	185,414 (46)	59,618 (41)	55,312 (33)	2296 (12)	30	4
20–24	48,666 (12)	18,146 (12)	24,408 (15)	2988 (16)	50	17
25–29	30,276 (7)	11,839 (8)	15,458 (9)	3322 (18)	51	28
30–34	15,554 (4)	7286 (5)	7741 (5)	2226 (12)	50	31
35–39	11,366 (3)	5329 (4)	4593 (3)	1484 (8)	40	28
40–44	8877 (2)	3049 (2)	2212 (1)	826 (4)	25	27
45–49	3308 (1)	1652 (1)	1081 (1)	439 (2)	33	26
50+	4559 (1)	2630 (2)	1948 (1)	618 (3)	43	23

Abbreviations: PEP, post-exposure prophylaxis; PEPFAR, President's Emergency Plan for AIDS Relief.
[a]Excludes missing data for sex and age.

prescription of PEP could lead to better rates of PEP completion. Policy and programmatic considerations that may further strengthen programming include strengthening PEP education and awareness campaigns, especially in community settings, and highlighting the importance of timely access to PEP (e.g. Every Hour Matters Campaign), making PEP more readily available including through community-based platforms and task shifting models, implementing targeted support systems for PEP adherence, especially for AGYW, and improving data collection systems to better track the PEP cascade from eligibility to completion [10, 26]. This study does not explore the barriers to accessing, initiating or completing PEP; however, this could be an area for future analysis. Follow-up research may help to identify specific barriers to PEP initiation and completion in different demographic groups, develop and test interventions to improve timely access to PEP and adherence, evaluate the effectiveness of integrated violence and HIV prevention services, and investigate the potential of PEP-to-PrEP for the population at highest risk of HIV acquisition.

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COMPETING INTERESTS

There are no conflicts of competing interest for authors to declare.

AUTHORS' CONTRIBUTIONS

UK and VT encompassed the concept design of the study, data analysis, interpretation of the data and writing the manuscript. All authors contributed to the review and revision of the manuscript. The manuscript underwent a review by all authors, and each one approved the final version.

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DATA AVAILABILITY STATEMENT

Data are available upon request from the authors.

REFERENCES

1. USAID. 2022 U.S. Strategy to Prevent and Respond to Gender-Based Violence Globally. Washington, DC: USAID; 2022.
2. WHO. Global, regional and national prevalence estimates for intimate partner violence against women and global and regional prevalence estimates for non-partner sexual violence against women. Geneva: WHO; 2018.
3. Leddy AM, Weiss E, Yam E, Pulerwitz J. Gender-based violence and engagement in biomedical HIV prevention, care and treatment: a scoping review. BMC Public Health. 2019;19(1):897.
4. Dunkle KL, Decker MR. Gender-based violence and HIV: reviewing the evidence for links and causal pathways in the general population and high-risk groups. Am J Reprod Immunol. 2013;69 Suppl 1:20–6.
5. UNAIDS. The Path that Ends AIDS: Global AIDS update 2023. 2023.

6. Kanagasabai U, Thorsen V, Zhu L, Annor FB, Chiang L, McOwen J, et al. Adverse childhood experiences, HIV and sexual risk behaviors—five sub-Saharan countries, 2018–2020. Child Abuse Negl. 2024;150:106541.
7. Picchetti V, Stamatakis C, Annor FB, Massetti GM, Hegle J. Association between lifetime sexual violence victimization and selected health conditions and risk behaviors among 13–24-year-olds in Lesotho: results from the Violence Against Children and Youth Survey (VACS). 2018.
8. Annor FB, Chiang LF, Oluoch PR, Mang'oli V, Mogaka M, Mwangi M, et al. Changes in prevalence of violence and risk factors for violence and HIV among children and young people in Kenya: a comparison of the 2010 and 2019 Kenya Violence Against Children and Youth Surveys. 2022.
9. WHO. Post-exposure prophylaxis to prevent HIV infection. Geneva: WHO; 2007.
10. WHO. Guidelines for HIV post-exposure prophylaxis. Geneva: WHO; 2024.
11. PEPFAR. The United States President's Emergency Plan for AIDS Relief: United States State Department. 2024. Accessed 2024. https://www.state.gov/pepfar/.
12. Kanagasabai U, Valleau C, Cain M, Chevalier MS, Hegle J, Patel P, et al. Understanding GBV service delivery in CDC-supported health facilities. AIDS Educ Prev. 2023;35:39–51.
13. PEPFAR. Monitoring Evaluation and Reporting Guidance 2.7. PEPFAR; 2023.
14. Abrahams N, Jewkes R. Barriers to post exposure prophylaxis (PEP) completion after rape: a South African qualitative study. Cult Health Sex. 2010;12(5):471–84.
15. Geng EH, Mugwanya KK, Pintye J, Kinuthia J, Abuna F, Lagat H, et al. Integrating preexposure prophylaxis delivery in routine family planning clinics: a feasibility programmatic evaluation in Kenya. PLoS Med. 2019;16(9):1–25.
16. Muriuki EM, Kimani J, Machuki Z, Kiarie J, Roxby AC. Sexual assault and HIV postexposure prophylaxis at an urban African hospital. AIDS Patient Care STDs. 2017;31(6):255–60.
17. Chacko L, Ford N, Sbaiti M, Siddiqui R. Adherence to HIV post-exposure prophylaxis in victims of sexual assault: a systematic review and meta-analysis. Sex Transm Infect. 2012;88(5):335–41.
18. Draughon JE, Sheridan DJ. Nonoccupational postexposure prophylaxis following sexual assault in industrialized low-HIV-prevalence countries: a review. Psychol Health Med. 2012;17(2):235–54.
19. Inciarte A, Leal L, Masfarre L, Gonzalez E, Diaz-Brito V, Lucero C, et al. Post-exposure prophylaxis for HIV infection in sexual assault victims. HIV Med. 2020;21(1):43–52.
20. Malinverni S, Libois A, Gennotte AF, La Morte C, Mols P. Prescription of non-occupational post-exposure HIV prophylaxis by emergency physicians: an analysis on accuracy of prescription and compliance. PLoS One. 2016;11(4):e0153021.
21. Hugo JM, Stall RD, Rebe K, Egan JE, Swardt GD, Struthers H, et al. Anti-retroviral therapy based HIV prevention among a sample of men who have sex with men in Cape Town, South Africa: use of post-exposure prophylaxis and knowledge on pre-exposure prophylaxis. AIDS Behav. 2016;20:S357–S64.
22. Gill MM, Ndimbii JN, Otieno-Masaba R, Ouma M, Jabuto S, Ochanda B. Adherence challenges and opportunities for optimizing care through enhanced adherence counseling for adolescents with suspected HIV treatment failure in Kenya. BMC Health Serv Res. 2022;22(1):962.
23. Brown SJ, Khasteganan N, Brown K, Hegarty K, Carter GJ, Tarzia L, et al. Psychosocial interventions for survivors of rape and sexual assault experienced during adulthood. 2019.
24. Dworkin ER, Menon SV, Bystrynski J, Allen NE. Sexual assault victimization and psychopathology: a review and meta-analysis. 2017.
25. UNAIDS. Women and girls and HIV. Geneva: UNAIDS; 2018.
26. TfG. Every Hour Matters USA: Together for Girls. 2017. Accessed 2024. https://www.togetherforgirls.org/en/resources/every-hour-matters-youth-engagement-toolkit-kenya.

SUPPORTING INFORMATION

Additional information may be found under the Supporting Information tab for this article:

Table S1. Post-violence care service utilization by violence type in 14 countries supported by U.S. CDC/PEPFAR, 2018-2023.

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RESEARCH ARTICLE

Healthcare provider recommendations to improve post-violence care HIV post-exposure prophylaxis access and adherence in Mozambique

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Abstract

Introduction: In Mozambique, post-exposure prophylaxis (PEP) to prevent HIV is offered as part of the essential package of post-violence care services at 1450 health facilities. However, HIV PEP access and adherence continue to be a challenge. Healthcare providers were interviewed to identify and synthesize their recommendations for improving PEP access and adherence.

Methods: We conducted semi-structured, in-depth interviews with 20 adolescent and adult healthcare providers (3 men and 17 women) who had a range of 2–15 years of experience from 20 health facilities across seven provinces during March–August 2023. Data were analysed using inductive and theoretical thematic analysis. We analysed how frequently health providers mentioned specific recommendations.

Results: Regarding PEP access, healthcare providers recommended community education as the most effective strategy (10 mentions). In particular, providers cited the importance of *palestras* [community health talks]. Providers also commonly highlighted the need to have PEP kits prepared (7 mentions) and PEP readily available at health facilities (6 mentions). Regarding PEP adherence, providers recommended client counselling/education (13 mentions) to ensure clients understand the importance of taking PEP, how to properly take PEP and the potential side effects, which can often deter clients from adhering. Additionally, providers highlighted *chamadas preventivas* [follow-up telephone calls] within 2 weeks or so after the initial visit (9 mentions) as the best means to ensure clients complete the full, 28-day regimen and return for retesting after 3 months. Healthcare providers explained that follow-up telephone calls, despite the client living far from the health facility, can create a bond that supports clients. Providers recommended the institutionalization of follow-up telephone calls for consistent implementation in all healthcare facilities that offer PEP.

Conclusions: Interviewed healthcare providers offered valuable insights and recommendations to improve PEP access and adherence, which could be considered for implementation in Mozambique and other sub-Saharan African countries.

Keywords: post-exposure prophylaxis; post-violence care; sexual violence; intimate-partner violence; HIV; access

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1 | INTRODUCTION

Worldwide, 31% of adolescent girls and women aged 15–49 years have experienced violence at some point in their lives, leading to both short- and long-term health consequences including HIV [1]. Women experiencing intimate partner violence (IPV) are 1.5 times more likely to acquire HIV compared with women who had not experienced IPV [2]. Mozambique has established and scaled up violence prevention and response within existing HIV clinical services over the past decade from an initial mere 56 public health facilities providing post-violence care services in 2012 to 1450 public health facilities providing post-violence care services in 2021—an overall 81% coverage of the total 1778 existing health facilities [3].

The essential package of post-violence care services has been defined by the Mozambique Ministry of Health (MoH) and the President's Emergency Plan for AIDS Relief (PEPFAR) to include provision of clinical services, rapid HIV testing with referral to care and treatment as appropriate, sexually transmitted infection (STI) tests/treatment, emergency contraception, additional counselling and referrals as needed (police,

legal, psychosocial support, etc.) and HIV post-exposure prophylaxis (PEP).

HIV PEP is an effective HIV-prevention method that consists of administering antiretrovirals to HIV-seronegative individuals exposed to a potential risk of HIV acquisition for 28 days, starting within 72 hours of exposure [4–9]. In 2005, the MoH published the first PEP guidelines, initially for healthcare providers exposed to HIV at work [10]. In 2011, the national guidelines were revised to expand PEP provision to all health facilities that offered post-violence care services. Since then, HIV PEP has been offered in Mozambique as part of the essential package of post-violence care services [10].

Despite this progress, PEP access and adherence has been a challenge in Mozambique. A study in Mozambique's Zambezia Province demonstrated that almost 60% of survivors of sexual violence arrived more than 72 hours after exposure and were, thus, ineligible for PEP [11]. This trend is not unique to Mozambique. Results from across 15 PEPFAR countries in sub-Saharan Africa (SSA) revealed that PEP coverage was 15% among older adolescents aged 15–19 years who experience sexual violence [12]. This statistic is particularly concerning because adolescent girls and women aged 15–24 years are at the highest risk for new HIV acquisition in SSA and at the highest risk for sexual violence [13, 14]. Additional studies have demonstrated poor HIV PEP adherence among a variety of populations [9, 15]. A systematic review and meta-analysis of PEP adherence revealed that the proportion of people considered eligible for PEP who completed the full 28-day course was 56.6%. Completion rates were lowest for survivors of sexual violence at 40.2% [16].

Considering these challenges, healthcare providers throughout Mozambique were interviewed to identify and synthesize their recommendations towards improving PEP access and adherence.

2 | METHODS

2.1 | Data collection

Semi-structured in-depth interviews (IDIs) with 20 health providers from 20 health facilities across seven provinces were conducted from March to August 2023. The individual interviews took place in a private room in the health facility so that interviewees could speak comfortably and in confidence. The interviews lasted approximately 30–45 minutes and were conducted in Portuguese by two, lead researchers on the team (ADA and MOB). The interviews followed a semi-structured format based on the interview guide developed by the research team to better understand the strengths/weaknesses of post-violence care in Mozambique as well as elicit recommendations to promote PEP access and adherence. The interview guide domains were as follows: socio-demographic and professional data; role of the provider, provider responsibilities; strengths of post-violence services; provider perspectives regarding strengths; weaknesses of post-violence services; provider perspectives regarding weaknesses; violence prevention activities; positive provider abilities; recommendations to promote PEP access and adherence.

The interviews were conducted, audio-recorded and transcribed by three members of the research team (ADA, MOB and MA). The transcriptions were then uploaded into MaxQDA for coding and analysis in Portuguese. Data on participants' position, sex and age were collected, but participant name and contact information were not recorded. Interviews were stripped of all unintentional identifiers during transcription and interviewees provided code numbers and names.

2.2 | Sampling

Purposive sampling using a theoretical sampling approach was employed. We sought "information-rich cases" described by Patton as "those from which one can learn a great deal about issues of central importance to the purpose of the research" [17]. We interviewed one manager or healthcare provider (sometimes the same person served both roles) of adolescent and adult post-violence services in 20 health facilities where we simultaneously conducted external quality assessments. External quality assessments were conducted in 50 health facilities that met 80% of the quality assessment criteria according to a structured quality assurance tool designed to assess post-violence clinical services [18]. Availability of the research team and geographic representation were also taken into consideration when selecting the health facilities where interviews would be conducted. The manager/healthcare providers we interviewed were selected according to the inclusion criteria (provide violence-related care for > 6 months, attended >1 violence course) and exclusion criteria (does not provide violence-related care, provide violence-related care for <6 months, attended < 1 violence course). Interviews were conducted until saturation was reached—that is: each additional interview was redundant, and there were diminishing returns on time spent conducting the interview. Saturation was reached after 20 interviews, and we did not conduct additional interviews during the external quality assessments.

A majority of the interviews were conducted in the southern region, in primary and urban health facilities. Over half the health facilities received over 100 cases of violence per year and half provided care to over 5000 clients in HIV care and treatment (Table 1).

2.3 | Data management

Consent forms were secured in a locked cabinet. Electronic data including audio files and transcriptions were stored on a password-protected network. Electronic data were backed up weekly. Access to all information was limited to study staff.

2.4 | Data analysis

Inductive and theoretical thematic analysis was used to study the data. Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data. It assists to organize and describe the data set [19]. The themes were both driven by the data (inductive) and the analyst (theoretical). The data analysis involved several steps. After an initial round of data collection (roughly 10 interviews), the research team of three (MD, ADA and MOB) coded two interviews together in order to identify emerging themes and develop the codebook using a standard iterative process. The codes were as follows: strengths, weaknesses, provider role,

Table 1. Characteristics of healthcare facilities included in the qualitative study of post-exposure prophylaxis access and adherence in Mozambique, 2023

Healthcare facility characteristics	Number of facilities	Percent
Region		
South	13	65%
Centre	4	20%
North	3	15%
Centre for Integrated Attendance (CAI)	3	15%
Level of healthcare facility		
Primary	16	80%
Secondary	4	20%
Tertiary	0	0%
Urban or rural		
Urban	13	65%
Rural	7	35%
Cases of violence: 2022		
0–100	9	45%
101–300	8	40%
301+	3	15%
Patients on HIV treatment: 2022		
0–3000	4	20%
3001–5000	6	30%
5001–10,000	7	35%
10,001–16,000	3	15%

Note: A wide variety of healthcare providers with numerous years of experience and both classroom and on-the-job trainings were interviewed (Table 2)—ensuring we obtained "information-rich cases" [17].

Table 2. Characteristics of healthcare providers interviewed in the qualitative study of post-exposure prophylaxis access and adherence in Mozambique, 2023

Healthcare provider characteristics	Number of facilities	Percent
Professional category		
Doctor	2	10%
Nurse—Superior level	4	20%
Nurse—Mid level	4	20%
Psychologist	3	15%
Superior technician	3	15%
Medical technician	3	15%
Sex		
Male	3	15%
Female	17	85%
Years in category		
1–4	9	45%
5–9	8	40%
10+	3	15%
Years worked in health facility		
1–4	12	60%
5–9	7	35%
10+	1	5%
Number of classroom trainings		
1–4	13	65%
5–9	4	20%
10+	3	15%
Number of on-the job trainings		
0–4	9	45%
5–9	8	40%
10+	3	15%
Post-violence care role: service provision/management/both		
Both	15	75%
Service provision only	5	25%
Number of post-violence care clients per month (avg)		
4–9	6	30%
10–15	6	30%
16–30	6	30%
30+	4	20%
Number of providers trained to offer post-violence care		
4–9	8	40%
10–14	7	35%
15–30	5	25%
Year health facility began to offer post-violence care		
2010–2015	8	40%
2015–2020	10	50%
N/A	2	10%

provider responsibilities, violence prevention activities, positive provider abilities, PEP access and adherence recommendations. The emerging themes were used to inform probes in subsequent interviews. Once data collection was complete, the team divided the remaining transcripts. After each team member coded her respective interviews, we reviewed and discussed coding approaches as well as the codebook.

After coming to a consensus on each coded interview, codes and data sets were merged. The codebook, merged/refined codes and coded interviews were circulated for final review and consensus among the group. Upon reaching a consensus, tables were created to consolidate the number of times providers mentioned specific recommendations regarding PEP access and adherence. We did not include multiple mentions by the same provider. For each of the top four recommendations mentioned, significant statements, previously identified through memos by researchers, were pulled from the transcripts. The significant statements highlight key aspects of the recommendations and further facilitate understanding. Tables and significant statements were then translated into English by one member of the research team (MD) and reviewed for accuracy and concordance by two additional members of the research team (ADA and MOB).

2.5 | Ethics statement

All research participants provided written consent, and no reimbursements were offered for participation. The data are covered by the Violence Umbrella Protocol (Project ID #: 0900f3eb81ac9ed9), reviewed by the Mozambique MoH Institutional Review Board and U.S. CDC, deemed not research, and conducted consistent with applicable U.S. federal law and U.S. CDC policy (45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq).

3 | RESULTS

3.1 | PEP access

Regarding PEP access, healthcare providers mentioned community education as the most effective strategy (10 mentions), followed by the preparation of complete PEP kits (7 mentions) and available medication (6 mentions).

Health providers cited the importance of group *palestras* [health talks]. *Palestras* are normally given in the markets or other open spaces where large groups of community members gather. They generally last 15–20 minutes and cover a specific health topic. One provider asserted:

> "Best approach is… the *palestras*. Because if we don't do *palestras*, they have no way to know…that information that the health facility provides services they will not know. So, we have to get out, get down from the place of comfort to the field. Yes."

A second provider asserted:

> "Then the recommendation is for the community, that has to know the key messages, that immediately after sexual violence he/she has to go to a health facility. And arrive as early as possible to be able to receive the package."

The assertions that being out of their "place of comfort" and in the community to disseminate information to the people who need it the most was often frequently followed by the recommendation to ensure that the PEP kit is prepared (7 mentions) and medication is readily available and accessible once the patient arrives at the health facility (6 mentions). A complete PEP kit in Mozambique includes PEP (child and adult dosages), an HIV test, tests/prophylaxes for the most common STIs (gonorrhoea, syphilis, trichomoniasis and chlamydia), hepatitis B test/vaccine, pregnancy test, emergency contraception and paracetamol [10].

One provider recommended:

> "Have the kits up to date, with complete medicines, with all of the alternative lines [of medication]. We know how to give priority to the victims so as not to waste time—or we will miss the opportunity. Because if she arrives for example at night and the person says: come back tomorrow, we don't know what time the violence was, and we risk her coming back tomorrow after 72 hours."

This recommendation was echoed by several other providers who acknowledged that if PEP is not available, the opportunity to administer PEP may be missed.

3.2 | PEP adherence

Regarding adherence, providers recommended client counselling or education at the facility as the most effective strategy (13 mentions), followed by follow-up telephone calls (9 mentions) and general follow-up (5 mentions). They emphasized the need to ensure clients completely understand the importance of taking the medication, how to properly take the medication and the potential side effects.

One provider summarized:

> "Counsel and encourage. Yes. For her to feel confident… to value what she is taking away, knowing that this is going to transform my life, in a better way. So, it is on the basis of this counseling that she will be able to see that in fact my life is here. We have to be aware, we have to have empathy, let her know that I'm here to support. She walks away with that image that it's in that hospital, it's that person that I put my trust in."

Another provider emphasized that efforts to counsel have not been achieved if the patient does not understand the importance of taking the medications (despite side effects) and returning for follow-up visits:

> "Counseling, because the person can take it and throw it away. Can take the medicine, get home, take it, have… reactions, some anomalies and vomiting, intestinal pains, do not know what. And she stops. That is why the majority of victims do not return after—efforts to counsel are weak. It is counseling. The person counsels, but does not achieve the goal of counseling, which is to make the victim return. Counseling is not just talking. It's not just saying haa you have to return—you have to take the last test. No—counseling is convincing the person of the importance of returning."

A third provider delved into great detail regarding the need to ensure that patients understand the potential negative side effects in order to achieve adherence:

> "To ensure good adherence to these medications we have to explain very well what are the side effects of the medications. Because if we don't explain, she takes it, we know the antiretrovirals have… sometimes cause nausea, headache, then vomiting, diarrhea, abdominal disorders. If we don't explain this, when she goes home, starts taking the medications, has these symptoms—stops. So, we have to explain very well the side effects of the drugs, and also explain the importance of taking the drugs."

Additionally, providers highlighted *chamadas preventivas* [follow-up telephone calls] within 2 weeks or so after the initial visit (9 mentions) as the best means to ensure clients complete the full regimen and retest after 3 months. Health providers explained that preventive telephone calls, despite the client living far from the health facility, can create a bond that supports clients.

One provider stated:

> "Doing a follow-up call, maybe after 15 days, would help, right? Understanding from a distance. Haa—okay, you started, I don't know what—how do you feel, did you have any adverse effects? And maybe in these 15 days we could, right, have feedback, that okay, I'm tired I don't want to continue—we will reinforce it, right? The need to continue and finish the prophylaxis."

A second provider was adamant that it is possible to create a bond with the patient even through follow-up calls:

> "Yes, that's exactly what I said—talking with the victim, creating that bond, him feeling comfortable, he feels welcome. I believe that exchanging numbers, talking, because the cases that we have are few, it's doable. It is possible for us to communicate: Where are you? How are you? Your husband? These days, what is it like? It's possible. It's the only thing we can do."

Health providers recommended the institutionalization of *chamadas preventivas* for consistent implementation in all health facilities. The following quote is an example of this recommendation:

> "Well, I think the Ministry should design a scheme just like the HIV program because ART comes from the HIV program. There they have calls to see if the person is taking the medication well—so, these are strategies that the health facility implements that after 7 days you have to call…reminder calls for the person to adhere. We had people returning because many times these people… then they feel more welcome."

4 | DISCUSSION

From IDIs with 20 healthcare providers in Mozambique, we obtained insightful information about improving PEP access and adherence. Interviewed providers recommended community education to improve PEP access. Providers repeatedly expressed that people need to know that HIV PEP is available and that it must be taken within 72 hours of a violence-related exposure. Interviewed providers were confident that with active community engagement via *palestras*, information about PEP availability can be appropriately disseminated, and survivors of violence can arrive at health facilities in time to receive essential services. Providers detailed several examples of increases in community members seeking PEP at health facilities after simple, local and low-cost community outreach activities had been conducted in nearby communities. This finding is consistent with a study in Zambezia Province that advocated for community-wide and targeted educational initiatives to increase the uptake of services within the 72-hour window [11]. Other studies conducted in nearby SSA countries also recommend the dissemination of information in the community as a means to address barriers to post-violence service uptake [12, 20–22]. Furthermore, the recommendation aligns with global guidelines on improved access to HIV PEP through community facilities and services [9]. This community education can be conducted by community partners and local leaders with minimal costs in order to ensure the timely arrival of survivors. A promising intervention out of Mombasa, Kenya used paralegals to serve as focal points for community engagement—conducting community dialogues to educate the community, identify survivors and engage them to seek post-violence services [23].

Client counselling/education on the importance of completing the PEP regimen was strongly recommended by providers to improve PEP adherence. Providers explained that clients are likely to stop taking PEP if they do not understand the importance of completing the regimen or if they do not understand the side effects. This observation is supported by the literature. An article on patient adherence explains that adherence barriers include insufficient explanations of adverse effects and lack of communication regarding lifestyle and economic conditions [24, 25]. Global guidelines also recommend enhanced adherence counselling for individuals initiating HIV PEP due to several studies that demonstrated the effectiveness [7, 9, 26, 27].

Another recommendation mentioned by providers to ensure PEP adherence was *chamadas preventivas*, within 2 weeks or so after the initial visit, to check in on clients and inquire about side effects, motivate the client to continue treatment and remind the client to return for testing after he or she finishes the full course of medication. Several providers mentioned the need for the MoH *Programa de Violência-Baseado no Gênero* [Gender-Based Violence Program] to institutionalize this strategy as has been done by the MoH HIV Program [28]. Various studies demonstrate that reminders improve patient adherence and that regular telephone reminders, emphasizing the importance of treatment adherence, are effective in enhancing adherence [29–32]. Reminders are also one of the least costly interventions [25].

Follow-up telephone calls are a recommended practice that the *Programa de Violência-Baseado no Gênero* has begun to adopt [33]. These follow-up calls currently occur at a handful of health facilities but are not widely used. The programme plans to make the follow-up calls a routine practice at all healthcare facilities that offer PEP.

In fact, the MoH plans to implement all of the provider recommendations during 2025 [33]. For example, a PEP community education campaign called *Cada Hora Conta* [Every Hour Counts] revised Standard Operating Procedures to address PEP kit preparation/PEP availability and additional trainings on PEP adherence counselling are currently being developed by a national technical working group for subsequent dissemination and implementation thereafter.

Considering that PEP access and adherence are also low across many sub-Saharan African countries with similar contexts [9, 12, 15], confronting similar challenges such as

staffing and resource shortages, we posit that the research findings might also be useful to other SSA countries.

Furthermore, although the focus of this study was on PEP access and adherence in instances of HIV exposure due to violence, provider recommendations might also serve to improve access and adherence in instances of HIV exposure via other routes—occupational, sharing needles and so on. In 2020, Mozambique MoH PEP Guidelines were updated to include HIV PEP administration in instances of all potential HIV exposures. However, HIV PEP is still primarily administered in instances of HIV exposure due to violence. Discussions regarding the utility of the study's findings in instances of HIV exposure via other routes are underway at the Mozambique MoH [10]. Furthermore, discussions within the MoH regarding the adoption of global guidance for increasing PEP access through community distribution and task-shifting within the Mozambique context have begun [9].

4.1 | Limitations

A limitation of the IDIs is that the providers interviewed were often the most experienced post-violence healthcare providers present—trained and well-versed in the provision of post-violence services. Therefore, the providers were often champions for the improvement of post-violence services and their opinions and knowledge of post-violence services are most likely not representative of other providers. A second limitation of the study is the potential for social-desirability bias due to the nature of one-on-one interviews. The research team encouraged honesty for programme improvement purposes and ensured participants that their responses would not be linked to their names or any other identifiable information.

5 | CONCLUSIONS

Interviewed healthcare providers offered valuable insights and recommendations to improve PEP access and adherence, which will be implemented in Mozambique and could be considered for implementation in other sub-Saharan African countries.

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COMPETING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

AUTHORS' CONTRIBUTIONS

MD, ADA, EMFX and RCDP developed the study design. MD, ADA and MOB led the data collection. MD, ADA, MOB and MA led the data analysis and interpretation. MD led the manuscript development and revisions. All authors significantly contributed to the data collection, analysis and manuscript development. The manuscript underwent a review by all authors, and each one approved the final version.

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DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the funding agencies.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1. Caring for women subjected to violence: a WHO curriculum for training healthcare providers. Geneva: World Health Organization; 2021.
2. Mecanismo multisectorial de atendimento integrado a mulher vitima de violencia [Multisectoral integrated care mechanism for women victims of violence]. Maputo: Ministry of Health Mozambique; 2012.
3. Relatorio Annual de Violencia Baseado no Genero [Annual Gender-Based Violence Report]. Maputo: Ministry of Health Mozambique; 2021.
4. Cardo DM, Culver DH, Ciesielski CA, Srivastava PU, Marcus R, Abiteboul D, et al. A case control study of HIV seroconversion in health care workers after percutaneous exposure. N Engl J Med. 1997;337:1485–90. https://doi.org/10.1056/nejm.
5. Isah A, Igboeli NU, Dim OF, Ekwuofu AA. HIV infections averted at PEPFAR-APIN clinics in Nigeria: a ten-year retrospective evaluation of the clinical outcomes of post-exposure prophylaxis services. Afr J AIDS Res. 2023;22:46–53. https://doi.org/10.2989/16085906.
6. Young T, Arens FJ, Kennedy GE, Laurie JW, Rutherford GW. Antiretroviral post-exposure prophylaxis (PEP) for occupational HIV exposure. Cochrane Database Syst Rev. 2007;2007(1):CD002835. https://doi.org/10.1002/14651858.CD002835.pub.
7. Guidelines on post-exposure prophylaxis and the use of co-trimoxazole prophylaxis for HIV-related infections among adults, adolescents and children: recommendations for a public health approach. Geneva: World Health Organization; 2014.
8. Updated recommendations in first-line and second-line antiretroviral regimens and post-exposure prophylaxis and recommendations on early infant diagnosis of HIV. Supplement to the 2016 consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Geneva: World Health Organization; 2018.
9. Guidelines for HIV post-exposure prophylaxis. Geneva: World Health Organization; 2024.
10. Clinical Protocol for Prophylaxis Post Exposure to HIV. Maputo: Ministry of Health Mozambique; 2020.
11. De Schacht C, Paulo P, Van Rompaey S, Graves E, Prigmore HL, Bravo M, et al. Health care services for survivors of gender-based violence: a community and clinic-based intervention in Zambézia Province, Mozambique. AIDS Care. 2023;35(1):16–24. https://doi.org/10.1080/09540121.2022.206731.
12. Kanagasabai U, Valleau C, Cain M, Chevalier MS, Hegle J, Patel P, et al. Understanding gender-based violence service delivery in CDC-supported health facilities: 15 sub-Saharan African countries, 2017–2021. AIDS Educ Prev. 2023;35:39–51. https://doi.org/10.1521/aeap.
13. Karim A, Baxter C, Birx D. Prevention of HIV in adolescent girls and young women: key to an AIDS-free generation. J Acquir Immune Defic Syndr. 2017;75:17–26. https://doi.org/10.1097/QAI.0000000000001316.
14. Decker M, Latimore A, Yasutake S, Haviland M, Ahmed S, Blum RW, et al. Gender-based violence against adolescent and young adult women in low- and middle-income countries. J Adolesc Health. 2015;56(2):188–96. https://doi.org/10.1016/j.jadohealth.2014.09.00.
15. Mushambi F, Timire C, Harries AD, Tweya H, Goverwa-Sibanda TP, Mungofa S, et al. High post-exposure prophylaxis uptake but low completion rates and

HIV testing follow-up in health workers, Harare, Zimbabwe. J Infect Dev Ctries. 2012;15:559–65. https://doi.org/10.3855/jidc.12214.
16. Forda N, Irvinea C, Shubberb Z, Baggaleya R, Beanlanda R, Vitoriaa M, et al. Adherence to HIV postexposure prophylaxis: a systematic review and meta-analysis. AIDS. 2014;28:2721–7
17. Patton MQ. Qualitative research and evaluation methods. Thousand Oaks, CA: Sage; 2002.
18. National Action Plan to Respond to Gender-based Violence in the Health Sector: 2019–2022. Maputo: Ministry of Health Mozambique; 2019.
19. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3(2):77–101.
20. Palermo T, Bleck J, Peterman A. Tip of the iceberg: reporting and gender-based violence in developing countries. Am J Epidemiol. 2014;179(5):602–12.
21. Wood S, Glass N, Decker M. An integrative review of safety strategies for women experiencing intimate partner violence in low and middle-income countries. Trauma Violence Abuse. 2021;22(1)68–82.
22. Ellsberg MT, Arango DJ, Morton M, Gennari F, Kiplesund S, Contreras M, et al. Prevention of violence against women and girls: what does the evidence say? Lancet. 2015;385(9977):1555–66. https://doi.org/10.1016/S0140-6736(14)61703-7
23. Temmerman M, Ogbe E, Manguro G, Khandwalla I, Thiongo M, Mandaliya KN, et al. The gender-based violence and recovery centre at Coast Provincial General Hospital, Mombasa, Kenya: an integrated care model for survivors of sexual violence. PLoS Med. 2019;16(8):e1002886. https://doi.org/10.1371/journal.pmed.1002886
24. Osterberg L, Blaschke T. Adherence to medication. N Engl J Med. 2025;353:487e97.
25. Ito H. What should we do to improve patients' adherence? J Exp Clin Med. 2013;5(4):127e130.
26. Bentz L, Enel P, Dunais B, Durant J, Poizot-Martin I, Tourette-Turgis C, et al. Evaluating counseling outcome on adherence to prophylaxis and follow-up after sexual HIV-risk exposure: a randomized controlled trial. AIDS Care. 2010;22:1509–16.
27. Roland ME, Neilands TB, Krone MR, Coates TJ, Franses K, Chesney MA, et al. A randomized noninferiority trial of standard versus enhanced risk reduction and adherence counseling for individuals receiving post-exposure prophylaxis following sexual exposures to HIV. Clin Infect Dis. 2011;53:76–83.
28. National Action Plan to Respond to Gender-based Violence in the Health Sector: 2024–2030. Maputo: Ministry of Health Mozambique; 2024.
29. Fulmer T, Feldman P, Kim T, Carty B, Beers M, Molina M, et al. An intervention study to enhance medication compliance in community dwelling elderly individuals. J Gerontol Nurs. 1999;25:6e14.
30. Hoffman L, Enders J, Luo J, Segal R, Pippins J, Kimberlin C. Impact of an antidepressant management program on medication adherence. Am J Manag Care. 2003;9:70e80.
31. Schedlbauer A, Schroeder K, Fahey T. How can adherence to lipid-lowering medication be improved? A systematic review of randomized controlled trials. Fam Pract. 2007;24:380e7.
32. Schedlbauer A, Davies P, Fahey T. Interventions to improve adherence to lipid lowering medication. Cochrane Database Syst Rev. 2010;17:CD004371.
33. Second Acceleration Response Plan to HIV and AIDS in Mozambique: 2024–2026. Maputo: Ministry of Health Mozambique; 2024.

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http://onlinelibrary.wiley.com/doi/10.1002/jia2.26460/full | https://doi.org/10.1002/jia2.26460

RESEARCH ARTICLE

Strengthening post-exposure prophylaxis uptake among survivors of sexual violence through immediate access at police stations in Nigeria's Federal Capital Territory

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Abstract

Introduction: Data on sexual violence (SV) prevalence in Nigeria is limited; however, 2014 data indicate that 24.8% of females aged 18–24 years experienced SV in childhood and only 3.5% received any form of services. Initiation of post-exposure prophylaxis (PEP) to prevent HIV acquisition following SV is most effective when started immediately and is not recommended after 72 hours. Police stations are often entry points for survivors; however, lengthy processes may result in delays and missed PEP opportunities. Using an ongoing phased approach, we introduced PEP into selected police stations in Nigeria's Federal Capital Territory in order to explore expanding access to time-sensitive HIV prevention within non-health services.

Methods: Our intervention phase consisted of the provision of training of police officers and the provision of PEP starter packs coupled with linkage to referral facilities. During two time periods (pre-intervention: January–March 2023) and (during intervention: July–September 2023), we evaluated routinely reported programme data from 27 U.S. Centers for Disease Control and Prevention-supported health facilities for changes in the provision of SV services and PEP initiation. We used geospatial mapping to assess the proximity of participating health facilities to police stations and to see changes in both SV and PEP service provision. The statistical significance of the difference in PEP uptake proportion during the two periods was determined using the Wilcoxon signed rank test at a 0.05 level of significance.

Results: Of the total 27 health facilities, 24 were within a 5-km radius of a participating police station. Total SV service provision increased from 114 cases to 218 cases, representing a 91.2% increase and with most of this increase seen among females. PEP initiation increased by 289.3% at the two time points, with 56 initiations pre-intervention to 218 PEP initiations during the intervention.

Conclusions: Our findings showed promise in increasing immediate access to PEP in non-health services and highlighted the feasibility of police stations and health facilities collaboration to address urgent health needs. There was an overall increase in PEP initiations by referral and non-referral facilities which could be the result of demand creation and increased access at police stations.

Keywords: HIV; police stations; post-exposure prophylaxis; prevention; Africa; sexual violence

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1 | INTRODUCTION

Sexual violence (SV) remains a serious public health concern worldwide, and especially in Africa [1], with individuals facing immediate and long-term health impacts including psychological disorders, unplanned pregnancy, chronic health conditions such as asthma, and HIV [2, 3]. Globally, approximately one-third (27%) of women will experience sexual and/or physical violence; and while most of this comes from an intimate partner, 6% of women will also experience non-partner SV at least once in their lives [4]. According to the 2014 Nigeria Violence Against Children Survey, one in four females reported experiencing SV during their childhood, with about 70% reporting multiple incidents of SV [5]. The survey findings also revealed that of the 24.8% of females aged 18–24 years who experienced SV in childhood, only 3.5% received any services [5, 6].

With approximately two million people living with HIV, Nigeria has one of the largest HIV epidemics globally [7]. Post-exposure prophylaxis (PEP) is an effective HIV prevention intervention when taken within 72 hours of a potential exposure to HIV, such as following an experience of SV [,8, 9]. However, data from Nigeria show inadequate levels of PEP uptake among survivors of SV, with adolescent survivors having especially low rates [10]. Many survivors initially seek help from non-health services such as police stations, leading to delays in initiating time-sensitive health interventions. A study conducted in Nigeria indicated that late reporting of rape cases at non-health facilities, such as police stations or community centers, is the major reason for the low initiation of PEP within the required 72-hour effectiveness window [11]. Other reasons for poor PEP use include misconceptions around PEP, stigma, societal judgement and the emotional state of survivors following rape, which can further traumatize the survivor and complicate timely PEP seeking and initiation [11–13]. Additionally, a cross-sectional study among Nigerian university students found that only a quarter of participants were aware of PEP, only 10% knew where to go to obtain PEP and less than 4% knew how much PEP costs [14].

Police play important roles in pursuing justice, protection and support for SV victims. However, the lack of survivor-friendly police stations combined with stigmatization, rape myths, victim blaming, unprofessional conduct by police and confusing legal processes all present barriers to police service utilization [15–17]. In Nigeria, before a perpetrator can be successfully prosecuted in court, the police are required to conduct thorough investigations into the incident and provide a detailed report [16, 18]. The strong focus on justice and the lengthy legal processes may result in a deprioritization of critical health interventions and delays in timely referrals to health facilities where PEP can be initiated. Integrating PEP services at victim response desks within police stations and sensitizing police units to provide a PEP starter dose may be an effective intervention to address some of these challenges. Recognizing police stations as potential sites for intervention, we explored how immediate access to PEP at police stations can enhance timely uptake among survivors of SV in Nigeria's Federal Capital Territory (FCT). Utilizing geospatial mapping, the study assesses the proximity of health facilities to police stations and changes in service receipt to evaluate the impact of this intervention.

2 | METHODS

We employed a cross-sectional design using routinely collected health service delivery data from two time points to examine changes in SV service delivery prior to and during our intervention activities. More specifically, we were interested if we would see changes in the proportion of individuals receiving PEP at participating health facilities if PEP starter packs were made available at police stations.

The target group was survivors of SV (males and females of all ages), who presented to participating police stations. Inclusion criteria to receive PEP included individuals who: were sexually assaulted with penetration, presented to one of the participating police stations within 72 hours of the incident, were willing to receive medical assistance, including PEP, and provided informed consent (or assent with guardian consent, where applicable, for minors).

Survivors who presented after 72 hours post-incident, declined PEP after counselling and were already HIV positive were excluded but were still linked to health facilities for other health services.

2.1 | Intervention

Police stations within Nigeria's FCT were selected as intervention sites based on the following criteria:

1. Out of six districts in the FCT, three districts with the highest prevalence of violence were selected,
2. High volume (>5 survivor cases in a month) of reported post-violence cases,
3. Police station location was within a 5-km radius to a supported health facility, and
4. Availability of clinician to administer PEP.

Each police station in Nigeria has a dedicated Response Desk staffed by a specialized team that handles cases of violence. This team often includes a clinician responsible for providing medical care, conducting HIV tests, administering necessary medications and initiating survivors on HIV antiretroviral therapy (ART). Before the intervention began, a total of 29 police sites met the criteria and participated in pre-intervention activities, including training and orientation to materials. A total of 29 police officers, one from each division, received a 5-day classroom training on key topics related to emergency response to SV, HIV prevention, the use of HIV test kits, the regimen for PEP, data reporting and referrals. The training was conducted by the local implementing partner overseeing HIV and violence prevention activities in the state. Following the training, additional activities were implemented, including the development of standard operating procedures (SOP) and reporting/documentation tools. Antiretroviral drugs were supplied to the police stations from the participating referral health facility.

The participating referral facilities were hospitals within the same districts as the police stations in the FCT that provided comprehensive HIV treatment, care and support to individuals of all ages. All 27 health facilities were supported by the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) through the U.S. Centers for Disease Control and Prevention (CDC). As part of regular supported programming, these facilities provided a package of post-violence care services, which included HIV testing and PEP. The provision of these services was routinely reported through a PEPFAR data reporting system, disaggregated by violence service type (sexual or physical and/or emotional) by age and sex, and PEP initiation. In alignment with the latest World Health Organization guidelines for PEP [19], receipt and completion of PEP is defined as individuals who initiated PEP within 72 hours of exposure and completed the full 28-day regimen.

Starting in July 2023, the participating police sites provided starter packs of PEP to individuals who presented within 72

hours of sexual assault. Upon reporting an incident, individuals provided written consent prior to undergoing HIV testing, which was conducted by a clinician at the response unit. Those who tested negative received an initial five-pill PEP starter pack at the police station to ensure timely initiation of treatment. Following the SOP, the police then referred the survivor to the designated nearest referral facility for the remainder of the 28-day PEP regimen and additional SV care services. The documentation at the police station was transferred to the referral facilities for immediate follow-up with the survivor. Regimen completion was documented at the health facility, and confirmation was done through a phone call to the survivor at the end of 28 days. This data was then reported through the regular programme data reporting via the data system in which PEP data is reported semi-annually.

Since PEP initiation at police stations was not part of routine care in Nigeria at the time, the intervention required additional training, protocol development and collaboration with health facilities to ensure proper administration, documentation and follow-up. The primary goal was to integrate an emergency response model into the existing system, ensuring that survivors received care in alignment with national guidelines while strengthening referral pathways. Ethical considerations were upheld by adhering to institutional frameworks and ensuring that all services, including HIV testing and PEP provision, followed standard protocols for voluntary participation and confidentiality.

2.2 | Data collection

We collected the data on the geo-coordinates of participating police stations (intervention sites) that had begun providing PEP for immediate initiation. We then conducted geospatial mapping to show the health facilities within a 5-km radius of the intervention facilities. We also mapped the proportion of PEP use out of total SV service provision for each of the health facilities providing post-SV care before intervention and during intervention in separate maps.

Routinely collected programme data on SV service provision came from participating health facilities. Each SV case represents an individual who received at least one service from a basic package of services delivered at the health facility; these services include HIV testing, counselling, injury treatment, sexually transmitted infection testing and/or treatment, emergency contraceptives and PEP (either initiation or provision of remainder of pack). Regardless of if an individual presented at a police station, they were only counted as an SV case if they received at least one SV service at a participating health facility.

2.3 | Data analysis

Utilizing routinely collected programme MER data from the participating referral health facilities, we analysed changes in SV service provision and PEP completion from two time points: pre-intervention and during implementation of the intervention. Given the phased approach, we allowed sufficient time for all sites to be implementing in line with data reporting schedules, which resulted in a 3-month gap (March–June) between pre-implementation and full implementation for data analysis. From March to June 2023, training of sites and preparation of intervention sites occurred. We compared the data before and after initiation of the intervention (January–March 2023 vs. July–September 2023). For each health facility, we calculated the number of police stations within its 5-km radius. We then conducted geospatial mapping to show the health facilities within a 5-km radius of the intervention facilities (i.e. police stations). We also mapped the proportion of PEP use out of total SV service provision for each of the health facilities providing post-SV care before intervention and during intervention in separate maps.

The proportion of PEP uptake was calculated by dividing the number of individuals receiving PEP by the total number of individuals receiving SV services at the health facility. We analysed changes in the proportion of PEP uptake in the health facilities during the study periods, and assessed differences using the Wilcoxon signed-rank test at an alpha of 0.05. We used the non-parametric alternative because of the small sample size. For each health facility, we also calculated the number of police stations within its 5-km radius. We then assessed the association of difference in PEP proportion per health facility and the number of police stations that included that health facility within its 5-km radius using Spearman rank correlation. We also assessed the association of the number of police stations with the difference in the number of PEP use reported in the health facility before and during the intervention and also the difference in SV cases reported in the health facility before and during the intervention using Spearman rank correlation.

All the analyses were performed using SAS version 9.4 software (SAS Institute, Cary, North Carolina). Geospatial mapping was done using QGIS Desktop 3.22.5.

2.4 | Ethical review

The data are covered by a protocol reviewed by CDC, deemed non-research, and conducted consistent with applicable federal law and CDC policy (45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq). Written consent was obtained from all health and non-health facilities used in the study.

3 | RESULTS

There was a 289.3% increase in the number of PEP initiations, from 56 individuals to 218 individuals, from Q2 (before the intervention period: January–March 2023) to Q4 (during the intervention period: July–September 2023). Within the same time frames, the number of reported SV cases increased from 114 to 218 representing a 91.2% increase. The proportion of individuals initiating PEP in relation to the number of SV cases increased from 49.1% pre-intervention to 100% during intervention, indicating an increase of around 104% (Table 1).

Of the participating 27 health facilities, 19 facilities reported cases of SV in the pre-intervention time point. In the intervention phase, the number of facilities reporting SV increased to 21. This showed a 10.5% increase in the number of facilities reporting SV after the intervention was initiated. During the pre-intervention period, out of 19 health facilities that reported at least one SV case, four (21.1%) facilities had

Table 1. Summary of results from health facilities, pre- and post-intervention (*n* = 27), Nigeria, Abuja, 2023

Year 2023	Pre-intervention	During intervention	% Increase
No. of health facilities with reported SV cases	19	21	10.5%
Number of SV cases	114	218	91.2%
Number initiated on PEP	56	218	289.3%
Proportion of PEP to SV cases	49.1% (56/114)	100% (218/218)	103.6%

Figure 1. Heat map showing the proportion of PEP uptake before and during the intervention for 18 health facilities. Each row indicates a health facility.

a PEP uptake proportion of 0% out of total SV cases and nine (47.37%) had a PEP uptake proportion of 100%. During the intervention period, the PEP uptake proportion out of total SV cases increased to 100% across all 21 facilities reporting at least one SV during the intervention period. It is important to note that one of the health facilities with reported SV in the pre-intervention phase did not have any SV reported during the intervention phase; therefore, a total of 18 facilities had reported SV for both time points.

Figure 1 shows the PEP uptake proportion in these 18 health facilities during the two study periods in a heat map. For these 18 health facilities, we found that the median difference in the PEP uptake proportion during the intervention period and before intervention was 25% (interquartile range: 0%, 66.67%) and this difference was statistically significant (*p*-value = 0.004). Figure 1 shows the PEP uptake proportion in the 19 health facilities with reported SV during the pre-intervention period.

Females were the majority of individuals receiving SV services during both pre- and active intervention points, at 87.7% and 87.6% of total SV cases. Pre-intervention PEP proportion initiation ranged from 0% among <15 males (*n* = 3 SV cases) to a high of 73% among ≥15 males (*n* = 11 SV cases). SV cases among ≥15 females saw the largest increase between the two time points, increasing from 48 cases to 149 cases during the intervention (Table 2).

Figures 2 and 3 show the location of the 29 police stations, the 5-km radius around them and the PEP proportion in the referral health facilities overlayed in the map of FCT for the two study periods, respectively. The proportion of PEP uptake was higher in the intervention phase compared to the pre-intervention phase.

Across 27 health facilities within 5 km of a police station, the average number of corresponding police stations within the 5-km radius was two. Three facilities (11.1%) were not within a 5-km radius of any police station, 16 (59.3%) were

Table 2. Summary of results by coarse age and sex, pre- and post-intervention, Nigeria, Abuja, 2023

	Pre-intervention				During intervention			
	Female		Male		Female		Male	
	<15	≥15	<15	≥15	<15	≥15	<15	≥15
SV cases	52	48	3	11	42	149	4	23
SV cases initiated on PEP	21	27	0	8	42	149	4	23
Proportion of PEP to total SV	40%	56%	0%	73%	100%	100%	100%	100%

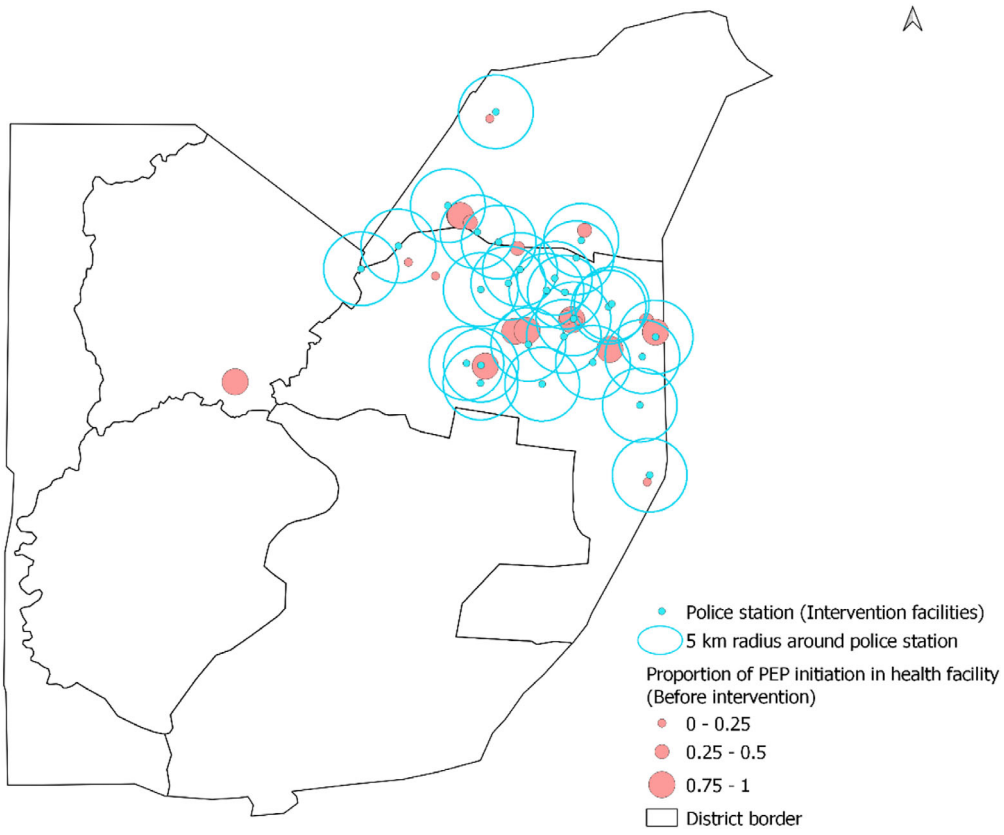

Figure 2. Map of Federal Capital Territory showing locations of police stations and PEP uptake proportion reported in the health facilities at the pre-intervention phase, 2023.

within a 5-km radius of one to two police stations and eight (29.6%) were within the 5-km radius of three to five police stations. Our estimate of the Spearman rank correlation coefficient showed a very weak association between the difference in PEP uptake proportion and the number of police stations that covered the health facility within its 5-km radius (n = 18, rho = 0.02, 95% CI: −0.45, 0.48, p-value = 0.94). Likewise, we did not find a significant association between the difference in the number of SV cases reported before and during the intervention and the number of police stations (n = 27, rho = 0.30, 95% CI: −0.09, 0.61, p-value = 0.125). However, we found a significantly positive association between the difference in the number of PEP use before and during the intervention and the number of police stations that covered the health facility within its 5-km radius (n = 21, rho = 0.52, 95% CI: 0.10, 0.77, p-value = 0.015).

4 | DISCUSSION

The intervention showed a significant increase in PEP uptake among survivors of SV who received services from health facilities. Between the two study periods, there was a 91.2% increase in the reported number of SV services, a 289.3% increase in PEP service initiation and a 103.6% increase in the proportion of PEP uptake out of total SV reported. PEP uptake as a proportion of SV increased from 49.1% in the pre-intervention phase to 100% in the intervention phase. The findings showed that not only did PEP initiation

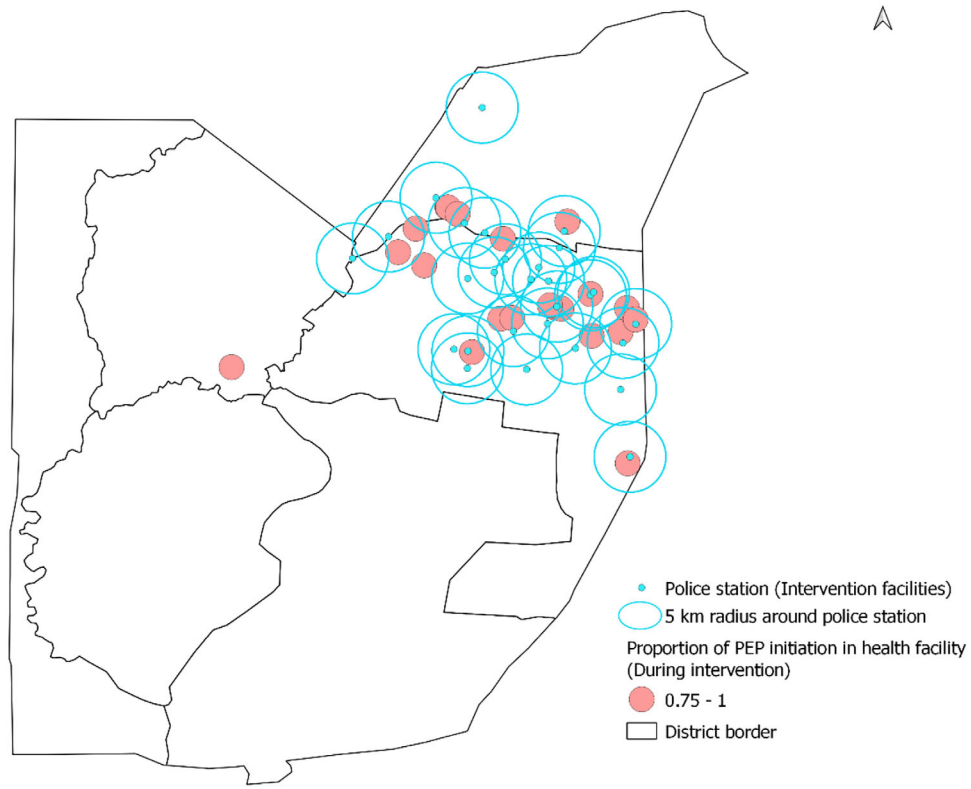

Figure 3. Map of FCT showing locations of police stations and PEP uptake proportion reported in the health facilities during the intervention phase.

increase but the overall number of SV services delivered also increased, especially for adult women. Similar to other findings, the majority of SV cases were female—further evidencing the disproportionate impact of SV on women and girls in Nigeria [16, 20]. While we did not measure individual changes in attitudes nor actual police behaviours with victims, previous studies have shown that training on SV can improve police interactions and service uptake to meet both the legal and health needs of survivors [21, 22].

The study highlighted the importance of providing immediate PEP access at locations where survivors first present for services, which may not be at health facilities. Police stations represent important service points for survivors and may hold promise in reducing timely access to critical HIV prevention interventions following an SV exposure. Integrating PEP provision into services offered at police stations can improve the overall response to SV and enhance health outcomes for survivors by giving survivors more time to present to health facilities and potentially through increasing demand for health services. The findings of this study are supported by a study carried out in Zambia in 2015 to assess the feasibility of providing PEP at police stations [23[. Their findings also pointed to the need to have police officers provide a PEP starter dose to survivors of SV with immediate referral to health facilities.

Beyond increasing PEP initiation rates, the intervention has the potential to improve awareness about PEP and the importance of timely SV service-seeking through police interactions with individuals and communities. In addition to availability and access, increasing knowledge of both PEP and where to access PEP are critical for increasing PEP use [24,25]. Conducting awareness campaigns to inform communities about PEP availability at police stations and other non-health service points may be beneficial in addition to activities such as training of police officers on administering PEP and caring for survivors of SV, and establishing clear policies and procedures to guide the integration of PEP provision within police stations.

This study has several strengths. One of the primary strengths of this study is its innovative approach to integrating health services within law enforcement settings, in which health services may not be the primary concern of the police. Second, the diversity of the study sites, including both urban and rural police stations, adds to the generalizability of the findings. Previous research has shown that a full regimen of PEP has more positive effects on PEP completion over starter packs in health settings [26]. However, given the non-clinical setting of police stations, the need for additional health interventions and the overall design of the intervention, starter packs were chosen as the best available option. Our integrated approach did not aim to replace the sensitive care and health interventions that are best delivered by trained health professionals; instead we strengthened links from police to existing health settings while not sacrificing critical time for PEP initiation. We believe this holistic approach can better meet the needs of survivors where they first come into contact with formal help services—which can ultimately lead to long-term benefits for community trust and

engagement while acknowledging the inherent necessity, and also sometimes friction, that exists between the police and SV victim supports [27].

This study has some important limitations. First, we only included data from CDC-supported health facilities; meaning that individuals could have sought care at other service sites. Additionally, the sample size of the study was very small, limiting the analysis' ability to explore relationships between other factors. While police stations across Nigeria have embedded victim units, the availability of a clinician to prescribe PEP and the quality may vary, especially outside of the FCT. Routinely collected programme data were limited to data from health-facility reporting in that we were not able to disaggregate SV cases who first reported to the police and linked to the health facility versus those who first presented at the health facility, which gives us a limited view of how many were referred through the police stations. A natural limitation of service delivery data is that it only reflects individuals who received services and not the total of those in need of services; this means it is possible that there could be a self-selection bias of who independently seeks services at both facilities and the police stations. Globally and in Nigeria, the majority of individuals who receive SV services are women and girls [1, 5, 6, 8] as SV is often underreported and it is possible that other populations such as men and boys would be deterred from seeking services through the police. Finally, without a comparison group, we cannot truly attribute changes to service receipt to the intervention. Despite the limitations, we feel this approach adds important nuance to the call to meet survivors with services where they first present—which includes law enforcement sites.

5 | CONCLUSIONS

The study highlights a promising strategy for increasing PEP uptake among survivors of SV. The initiation of PEP within police stations reduces the barriers to PEP access that survivors encounter following a sexual assault. By reducing barriers to PEP access and fostering a supportive environment for survivors, this intervention has the potential to significantly improve health outcomes and prevent HIV transmission. Further research may help define the long-term sustainability of the intervention and to refine the model for broader implementation. Partnering with police can be considered as an option to improving survivors of SV timely access to PEP and may contribute to ending HIV as a public health threat in Nigeria.

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COMPETING INTERESTS

The authors have no conflicts of interest to declare.

AUTHORS' CONTRIBUTIONS

BA and DC-K developed the study's concept design. The writing of the manuscript, data analysis and data interpretation were done by BA, MC, UK and SD. All authors participated in reviewing and revising the manuscript. After the manuscript's review, all authors approved the final version.

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DISCLAIMER

This study manuscript is provided for informational and research purposes. The findings and conclusions in this manuscript are those of the author(s) and do not necessarily represent the official position of the funding agencies.

DATA AVAILABILITY STATEMENT

Data are available upon request from authors.

REFERENCES

1. Ekemma ONE. The unnamed pandemic of sexual and gender-based violence in Africa. J Afr Stud Sustain Dev. 2021
2. Jina R, Thomas LS. Health consequences of sexual violence against women. Best Pract Res Clin Obstet Gynaecol. 2013;27(1):15–26.
3. World Health Organization. Sexual violence and health. 2021. Retrieved from https://www.who.int/news-room/fact-sheets/detail/violence-against-women on 10 August 2024.
4. World Health Organization. 2021. Violence against women prevalence estimates, 2018: global, regional and national prevalence estimates for intimate partner violence against women and global and regional prevalence estimates for non-partner sexual violence against women.
5. Ajayi AI, Alex-Ojei CA, Ahinkorah BO. Sexual violence among young women in Nigeria: a cross-sectional study of prevalence, reporting and care-seeking behaviours. Afr Health Sci. 2023;23(1):286–300.
6. Violence against children in Nigeria. Findings from a National Survey. 2014. https://www.unicef.org/nigeria/media/1586/file/Nigeria-violence-against-children-national-survey.pdf. Accessed 23 September 2024.
7. Onovo AA, Adeyemi A, Onime D, Kalnoky M, Kagniniwa B, Dessie M, et al. Estimation of HIV prevalence and burden in Nigeria: a Bayesian predictive modelling study. eClinicalMedicine. 2023:62;102098.
8. 16 Facts about violence against women and girls. 2022. https://www.unicef.org/nigeria/media/6696/file/16%20facts%20document.pdf. Accessed 12 October 2024.
9. Centers for Disease Control and Prevention. Post-exposure prophylaxis (PEP). 2021. https://www.cdc.gov/hiv/basics/pep.html. Accessed 19 September 2024.
10. Kanagasabai U, Valleau C, Cain M, Chevalier MS, Hegle J, Patel P, et al. Understanding gender-based violence service delivery in CDC-supported health facilities: 15 sub-Saharan African countries, 2017–2021. AIDS Educ Prev. 2023;35:39–51.
11. Akinlusi FM, Rabiu KA, Olawepo TA, Adewunmi AA, Ottun TA, Akinola OI. Sexual assault in Lagos, Nigeria: a five year retrospective review. BMC Women's Health. 2014;14:115. doi: https://doi.org/10.1186/1472-6874-14-115
12. Gatuguta A, Merrill KG, Colombini M, Soremekun S, Seeley J, Mwanzo I, Devries K. Missed treatment opportunities and barriers to comprehensive treatment for sexual violence survivors in Kenya: a mixed methods study. BMC Public Health. 2018;18:769. doi: 10.1186/s12889-018-5681-5
13. Akangbe Tomisin A. Culture, religion and help-seeking for intimate partner violence victims in Nigeria: a narrative review. Culture. 2020;3(2)::56–62.
14. Ajayi AI, Ismail KO, Adeniyi OV, Akpan W. Awareness and use of pre-exposure and postexposure prophylaxes among Nigerian university students: findings from a cross-sectional survey. Medicine (Baltimore). 2018;97(36):e12226.
15. Aborisade RA. On the 'darkness of dark figure' of sexual crimes: survivors' rape reporting experiences with the Nigerian police. Int J Law Crime Justice. 2023;73:100576.

16. Iloanusi SH, Mgbere OO, Abughosh SM, Essien EJ. HIV non-occupational post exposure prophylaxis in Nigeria: a systematic review of research evidence and practice. Int J MCH AIDS. 2019;8(2):101–19.
17. Nwusulor EE, Onwubiko II. Sexual violence and victim blaming in Nigeria. Women Health Open J. 2021;7(1):27–30.
18. Nigeria A. Harrowing journey. Access to justice for women and girls survivors for rape. Amnesty Internation https://www.amnesty.org/en/wp-content/uploads/2021/11/AFR4449592021ENGLISH.pdf. Accessed 17 October 2024.
19. Guidelines for HIV post-exposure prophylaxis. Geneva: World Health Organization; 2024.
20. Ford N, Shubber Z, Calmy A, Irvine C, Beanland R, Vitoria M, et al. Adherence to HIV post-exposure prophylaxis: a systematic review and meta-analysis. AIDS. 2014;28(18):2721–27.
21. Rich K. Trauma-Informed Police Responses to Rape Victims. Journal of Aggression, Maltreatment & Trauma. 2019;28(4):463–80.
22. Mourtgos SM, Adams IT, Mastracci SH. Improving victim engagement and officer response in rape investigations: a longitudinal assessment of a brief training. J Crim Just. 2021;74:101818.
23. Zama M, Dennis M, Price J, Topp SM. Assessing the feasibility of police initiation of HIV post-exposure prophylaxis for sexual violence survivors in Lusaka, Zambia. BMC Proceed. 2015;9:A3–A3.
24. Isano S, Wong R, Logan J, El-Halabi S, El-Khatib Z. Barriers to post exposure prophylaxis use among men who have sex with men in sub-Saharan Africa: an online cross-sectional survey. Prev Med Rep. 2020;19:101100.
25. Shao Y, Zhang M, Sun LJ, Zhang HW, Liu A, Wang X, et al. Effectiveness of onsite and online education in enhancing knowledge and use of human immunodeficiency virus pre- and post-exposure prophylaxis. World J Clin Cases. 2024;12(22):5042–50.
26. Ford N, Venter F, Irvine C, Beanland R, Shubber Z. Starter packs versus full prescription of antiretroviral drugs for postexposure prophylaxis: a systematic review. Clin Infect Dis. 2015;60 Suppl 3:S182–6.
27. Aborisade RA, Adeleke OA, Ebobo UC, Ogunmefun FM, Chineyemba LI, Adegoke N, et al. "We can't work with them, we can't work without them": the police-victim advocacy nexus in processing sexual offenses in the Nigerian justice system. Crim Just Behav. 2024;51(11):1773–93. https://doi.org/10.1177/00938548241267249

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RESEARCH ARTICLE

Developing and evaluating a community-driven intervention to promote uptake of HIV and contraception services among students enrolled in colleges and universities in Zimbabwe

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Abstract

Introduction: There is a growing appreciation that community-led interventions are key to sustaining the HIV response and achieving HIV prevention and treatment targets. Together with young people in colleges/universities and Ministry of Health (MOH), we developed and evaluated a student-led intervention for promoting the uptake of HIV self-testing (HIVST), post-exposure prophylaxis (PEP) and emergency contraception (EC) among college/university students.

Methods: Over 3 months, in biweekly study team meetings, two workshops with students, two meetings with MOH, and a joint workshop with students, MOH and relevant stakeholders, we co-developed an intervention for peer-led promotion/distribution of HIVST, PEP, EC and condoms. The agreed intervention was piloted in three Zimbabwean colleges/universities from December 2023 to February 2024. Student peers distributed HIVST and condoms directly, and vouchers for PEP and EC that were redeemed at college/nearby clinics. During co-development, students strongly preferred peer distribution of all commodities but this was restricted by regulatory requirements for PEP and EC. Peer distributors (n = 14) kept daily audio diaries of their experiences. In-depth interviews were held with students (n = 18), peer distributors (n = 11) and key informants (n = 12) to explore views/preferences, with participant observations and four focus group discussions to provide additional insights. We determined the intervention development and implementation costs.

Results: Peer-led distribution of HIVST, PEP and EC to college/university students was acceptable, feasible, appropriate and generally implemented as intended. PEP and EC acceptability was driven by high HIV and pregnancy risk among students, who had no easy access to services. Of 100 PEP and 257 EC vouchers distributed, 30% and 40% were redeemed, respectively. The main barrier to PEP and EC uptake was moral judgement against premarital sex, which affected female students more. Judgemental health worker attitudes also limited uptake of PEP and EC. EC voucher redemption among female students was lower versus males, aOR = 0.4 (95% CI = 0.2–0.8), p = 0.019. Redemption was also higher at the college where the nearby clinic could be accessed discreetly. Total cost of the intervention per student was $14.57 (cross-institution range: $7.26–$35.52).

Conclusions: Student-led distribution of HIVST, PEP and EC was feasible, acceptable and affordable. Making the intervention more community-driven according to the 2024 WHO PEP guidelines will likely achieve great impact.

Keywords: community-driven; HIV prevention; PEP; self-care; sexual and reproductive health; young people

Additional information may be found under the Supporting Information tab of this article.

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1 | INTRODUCTION

Community-led responses are actions/strategies informed by communities, and implemented by/for them to improve their health and human rights [1]. Communities are increasingly being recognized as key to driving sustained responses for achieving HIV prevention and treatment goals [2]. Correspondingly, in 2016, UN member states committed to ensuring that at least 30% of HIV service delivery is community-led by 2030 [1]. Progress towards this is slow, with calls

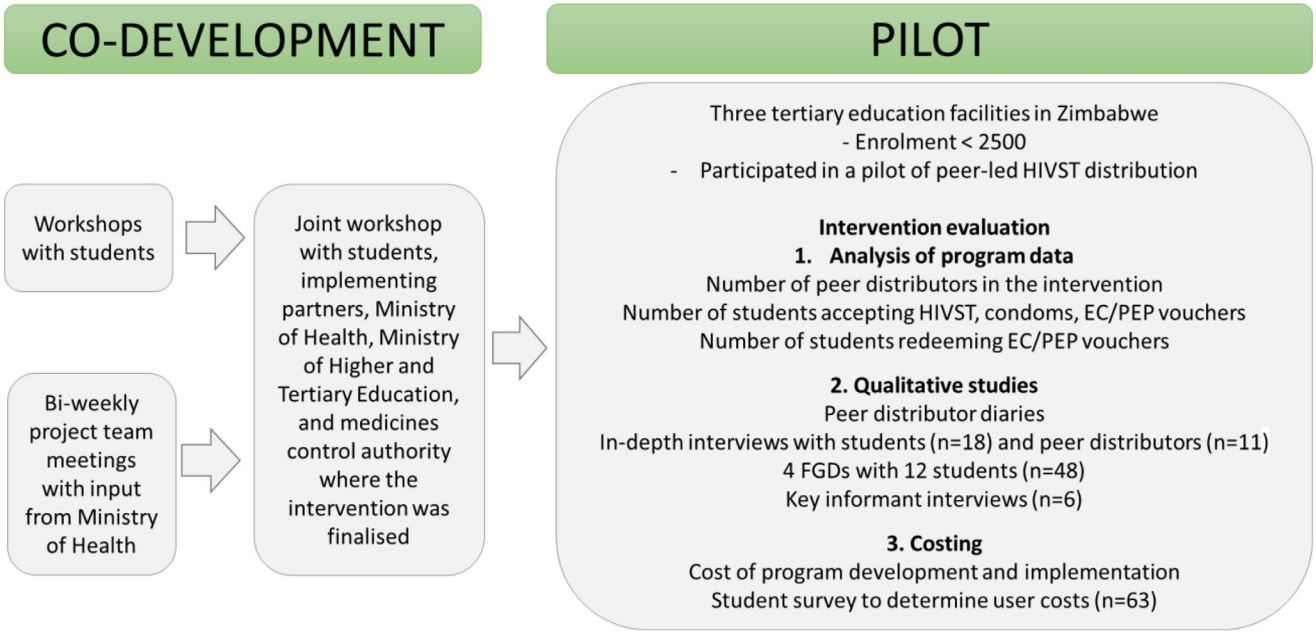


Figure 1. Overview of the study. Abbreviations: EC, emergency contraception; FGDs, focus group discussions; HIVST, HIV self-test; PEP, post-exposure prophylaxis.

for research to inform how community-led models, including youth-led models, can be supported.

Youth-led responses are important because young people lag behind in the uptake of HIV and sexual and reproductive health (SRH) services [3]. Across eastern, western, central and southern Africa (EWCSA), only 65% of people living with HIV aged 15–24 years know their HIV status, compared with 84% among adults >15 years [4]. Use of condoms, pre-exposure prophylaxis (PrEP), post-exposure prophylaxis (PEP) and voluntary medical male circumcision (VMMC) among young people is suboptimal [5, 6]. HIV incidence is high; about 160,000 women aged 15–24 years acquired HIV in EWCSA in 2022 [7], with incidence as high as 0.76% among adolescent girls and young women in Zimbabwe [8]. More than 80% of sexually active adolescents in EWCSA do not use contraception (14.6% unmet contraception need in Zimbabwe) [9], with millions facing unintended pregnancy, unsafe abortions and school drop-out [10]. There is a high prevalence of spontaneous sex among young people, associated with the non-use of condoms and contraception [11, 12]. This highlights the importance of emergency prevention for HIV and contraception, namely PEP and emergency contraception (EC), in addition to other combination prevention interventions. However, as stated above, these services are underutilized [13]. The recently updated World Health Organisation (WHO) PEP guidelines that endorse PEP delivery in communities, and through task sharing, will be important for driving uptake among young people [13].

Here, we describe a student-led approach incorporating HIV self-testing (HIVST) [14], and passive linkage (i.e. no active follow-up to encourage linkage) to PEP and EC services for young people enrolled in colleges/universities. The approach promoted self-care, where individuals take care of their health with/without health worker (HW) support [15–18]. Self-care is recommended by WHO as critical for achieving universal health coverage [15–18]. We aimed to co-develop and evaluate the acceptability, feasibility, adoption, appropriateness, fidelity and cost, of a student-led self-care intervention for promoting HIVST, PEP and EC uptake among college/university students.

2 | METHODS

2.1 | Study overview

Together with college/university students, Ministry of Health (MOH) and relevant stakeholders, we developed a student-led self-care intervention for HIV/SRH. Intervention development followed the WHO/Narasimhan self-care framework that upholds human rights and gender equality while taking a people-centred approach in an environment with health systems support and accountability [15, 18, 19]. We piloted the intervention in three colleges/universities over 1 month and used mixed methods to evaluate it (Figure 1).

2.2 | Co-development of the intervention

Our team comprised researchers and UNAIDS partners who worked on a completed trial (PACTR202111848628644) of peer-led HIVST [14], where students requested an intervention that met their HIV prevention and contraception needs. Over 3 months, the team held biweekly meetings to develop a peer-led intervention comprising HIVST, PEP and EC with insights from MOH (two meetings), and the medicines control authority (one meeting), Figure 1. We also held two workshops with students from the participating institutions to

Table 1. Characteristics of study colleges/universities

	Polytechnic college	University	Vocational college
Location	Small town about 100 km from the capital city (Harare)	Small town, about 90 km from Harare	Located in a high-density residential suburb in Harare
Ownership	Government	Private (Christian)	Private (Christian)
Maximum enrolment	1200	2220	800
Subject area	Technical and vocational multi-skills training. Offers national certificates, national diplomas, higher national diplomas and Bachelor of Technology	Degree-level courses in law, commercial subjects, arts and education	Industrial training. Offers national diplomas, national certificates, national foundational certificates and short courses
Clinic location	Campus	Campus	Community
HIV services available at clinic	PrEP and ART initiation; Additional testing for positive self-testing	PrEP and ART initiation; additional testing for positive self-testing	PrEP, VMMC and ART initiation; Additional testing for positive self-testing
Contraception services offered	Pill, injectable, emergency contraception, condoms[a]	Pill, injectable, emergency contraception, condoms[a]	Pill, injectable, implant, emergency contraception, condoms

Abbreviations: ART, antiretroviral therapy; PrEP, pre-exposure prophylaxis; VMMC, voluntary male medical circumcision.
[a]Although clinics technically offered condoms, they did not have condoms in stock during the study.

co-develop the intervention. We used insights from the meetings and workshops to develop a preliminary intervention that was finalized in a joint co-development workshop including students who participated in the above workshops, MOH and their partner implementers, and representatives of college/university leadership.

2.3 | The agreed intervention

2.3.1 | *Commodities to be distributed and distribution model*

HIVST, PEP, EC, male and female condoms would be provided. Mobilization and commodity distribution would be peer-led. Although students preferred collecting all commodities from peer distributors, national regulations restricted unlicensed personnel, such as students, from distributing PEP and EC. To address this, workshop participants agreed that peer distributors would distribute PEP and EC vouchers that could be redeemed through licensed HWs at college/nearby clinics. Voucher booklets were also securely placed at locations suggested by students (e.g. library, toilets) to give an option for self-collection. HIVST, male and female condoms were distributed directly according to MOH guidelines. Students accessing HIVST received information on linkage to appropriate post-test services.

2.3.2 | *Documenting uptake of commodities*

Basic demographic information would be collected during the distribution of condoms, HIVST, PEP and EC vouchers. Existing MOH registers would be used at clinics for documenting PEP and EC uptake.

2.4 | Intervention pilot

We piloted the agreed intervention at three colleges/universities from December 2023 to February 2024. PEP, EC, male and female condoms and HIVST were provided by the study.

2.4.1 | *Description of participating colleges/universities*

The three colleges/universities participated in the preceding HIVST study [14]. They were purposively selected to include different institution types and geographic variation, with a maximum enrolment of 2500. The maximum enrolment (2500) was determined pragmatically. We included a Polytechnic college, University and Vocational college, with total enrolments of 1200, 2220 and 800 (Table 1). The Polytechnic college and University had onsite clinics where students redeemed EC and PEP vouchers, while students from the Vocational college redeemed the vouchers from a nearby public sector clinic.

2.4.2 | *Selection and training of peer distributors*

At each college/university, students and college/university leadership identified potential peer distributors who were students aged ≥16 years and willing (written informed consent) to be distributors. Based on the previous peer-led HIVST trial [14], we selected one peer distributor per 300 students, ensuring the representation of students who lived on/off campus. Before they started distribution, peer distributors were trained on (1) condom demonstration, (2) HIV testing and counselling according to MOH curricula, including how to demonstrate the correct use of HIVST and support people who are self-testing, (3) educating people on PEP and EC, (4) ethical principles to uphold, (5) how to distribute and

Table 2. Commodity distribution procedures and criteria

Commodity	Quantity distributed at a time	Inclusion criteria	Explanation from peer distributors
HIVST	1	• Student enrolled at participating college/university • Not aware of HIV status	*Strong emphasis that those who knew their HIV status and were on HIV treatment should not use self-test, with warning of risk of false negatives explained.*
PEP vouchers	1	• Student enrolled at participating college/university • Self-reported HIV-negative status • Had recent (<72 hours) unprotected sex with a person living with HIV or someone of unknown HIV status and suspected to be at high risk of HIV	*PEP needed to be taken as soon as possible after unprotected sex, and no later than 72 hours.*
EC vouchers	1	• Student enrolled at participating college/university • Female student[a] • Not on a current family planning method • Had recent (<72 hours) unprotected sex	*EC needed to be taken as soon as possible after unprotected sex, and no later than 72 hours*
Condoms[b]	5	• Student enrolled at the facility • Students enrolled at the institution	

Abbreviations: EC, emergency contraception; HIVST, HIV self-testing; PEP, post-exposure prophylaxis.
[a]During implementation, distributors had requests by boyfriends to collect vouchers on behalf of their girlfriends, and this was allowed.
[b]Both male and female condoms.

document uptake of commodities and/or vouchers, including eligibility criteria.

2.4.3 | *Distribution of commodities during the pilot*

At each college/university, distribution was done over 1 month. Eligibility criteria for receiving commodities and distribution considerations are summarized in Table 2. Students provided verbal consent to collect commodities, in line with local standard of care. Additional criteria specific to each commodity are summarized in Table 2. Distributors documented HIVST uptake in an mHealth app that collected information on age, sex and institution. For each EC and PEP voucher, the distributor kept a stub with recipient age, sex, level in college and institution (stubs were self-completed for self-collections). Distributors were trained to uphold privacy in all interactions. Distributors were paid a fixed stipend of US$50 after distribution ended.

2.5 | Evaluation of the intervention

Using Proctor's Framework [20], we analysed programme data, conducted cost surveys and used qualitative studies to evaluate the intervention for: acceptability, adoption (uptake), appropriateness, feasibility, fidelity and costs. Table 3 highlights the methods used for each outcome.

2.6 | Programme data

We descriptively computed Acceptability and Adoption outcomes in Table 3. Univariable and multivariable logistic regression was used to determine factors associated with redemption of PEP and EC. For the outcome variables (% redemption of PEP; % redemption of EC), the numerators were numbers of students who redeemed PEP or EC and the denominators were numbers of students who collected PEP and EC vouchers, respectively. For adjusted analyses, age, sex, level in college and institution were built into the same logistic regression model. We verified that there was no collinearity between age and level in college. Programme data were analysed using STATA v17.0 [21].

2.7 | Costing

We estimated full annual economic costs including actual (financial) expenses and non-financial costs (student distributors' time and materials, other donated inputs and cross subsidization by pre-existing health programmes) for resource inputs consumed during distribution. Costs were classified according to the rollout stage—(1) pre-implementation (meetings and workshops), (2) start-up, for example training, (3) implementation and (4) type (capital and recurrent).

Table 3. Proctors' outcomes and evaluation methods

Outcome	Indicators	Evaluation methods
Acceptability	% invited distributors accepted participation	Analysis of programme data
	% invited distributors completed training	Analysis of programme data
	Acceptability themes from qualitative research	Peer distributor audio diaries
		Peer distributor in-depth interviews
		Participant observation
		Student in-depth interviews
		Student focus group discussions
		Key informant interviews
Adoption (uptake)	% Students accepting HIVST	Analysis of programme data
	% Students accepting PEP	
	% Students accepting EC	
	% Students accepting male/female condoms	
	% Students redeeming PEP vouchers	
	% Students redeeming EC vouchers	
	Themes from qualitative studies related to adoption	Peer distributor audio diaries
		Peer distributor in-depth interviews
		Participant observation
		Student in-depth interviews
		Student FGDs
		Key informant interviews
Appropriateness, feasibility, fidelity	Themes from qualitative studies	Peer distributor audio diaries
		Peer distributor in-depth interviews
		Participant observation
		Student in-depth interviews
		Student focus group discussions
		Key informant interviews
Costs	Cost of intervention development	Programme data
	Cost of intervention provision	Programme data
	Cost per student enrolled	

Abbreviations: EC, emergency contraception; FGDs, focus group discussions; HIVST, HIV self-testing; PEP, post-exposure prophylaxis.

2.7.1 | *Costing analysis*

To ensure that only the value of capital items used during the project lifetime were included, pre-implementation, start-up and other capital costs were annualized based on appropriate useful lifespans and at a 3% discount rate. Interviews with programme implementation team members helped disaggregate and allocate staff time to relevant activities. Distributors' time was valued based on the fixed stipend of US$50 paid after distribution. Input costs, on-site observations, and monitoring and evaluation data were used to estimate total programme economic costs of product distribution. Cost per student was estimated by dividing programme cost by student enrolment per institution. Costs were estimated in 2023 US dollars. Data management and analysis was conducted in Microsoft Excel®.

2.8 | Qualitative studies

As indicated in Table 3, we used various qualitative methods to explore acceptability, adoption, appropriateness, feasibility and fidelity (whether intervention was implemented as intended). For distributors, we recruited all who were willing/able to participate in qualitative studies; for other participant types, we conducted recruitment until theoretical saturation was reached [22].

- *Participant observations:* Trained social science researchers observed student behaviour and interactions about the intervention. Observations were made during distributor training and at two support visits to each college/institution according to a guide soliciting impressions on distributor comprehension of training, distributor enthusiasm, acceptability of the intervention among students and fidelity to implementation.
- *Audio diaries among distributors (n = 14):* Trained distributors were asked to make audio records depicting their experiences from the start of distribution to 2 weeks after the end of distribution. Social science researchers provided training on how to make audio records on tablets, including examples of experiences and impressions to record, and ethical principles to uphold (e.g. upholding confidentiality by not mentioning people's names in audio recordings).

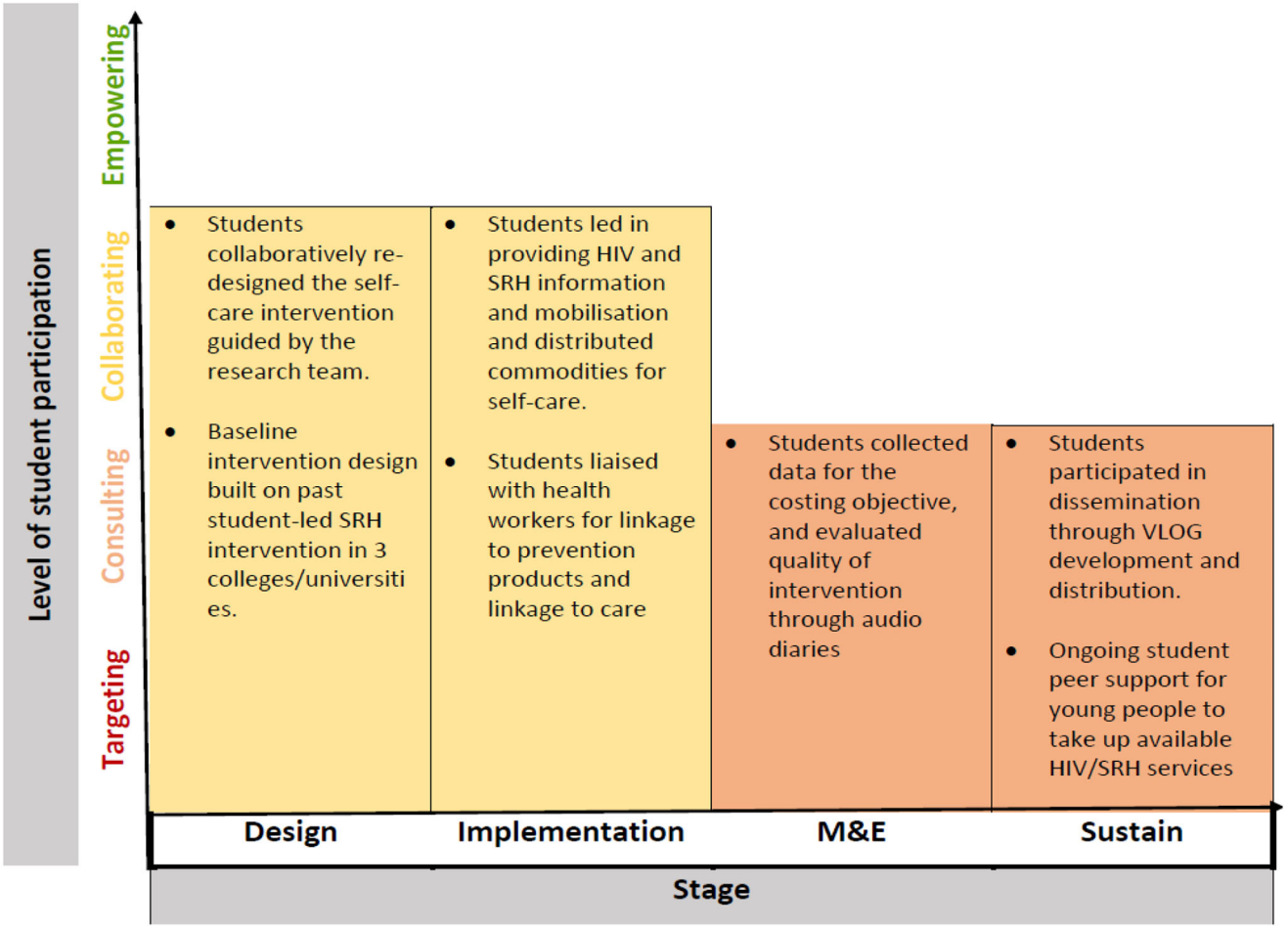


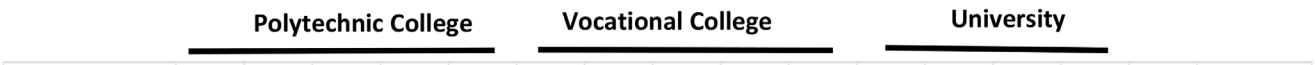
Figure 2. An illustration of the level of student participation in the different stages of the self-care intervention in accordance with the McGee et al. [25] framework for qualifying community-led interventions. Abbreviations: M&E, monitoring and evaluation; SRH, sexual and reproductive health; VLOG, video blog.

- *In-depth interviews (IDIs) among distributors (n = 11):* One month after the distribution was completed, distributors were interviewed in-depth to explore experiences with distribution.
- *IDIs among students (n = 18):* One month after distribution ended, students were interviewed in-depth to explore user experiences, acceptability of the intervention, and barriers and facilitators to uptake of the different commodities. Purposive selection was done to ensure balance by sex, study year group and uptake/non-uptake of commodities.
- *Focus group discussions (FGDs) among students (4 FGDs, n = 45):* One month after implementation, four FGDs with 11–12 students per group were held with students who accepted/did not accept commodities to explore insights at group level.
- *Key informant interviews (n = 12)* MOH representatives at central and local levels, and MOH implementing partners in the fields of HIV and contraception were interviewed in-depth about views on the intervention and how it can be improved.

IDIs, FGDs and key informant interviews were facilitated by trained social science researchers using discussion guides and were audio-recorded. Analysis was thematic [23]; commencing together with data collection with field notes for each audio diary, interview/discussion focused on emerging themes. The research team had regular discussions to interrogate qualitative findings, their relationship with programme data and to inform further exploration. After data collection was complete, analytic summaries of each theme drew comparisons within and across participants and data collection methods. These summaries were used to develop coding frameworks that were used for coding the data in NVIVO 11 [24].

2.9 | Community-driven nature of the study

Various components of the study were student-driven, including intervention conception, development and implementation. Figure 2 summarizes the extent to which the different components were student-driven.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Static site*	Total
Male Condoms	35	31	25	59	23	39	38	0	50	44	14	60	50	5	0	**473**
Female condoms	19	7	2	0	27	0	11	0	0	14	7	16	4	0	0	**107**
HIVST	46	67	51	87	87	32	16	18	50	38	34	54	14	22	0	**616**
EC voucher	21	17	20	1	21	23	42	2	60	0	13	25	1	4	7	**257**
EC redeemed	2	3	20	0	15	12	1	0	26	0	5	17	0	0	3	**104**
PEP voucher	6	28	0	0	5	0	0	0	5	10	6	25	5	4	6	**100**
PEP redeemed	0	2	0	0	3	0	0	0	2	2	0	10	3	2	6	**30**

Figure 3. Commodities distributed stratified by peer distributor (1–14) and institution. Abbreviations: EC, emergency contraception; HIVST, HIV self-testing; PEP, post-exposure prophylaxis. *Indicates vouchers for PEP and EC that were self-collected from public points such as the library, auditorium and toilets rather than collected from a distributor.

2.10 | Ethical considerations

Ethical approval was obtained from the national ethics committee, Medical Research Council of Zimbabwe (Ref MRCZ/A/2971). Written informed consent was obtained before participation in all qualitative studies.

3 | RESULTS

3.1 | Programme data analysis

3.1.1 | *Acceptability*

Across the three institutions, 17 students who were suggested by their colleges were invited to participate as distributors, and all accepted participation. Of these, 15 (88.2%) completed training, and 14 (93.3%) started and completed distribution, Figure 3.

3.1.2 | *Adoption*

Of 4220 enrolled students across the three colleges, 2896 students were present during the pilot (the rest were away on scheduled industrial attachments). Across the three institutions, 473 and 107 students accepted male and female condoms, respectively, 616 accepted HIVST, and 257 and 100 accepted EC and PEP vouchers, respectively, Figure 3.

The median (IQR) age of students accepting male condoms was 22 (20–24) years, female condoms: 21 (20–23) years, HIVST: 22 (17–24) years, PEP vouchers: 23 (21–25) years and EC vouchers: 21 (19–23) years (Table 4). Both males (n = 118; 45.9%) and females (n = 108; 42%) collected EC vouchers, and a greater proportion of first-year students (n = 109; 42.4%) collected EC vouchers compared to other college levels (Table 4). This was mostly driven by the first-year students at the vocational college (Table S1).

The highest uptake of all commodities happened in week 1 of implementation, with a general dip in weeks 2 and 3 and an increase in week 4, Figure 4.

Redemption of PEP vouchers. Of the 100 PEP vouchers distributed, 30 (30.0%) were redeemed. Redemption did not differ by age, sex or year group (Table 5). There was a tendency towards a difference of PEP redemption by institution: at the polytechnic college, 11 (24.4%) students who collected PEP vouchers redeemed them, compared with 34% at the vocational college, adjusted odds ratio (aOR) 3.9 (0.9–17.4), p = 0.075 and 40% at the University, aOR 3.6 (0.3–28.9), p = 0.287. Of note, all six PEP vouchers that were self-collected (rather than collected from a peer) were redeemed.

Redemption of EC vouchers. Out of the 257 EC vouchers distributed, 104 (40.4%) were redeemed. Twenty-seven (25%) female students redeemed EC vouchers compared to 46 (40%) male students (aOR = 0.4 95% CI = 0.2–0.8; p = 0.019) (Table 5). Redemption of EC was also higher at the vocational college compared to the Polytechnic College, aOR 3.5 (1.2–10.2), p = 0.021.

3.2 | Costing results

Table 6 summarizes the programme and unit costs by college/university. The total programme costs were $42,205 (cross-institution range: $13,674–$14,598) when the value of distributor time is based on the $50 incentive paid after

Table 4. Characteristics of students taking up commodities

Characteristic	Male condom (*N* = 473)	Female condom (*N* = 107)	HIVST (*N* = 616)	PEP voucher (*N* = 100)	EC voucher (*N* = 257)
Age (median [IQR])	22 (20–24)	21 (20–23)	22 (17–24)	23 (21–25)	21 (19–23)
	n **(*n*/*N*%)**	***n*** **(*n*/*N*%)**	***n*** **(*n*/*N*%)**	***n*** **(*n*/*N*%)**	***n*** **(*n*/*N*%)**
Age range in years					
16–19	62 (13.1)	16 (15.0)	91 (14.8)	3 (3.0)	57 (22.2)
20–24	327 (69.1)	77 (72.0)	382 (62.0)	63 (63.0)	135 (52.5)
25–29	77 (16.3)	14 (13.0)	130 (21.1)	26 (26.0)	33 (12.8)
30 +	7 (1.5)	0 (0.0)	13 (2.1)	0 (0.0)	1 (0.4)
Missing	0 (0.0)	0 (0.0)	0 (0.0)	8 (8.0)	31 (12.1)
Sex					
Male	418 (88.4)	25 (23.4)	307 (49.8)	51 (51.0)	118 (45.9)
Female	47 (9.9)	82 (76.6)	309 (50.2)	41 (41.0)	108 (42.0)
Missing	8 (1.7)	0 (0.0)	0 (0.0)	8 (8.0)	31 (12.1)
Level in college					
First	154 (32.6)	34 (31.8)	–[a]	18 (18.0)	109 (42.4)
Second	153 (32.3)	44 (41.1)	–[a]	34 (34.0)	64 (24.9)
Third	126 (26.6)	22 (20.6)	–[a]	23 (23.0)	33 (12.8)
Fourth and over	30 (6.3)	7 (6.5)	–[a]	12 (12.0)	17 (6.6)
Missing	10 (2.1)	0 (0.0)	–[a]	13 (13.0)	34 (13.2)
Institution					
Polytechnic college	173 (36.6)	55 (51.4)	338 (54.9)	45 (45.0)	81 (31.5)
Vocational college	127 (26.8)	11 (10.3)	116 (18.8)	5 (5.0)	128 (49.8)
University	173 (36.6)	41 (38.3)	162 (26.3)	50 (50.0)	48 (18.7)

Abbreviations: EC, emergency contraception; HIVST, HIV self-testing; IQR, inter-quartile range; PEP, post-exposure prophylaxis.
[a]Indicates that the tool used for documenting HIVST distribution did not collect this data.

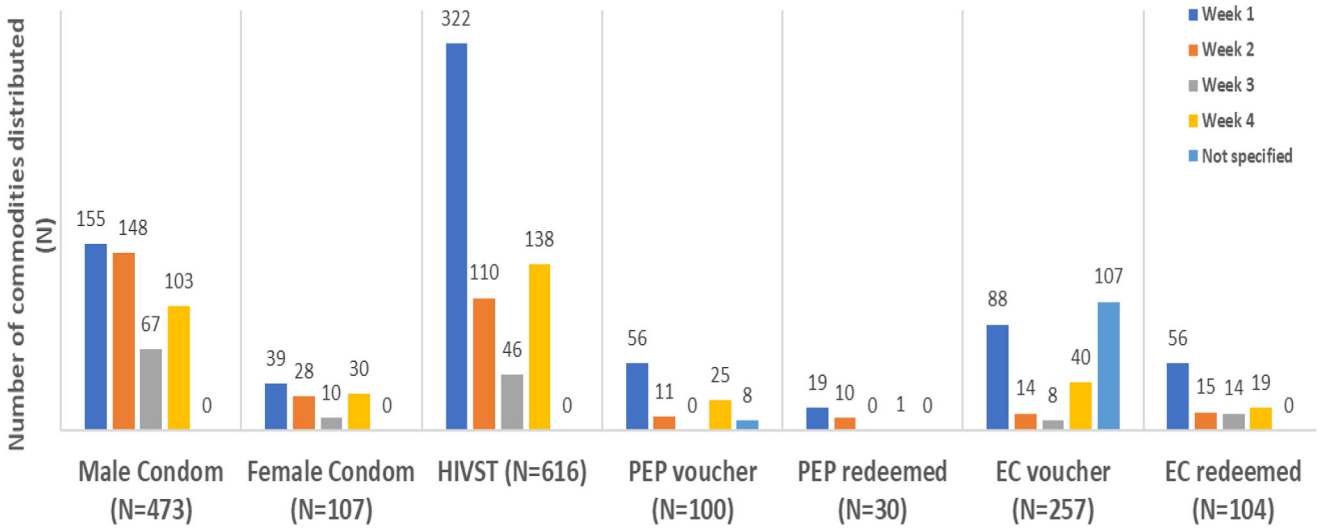


Figure 4. Number of commodities distributed in the intervention pilot, per week. Abbreviations: EC, emergency contraception; HIVST, HIV self-testing; PEP, post-exposure prophylaxis.

Table 5. Factors associated with redeeming PEP or EC among students who accepted vouchers

	Characteristic	Frequency *n*(*n*/*N*%)	Redemptions n_1 (n_1/*n*%)	Unadjusted OR (95% CI)	*p*	Adjusted OR (95% CI)	*p*
PEP (*N* = 92)	Age			0.9 (0.7–1.1)	0.356	0.9 (0.6–1.3)	0.540
	Age range in years						
	16–24	66 (71.8)	18 (28.6)	1.7 (0.5–5.1)	0.363		
	25–29	26 (28.3)	5 (19.2)	Ref.	Ref.		
	Sex						
	Female	41 (44.6)	9 (22.0)	Ref.	Ref.	Ref.	Ref.
	Male	51 (55.4)	14 (27.5)	1.3 (0.5–3.5)	0.546	1.6 (0.5–5.1)	0.396
	Level in college						
	First	18 (19.6)	5 (26.3)	Ref.	Ref.	Ref.	Ref.
	Second	34 (37.0)	7 (21.2)	0.8 (0.2–2.8)	0.675	0.5 (0.1–2.4)	0.387
	Third	23 (26.4)	6 (26.0)	1.0 (0.3–4.0)	0.987	1.5 (0.2–11.6)	0.713
	Fourth and above	12 (13.8)	5 (41.7)	2.0 (0.4–9.3)	0.376	1.3 (0.1–12.6)	0.541
	Institution						
	Polytechnic college	45 (48.9)	11 (24.4)	Ref.	Ref.	Ref.	Ref.
	Vocational college	50 (54.3)	17 (34.0)	1.6 (0.6–3.9)	0.309	3.9 (0.9–17.4)	0.075
	University	5 (5.4)	2 (40.0)	2.1 (0.3–13.9)	0.459	3.6 (0.3–28.9)	0.287
EC (*N* = 226)	Age			1.0 (0.9–1.20)	0.490	1.0 (0.9–1.1)	0.811
	Age range in years						
	16–19	57 (25.2)	14 (24.6)	Ref.	Ref.		
	20–24	135 (59.7)	51 (37.8)	1.9 (0.9–3.7)	0.085		
	25+	34 (15.0)	8 (23.5)	0.9 (0.3–2.6)	0.911		
	Sex						
	Male	118 (52.2)	46 (40.0)	Ref.	Ref.	Ref.	Ref.
	Female	108 (47.8)	27 (25.0)	0.5 (0.3–0.9)	0.026	0.4 (0.2–0.8)	0.019
	Level in college						
	First	109 (48.9)	32 (29.4)	Ref.	Ref.	Ref.	Ref.
	Second	64 (28.7)	18 (28.1)	1.1 (0.5–2.1)	0.863	1.3 (0.6–2.8)	0.522
	Third	33 (14.8)	14 (42.4)	1.8 (0.8–4.0)	0.163	2.1 (0.8–5.7)	0.128
	Fourth and above	17 (17.6)	9 (52.9)	2.7 (1.0–7.6)	0.060	1.3 (0.3–5.0)	0.715
	Institution						
	Polytechnic college	81 (31.5)	41 (50.6)	Ref.	Ref.	Ref.	Ref.
	Vocational college	48 (18.7)	24 (50.0)	1.0 (0.5–2.0)	0.946	3.5 (1.2–10.2)	0.021
	University	128 (49.8)	39 (30.5)	0.4 (0.2–0.8)	0.004	0.9 (0.3–2.7)	0.828

distribution. Dividing total programme cost by number of students exposed to the intervention *(Students on campus during 4-week intervention period)* yielded cost per student of $14.57 (cross-institution range: $7.26–$35.52). However, and for the purposes of budgeting/planning for wider student reach, dividing total programme cost by total student enrolment *(including students who were away on industrial attachment during the intervention)* yielded cost per student of $10.00 (cross-institution range: $6.28–$17.09). Most (98%) costs were recurrent implementation inputs, with programme personnel (54%) and supervision (31%) as the main cost drivers.

3.3 | Qualitative study results

3.3.1 | *Acceptability and adoption (uptake)*

There was high acceptability and a great need for HIV and pregnancy prevention services among students. Across all data collection methods, students, distributors, lecturers and HWs said PEP and EC provision for students was long overdue. It was widely discussed that students needed these services but had no easy access. Although both college/university clinics reportedly offered condoms, none were available during the pilot.

> "…here they don't allow distribution of condoms because they say it's a Christian institution, so the children have no access" (KII, 38-year-old female, HW).

Distributors reported that even before their distributor training was complete, they were overwhelmed by requests for products and information—this was confirmed during participant observations where some students requested immediate EC and PEP voucher access because the windows since unprotected sex were closing. Distributors reported rapid

Table 6. Programme and unit cost summary by implementation stage

Cost categories $ (by input)	Polytechnic college	Vocational college	University	Total
Intervention development	***Cost ($)***	***Cost ($)***	***Cost ($)***	***Cost ($)***
Sensitization (students)	$5	$5	$5	$15
Consultation meeting with stakeholders	$175	$175	$175	$175
Total capital cost—Intervention development	$190	$190	$190	$190
Implementation				
Initial training	$281	$227	$58	$566
Total capital cost—Implementation	$281	$227	$58	$566
Capital costs				
Intervention—Implementation				
Sensitization (students)	$5	$5	$5	$15
Joint workshop	$58	$58	$58	$175
Initial training	$281	$227	$58	$566
Total capital cost—Implementation	$344	$290	$122	$756
Recurrent costs—Implementation				
Personnel HQ	$4295	$4440	$4368	$13,103
Personnel (programme)	$7539	$7540	$7540	$22,619
Personnel (student distributors)	$250	$250	$250	$750
Supplies (distributors)	$71	$71	$71	$214
Supplies (products)	$1359	$525	$700	$2583
Visits (support and supervision + closeout)	$468	$319	$479	$1266
Communications	$45	$45	$45	$135
Vehicle operation and maintenance	$31	$31	$31	$92
Building operation and maintenance	$100	$103	$101	$304
Other recurrent	$96	$99	$97	$292
Total recurrent cost—Implementation	$14,254	$13,384	$13,811	$41,449
Total programme cost	$14,598	$13,674	$13,933	$42,205
Total # students exposed[a]	591	385	1920	2896
Cost per student enrolled	$24.70	$35.52	$7.26	$14.57
Total student enrolment[b]	1200	800	2220	4220
Cost per student enrolled (total enrolment)	$12.17	$17.09	$6.28	$10.00

Abbreviation: HQ, head quarter.
[a]# students exposed—students on campus during 4-week intervention period.
[b]Total student enrolment—for budgeting/planning for wider reach.

uptake of PEP, EC, HIVST kits and condoms soon after distribution began (Figure 4).

The main driver of acceptability of HIV and pregnancy prevention services was the high risk for HIV, sexually transmitted infections (STI) and pregnancy among students, which was acknowledged across all data collection methods. Many students reportedly engaged in condomless sex and had concurrent sexual partners within and outside college, including transactional sex partners. Distributors noted that before the intervention, in their role as peer educators/counsellors, they frequently interacted with students suffering from STIs with no access to treatment, with many reports of unintended pregnancies and abortions. Participant observers and students described "semester marriages" where students moved in together to save accommodation/living costs, with reports that condom use in such partnerships was rare. In such "stable" relationships, condom use was thought a sign of partner distrust: *"wearing a condom against a partner is accusing them of witchcraft."* Students reportedly often found themselves in situations where they had spontaneous sex, where condom use was less likely—students reported that this made PEP invaluable.

> "When this program came and they introduced PEP to us, these things are very important especially to students because there is a lot of mischief" (IDI, 27-year-old male, Peer distributor 4)

Views on peer-driven distribution. Acceptability and adoption were also motivated by the peer-driven nature of the intervention, which students reported leveraged the influence, trust and non-judgemental nature of existing peer

relationships. Having the peer distributors in proximity also facilitated easy uptake.

> "I think if (PEP) is distributed by these young distributors, it will be better because we are able to talk to them and say, 'mate things are not well, this is what happened, so I want PEPP" (IDI, 24-year-old female, Student).

Key informants were also supportive of peer-led distribution. However, some worried that the quality of service provided by peers may be suboptimal, with assertions that peer distributors lacked specialized training and had the potential to misuse products in their custody. They worried that peer distributors may have problems upholding confidentiality, although no reports of breached confidentiality were made. A few students also raised concerns about confidentiality and suggested including distribution by lecturers, which they said would expand the choices available for students who worried about lack of confidentiality among peers.

> "I think the morning after program needs to be administered by an older person who is not a student, maybe a lecturer. Because students have a challenge that even the one who is distributing, you don't know to what extent they can maintain confidentiality…" (FGD, 18-year-old, Female student).

Barriers to uptake of commodities. Moral judgement related to premarital sex was a major barrier to the uptake of services. This is a deeply enshrined societal judgement across Zimbabwe. Although reports showed it was perceived everywhere, students in Christian-owned institutions worried about potential judgement from lecturers, nurses and other college staff who were seen as proponents of Christian values that discourage premarital sex. Although students felt comfortable collecting PEP and EC vouchers from peers, fear of moral judgement made it challenging for them to openly redeem vouchers from clinics. At two colleges, the walkway to the clinic and clinic entrance were clearly visible from lecturers' and/or Christian leaders' residences, which amplified the difficulty. Female students reportedly worried about moral judgement more than male students; some female students felt too shy to collect any of the commodities, even from peer distributors. Male partners, keen to prevent unintended pregnancy, were reported to play active roles in collecting EC vouchers and redeeming them for their shy girlfriends. This was confirmed by the programme data which showed that 40% of male students who collected EC vouchers redeemed them compared to 25% among females.

> "You could be seen going there to take it (PEP) so it was not safe for students to go there just because you would go to the clinic in daylight from 8 to 4… because our clinic is in the open." (IDI, 27-year-old male-Peer distributor 2).

> "…Girls were particularly shy to go and collect morning after, so boys did it for them…" (20-year-old female, Peer distributor 14)

Age differences between HWs and students created a significant barrier for students to redeem PEP/EC. Students perceived HWs to be "*adult-like*," which made it difficult to admit to being sexually active, let alone without condoms.

> "So for someone to make the initial decision to go and see the elderly nurses who are as old as one's father or mother, or for someone to clearly tell their story, haa I don't think one will feel comfortable" (IDI, 24-year-old, Female student).

Students notably reported that HWs exhibited judgemental attitudes, lack of empathy, and were mean and unwelcoming towards students redeeming PEP/EC vouchers. They reportedly used demeaning words and shouted at students for engaging in premarital sex or unprotected sex. In some cases, HWs threatened to or refused to give commodities to discourage students from continued "risky" behaviour.

> "The nurse said, but you can't just come and tell me that, so you are going to have to get it (HIV)…I can just deny you (the PEP), then you will get it, the disease." (FGD, 24-year-old, Female student).

> "…haa the nurses can embarrass you, especially if you try to use a low voice (to prevent other people hearing), they will immediately shout, saying 'uhh, you recklessly decided to have wet sex (unprotected sex), that's why you want morning after'." (FGD, 22-year-old, Female student).

Students underscored the need for peer distributors to provide both PEP and EC directly, rather than vouchers, to evade the negative interactions with HWs. Some lecturers also supported this notion.

Pill burden associated with PEP was also a barrier, which interacted with moral judgement. Students shared that because PEP involves a lengthy medication course, it can be overwhelming and increase the likelihood of others noticing. Activities that happen during the 28-day period could discourage continuation, for example some students reported that if they had to go home during the 28-day period they would stop taking PEP so that parents would not find out.

> "…the (28-day) course may be a challenge…if people see you taking it (PEP)…one may miss doses over the 28 days. Maybe they go home over the weekend so they decide to pause, or another time they may fear that their roommate has seen them and decide to stop." (IDI, 25-year-old, Female student)

However, lived experiences from students who took-up PEP demonstrated commitment to prevail over adherence challenges.

> "During the first days it was not easy because I was not used to taking medication. So, as you keep taking it, you end up getting used to it" (IDI, 23-year-old, Female student)

Another barrier was reluctance to undergo provider-delivered HIV testing, a prerequisite for accessing PEP according to national guidelines. Students who received PEP vouchers had generally also received HIVST and tested themselves; they reported feeling that the additional testing was a waste of time. Some students feared an HIV-positive result.

> "So, think about the whole process where I start by getting tested using the blood thing, then what, yet I already tested myself. For me to get tested, then wait, that's why I didn't return to go and collect what's-the-name, the PEP…" (IDI, 22-year-old, Female student)

3.3.2 | *Feasibility, appropriateness and fidelity to implementation*

Participant observations and programme data showed that peer distributors implemented the intervention as expected. Distributors confirmed this, reporting that they enjoyed the work and found it feasible to do. HWs reported facilitating PEP and EC redemption as expected. However, as described above, students reported judgemental and unfriendly treatment when seeking PEP and EC vouchers. Most HW narratives painted their work in a good light, highlighting *"provision of counselling to discourage risky behaviour."*

The intervention provided a 28-day course of PEP following potential exposure to HIV. Provision of PEP for future exposures (PEP-in-pocket) was not part of the intervention. However, we found students collecting PEP/EC for future use, highlighting acknowledgement of HIV and pregnancy risk and acceptability of the intervention. Desire for PEP-in-pocket was associated with knowledge that the programme was coming to an end, and students wanted to be sure they got emergency stocks before the opportunity lapsed. There was an indication that in an emergency, PEP-in-pocket was useful for starting early within the 72-hour window as it avoided lengthy and dreaded processes before collection (HIV testing).

> "I then had strong desire to ensure that I always have PEP because tomorrow is unknown, to be honest(chuckles)" (24-year-old, Female student).

> "What if we keep the PEP, so that if there is an emergency, I just take it. The problem is that nurses want us to get tested, but if the young person already has their PEP in the room, they will just take it." (IDI, 20-year-old female, Peer distributor 5).

There were indications of fears of risk compensation during intervention implementation. HWs, lecturers across all institutions, some key informants and students reported that PEP and EC availability appeared to encourage unprotected sex among students. Narratives by lecturers, HWs and other key informants were hypothetical on this, although some students and peer distributors said they knew this was happening. One student confessed that his girlfriend encouraged him not to wear a condom as she could use the morning after pill afterwards.

> "…it made students indulge in unprotected sex instead of abstinence… So, students were no longer using condoms thinking 'we will take PEP anyway" (IDI, 27-year-old male, Peer distributor 2).

4 | DISCUSSION

In this mixed-methods study, we found that a co-developed self-care intervention with peer-led distribution of HIVST, PEP and EC to college/university students was acceptable, feasible, appropriate, and generally implemented as intended. Acceptability of PEP and EC was driven by unmet need—there were reports of high HIV and pregnancy risk among students, yet there was no easy access to HIV prevention and contraception services. Although students preferred to have PEP and EC distributed directly by peers, regulatory requirements did not support this, hence student peers distributed vouchers that were redeemed at nearby clinics. Of the PEP and EC vouchers that were distributed, 30% and 40% were redeemed. The main barrier to PEP and EC uptake was moral judgement associated with premarital sex, which affected female students more than males. Unfriendly HW attitudes limited the uptake of PEP and EC.

The high HIV risk we reported is in line with global data for young people [26–30]. It is worrying that despite this high risk, there is poor access to HIV and SRH services, which has also been reported in other settings [31]. Poor condom access in study communities in 2024 is shocking. Condom use and education has decreased among young people globally amid cuts in condom promotion budgets [32]. There is an urgent need to revitalize this, ensuring that this includes condom negotiation skills alongside implementation of combination prevention programmes that include PEP to PrEP or PrEP to PEP transitions and optimum access to contraception services.

Provision of services needs to address barriers uncovered in this study, including moral judgement for premarital sex and unfriendly/judgemental attitudes of HWs. At the vocational college, redemption of vouchers was likely higher because the clinic is separate from the college, so students could access the clinic without fear of being seen by their peers and lecturers. Investing in youth friendly programmes that uphold confidentiality and discreetness may be key to optimizing uptake of HIV and SRH services among young people. Additionally, as shown in this study, students could benefit from the direct provision of PEP and EC by their peers, and from the inclusion of a PEP-in-pocket model. This would strengthen the community-driven model and is in line with the recently updated WHO PEP guidelines.

Thirty percent of students who collected PEP vouchers redeemed them in this study. This linkage rate is in line with other rates of 21–26% reported for linkage from community HIV testing programmes to health facilities in South Africa [33, 34] and Zimbabwe [35]. Vouchers may have achieved this through providing physical reminders or cues to go to the clinic [36]. Additionally, presenting a voucher meant that the student would then not have to verbally spell out the purpose

of the clinic visit, which students would have found helpful in the context of the moral stigma for sexual activity that is described above. The 70% who deemed themselves at risk of HIV acquisition but did not redeem their vouchers represent a group with concerning unmet HIV prevention need. Implementation of the WHO guidelines for PEP has the potential to bridge this gap, and it will be useful for programmes to adopt WHO guidelines that endorse the use of HIVST for PEP and PrEP [37]. HIVST will make it easier to implement community-driven PEP models and address barriers related to repeated testing that were reported in this study.

Of note, there were indications of actual or hypothetical risk compensation with the use of PEP and EC. Risk compensation has been reported in other HIV prevention programmes where increases in STI have been reported following the implementation of PrEP programmes [38, 39]. Although the data are conflicting, there is evidence that STI rates were rising before PrEP, and there is modelling evidence to show the gains, at least for HIV, far outweigh the problems caused by risk compensation [39]. Further research is needed to quantify the magnitude and impact of the problem in this population and to explore interventions that address it.

Results of our economic cost analysis show that promoting self-care among college/university students is affordable at US$10–$14 per participant, falling within the range of reported costs of peer-led distribution programmes across high HIV prevalence settings in Africa varying between US$4 per participant reached to US$36 per HIVST kit pack distributed [40, 41]. Personnel costs account for more than two-thirds of costs reflecting the intensive nature of supervision and support provided to peer distributors and potentially a source of cost reductions as programmes mature and less support is required or with higher distribution numbers leading to economies of scale [35, 42].

The strengths of our mixed-methods study include the fact that together with students and MOH we developed a context-relevant intervention, including a costing study. We used robust methods in intervention development and evaluation. We provide timely evidence to inform the operationalization of recent WHO PEP guidelines on community-based provision and task sharing. Limitations relate to the small size of the pilot, limiting generalizability and requiring caution in the interpretation of results of the logistic regression. We did not collect data on adherence or completion rates for PEP. The pilot was short in duration, which limits understanding of how evaluated outcomes change with time. Limitations also relate to the accuracy of self-reports on time since condomless sex, which would be expected for a study of this nature.

5 | CONCLUSIONS

In conclusion, this mixed-methods evaluation of a co-developed peer-led intervention for HIVST, PEP and EC found that the intervention was acceptable, feasible, appropriate and implemented as intended. The costs of intervention development and implementation were in line with those of similar interventions, with potential cost reduction for large programmes benefiting from economies of scale. Although young people are at an ongoing risk of HIV, STIs and unintended pregnancy, access to relevant HIV and SRH services is limited. Factors such as stigma and unfriendly HWs limit the uptake of HIV and SRH services. The study highlights an urgent need for addressing the challenges we uncovered to drive the attainment of health targets now and in the future. A larger, comparative evaluation of the intervention that is refined as suggested here is needed to evaluate its impact.

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COMPETING INTERESTS

The authors declared no competing interests.

AUTHORS' CONTRIBUTIONS

OK: Writing original draft, formal analysis, visualization. LM: Writing original draft, project administration, formal analysis. CM: Writing original draft, methodology, formal analysis. MKT: Project administration, writing—review and editing. NR: Investigation, writing—review and editing. EM: Data curation. JK: Conceptualization. FT-P: Conceptualization, methodology, writing—review and editing. FMC: Conceptualization, methodology, writing—review and editing, supervision. ELS: Conceptualization, writing an original draft, methodology, funding acquisition, supervision.

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DATA AVAILABILITY STATEMENT

Data are available upon request. De-identified data are available from the corresponding author on request.

REFERENCES

1. UNAIDS. Community-led AIDS responses: final report based on the recommendations of the multistakeholder task team. 2022.
2. UNAIDS. Global AIDS strategy 2021–2026. End inequalities. End AIDS. 2021.
3. Joint United Nations Programme on HIV/AIDS (UNAIDS). IN DANGER: UNAIDS Global AIDS Update 2022. Geneva: UNAIDS; 2022.
4. Giguère K, Eaton JW, Marsh K, Johnson LF, Johnson CC, Ehui E, et al. Trends in knowledge of HIV status and efficiency of HIV testing services in sub-Saharan Africa, 2000–20: a modelling study using survey and HIV testing programme data. Lancet HIV. 2021;8(5):e284–e93.
5. UNAIDS. 2020 Global AIDS Update. 2020.
6. UNAIDS. 2021 Global AIDS Update: confronting inequalities - lessons for pandemic responses from 40 years of AIDS. 2021.
7. UNAIDS. The path that ends AIDS: 2023 UNAIDS Global AIDS update. Geneva: UNAIDS; 2023.
8. PHIA Project. Zimbabwe Population-based HIV Impact Assessment [ZIMPHIA 2020]. 2021. https://phia.icap.columbia.edu/zimbabwe2020-final-report/.
9. Zimbabwe National Statistics Agency (ZIMSTAT). Demographic and Health Survey 2023–24: Key Indicators. Rockville, MD: Zimbabwe National Statistics Agency (ZIMSTAT).

10. McCurdy RJ, Jiang X, Schnatz PF. Long-acting reversible contraception in adolescents in sub-Saharan Africa: evidence from demographic and health surveys. Eur J Contracept Reprod Health Care. 2018;23(5):357–64.
11. Nathan SF, Berglas NF, Kaller S, Mays A, Biggs MA. Reasons for having unprotected sex among adolescents and young adults accessing reproductive health services. Women's Health Issues. 2023;33(3):222–7.
12. UNFPA. Zimbabwe commemorates World Contraception Day with milestone achievement. 2023. (accessed 12 February 2025). https://zimbabwe.unfpa.org/en/news/zimbabwe-commemorates-world-contraception-day-milestone-achievement#:~:text=As%20a%20result%20of%20Government's,per%20cent%20as%20of%202021.
13. World Health Organisation. Guidelines for HIV post-exposure prophylaxis. Geneva: WHO; 2023.
14. Tumushime MK, Takaruza A, Ruhode N, Chidhanguro K, Masiyambiri F, Mancitshana L, Sibanda EL, et al. Piloting interventions to increase uptake of HIV self-testing and linkage to post-services among tertiary education students in Zimbabwe. AIDS 2024, poster presentation at the 25th International AIDS Conference. Munich, Germany; 2024.
15. World Health Organisation. WHO guideline on self-care interventions for health and well-being, 2022 revision. 2022. (accessed 28 August 2024 2024). https://www.who.int/publications/i/item/9789240052192
16. World Health Organisation. WHO consolidated guideline on self-care interventions for health. 2021.
17. World Health Organisation. WHO consolidated guideline on self-care interventions for health: sexual and reproductive health and rights. 2019.
18. World Health Organisation. Implementation of self-care interventions for health and well-being: guidance for health systems. 2024.
19. Narasimhan M, Allotey P, Hardon A. Self care interventions to advance health and wellbeing: a conceptual framework to inform normative guidance. BMJ. 2019;365:l688.
20. Proctor E, Silmere H, Raghavan R, Hovmand P, Aarons G, Bunger A, et al. Outcomes for implementation research: conceptual distinctions, measurement challenges, and research agenda. Adm Policy Ment Health. 2011;38(2):65–76.
21. StataCorp. Stata Statistical Software: Release 18. College Station, TX: StataCorp LLC; 2023.
22. Rahimi S, Khatooni M. Saturation in qualitative research: an evolutionary concept analysis. Int J Nurs Stud Adv. 2024;6:100174.
23. Green J, Browne J. Principles of social research. London: Oxford University Press; 2005.
24. QSR International. NVIVO 11. 2017 (accessed November 2020). https://lumivero.com/products/nvivo/
25. McGee K, Sprague L, Indravudh P, Nassif E, Terris-Prestholt F. Clarifying community engagement: a framework for qualifying the community-led HIV response. UNAIDS Working Paper. 2024.
26. Li W, Chu J, Zhu Z, Li X, Ge Y, He Y, et al. Epidemiological characteristics of HIV infection among college students in Nanjing, China: a cross-sectional survey. BMJ Open. 2020;10(5):e035889.
27. Milic M, Gazibara T, Dotlic J, Katanic N, Filimonovic J, Mitic K, et al. Risk perception about HIV among university students in one of the last hotspots for HIV transmission in Europe. J Epidemiol Glob Health. 2023;13(4):794–806.
28. Segawa I, Bakeera-Kitaka S, Ssebambulidde K, Muwonge TR, Oriokot L, Ojiambo KO, et al. Factors associated with HIV self-testing among female university students in Uganda: a cross-sectional study. AIDS Res Ther. 2022;19(1):59.
29. Sulemana A, Abu M, Yidana Z, Apraku E, Iddrisu M, Badasu D. Young people's experiences in accessing sexual and reproductive health services in sub-Saharan Africa from 1994 to 2019 - a content analysis. Int J Sex Reprod Health Care. 2020;3:017–26.
30. UNAIDS. Putting young key populations first: HIV and young people from key populations in the Asia and Pacific region. Geneva; 2022.
31. Chipako I, Singhal S, Hollingsworth B. Factors associated with long-acting reversible contraceptives usage among sexually active adolescent girls and young women in Zimbabwe. PLOS Glob Public Health. 2024;4(8):e0003551.
32. World Health Organisation. Alarming decline in adolescent condom use, increased risk of sexually transmitted infections and unintended pregnancies, reveals new WHO report. 2024. (accessed 8 September 2024). https://www.who.int/europe/news/item/29-08-2024-alarming-decline-in-adolescent-condom-use–increased-risk-of-sexually-transmitted-infections-and-unintended-pregnancies–reveals-new-who-report#:~:text=Decline%20in%20condom%20use%3A%20the,girls%20between%202014%20and%202022
33. Sharma M, Ying R, Tarr G, Barnabas R. Systematic review and meta-analysis of community and facility-based HIV testing to address linkage to care gaps in sub-Saharan Africa. Nature. 2015;528(7580):S77–85.
34. Maughan-Brown B, Beckett S, Kharsany ABM, Cawood C, Khanyile D, Lewis L, et al. Poor rates of linkage to HIV care and uptake of treatment after home-based HIV testing among newly diagnosed 15-to-49 year-old men and women in a high HIV prevalence setting in South Africa. AIDS Care. 2021;33(1):70–9.
35. Sibanda EL, Mangenah C, Neuman M, Tumushime M, Watadzaushe C, Mutseta MN, et al. Comparison of community-led distribution of HIV self-tests kits with distribution by paid distributors: a cluster randomised trial in rural Zimbabwean communities. BMJ Glob Health. 2021;6(Suppl 4):e005000.
36. McLean S, Gee M, Booth A, Salway S, Nancarrow S, Cobb M, et al. Targeting the Use of Reminders and Notifications for Uptake by Populations (TURNUP): a systematic review and evidence synthesis. Southampton: NIHR Journals Library; 2014.
37. PrEP Watch. HIV self-testing and PrEP: opportunities for scale-up. 2024. (accessed 8 September 2024). https://www.prepwatch.org/resources/hiv-self-testing-and-prep-opportunities-for-scale-up/
38. Milam J, Jain S, Dubé MP, Daar ES, Sun X, Corado K, et al. Sexual risk compensation in a pre-exposure prophylaxis demonstration study among individuals at risk of HIV. J Acquir Immune Defic Syndr. 2019;80(1):e9–e13.
39. von Schreeb S, Pedersen SK, Christensen H, Jørgsensen KM, Harritshøj LH, Hertz FB, et al. Questioning risk compensation: pre-exposure prophylaxis (PrEP) and sexually transmitted infections among men who have sex with men, capital region of Denmark, 2019 to 2022. Eurosurveillance. 2024;29(13):2300451.
40. Shahmanesh M, Mthiyane TN, Herbsst C, Neuman M, Adeagbo O, Mee P, et al. Effect of peer-distributed HIV self-test kits on demand for biomedical HIV prevention in rural KwaZulu-Natal, South Africa: a three-armed cluster-randomised trial comparing social networks versus direct delivery. BMJ Glob Health. 2021;6(Suppl 4):e004574.
41. Torres-Rueda S, Ferrari G, Orangi S, Hitimana R, Daviaud E, Tawiah T, et al. What will it cost to prevent violence against women and girls in low- and middle-income countries? Evidence from Ghana, Kenya, Pakistan, Rwanda, South Africa and Zambia. Health Policy Plan. 2020;35(7):855–66.
42. Bernet PM, Singh S. Economies of scale in the production of public health services: an analysis of local health districts in Florida. Am J Public Health. 2015;105 Suppl 2(Suppl 2):S260–7.

SUPPORTING INFORMATION

Additional information may be found under the Supporting Information tab for this article:

Table S1: Characteristics of students taking up commodities by institution

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RESEARCH ARTICLE

A modified pharmacy provider-led delivery model of oral HIV pre- and post-exposure prophylaxis in Kenya: a pilot study extension

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Abstract

Introduction: Private pharmacies in Africa reach individuals with ongoing and periodic HIV risk, yet few countries currently leverage pharmacies as an HIV service delivery platform. We conducted a 6-month pilot to evaluate a model for pharmacy provider-led delivery of HIV pre- and post-exposure prophylaxis (PrEP and PEP) in Kenya.

Methods: At 12 private pharmacies in Kisumu and Kiambu Counties, licensed pharmacy providers initiated and managed eligible clients ≥18 years on PrEP and PEP under remote clinician supervision (NCT04558554); four of these pharmacies additionally offered sextually transmitted infection (STI) testing. PrEP/PEP clients were scheduled for follow-up 1 month later and then quarterly (PrEP clients only). Primary outcomes included PrEP and PEP initiation and continuation during the pilot period. Client and providers rated the model across multiple constructs of acceptability and feasibility from established frameworks.

Results: From January to July 2022, 1028 clients interested in PrEP, PEP and/or STI testing were screened and 829 initiated one or more service: 661 PrEP, 162 PEP and 52 STI testing. About half of clients (48%, 398/829) were male, most were unmarried (78%, 644/829) and PrEP-naïve (89%, 737/829), and the median age was 25 years (IQR 22–31). Most PrEP clients reported inconsistent condom use (88%, 581/661) or sex with partners of unknown HIV status (70%, 460/661) in the past 6 months. Most PEP clients reported condomless sex (48%, 78/162) or a condom break (46%, 75/162) in the past 72 hours; 4% (6/162) reported sexual assault. Among PrEP clients eligible for a refill, 73% (479/658) refilled at least once and 60% (197/328) twice. Among PEP clients eligible for follow-up, 44% (65/148) completed follow-up HIV testing and 20% (30/148) transitioned to PrEP. Among STI clients, 19% (10/52) tested positive for gonorrhoea (n = 7) and/or chlamydia (n = 5). Most clients and providers (≥92%) found the delivery model and its implementation strategies acceptable. All providers (n = 12) thought it was possible to deliver PrEP and PEP at pharmacies in Kenya.

Conclusions: Pharmacy PrEP/PEP delivery achieved high uptake, continuation and acceptability among eligible clients that could benefit, highlighting the potential of pharmacies to expand HIV prevention service coverage in Kenya, particularly to individuals not accessing these services at clinics.

Keywords: differentiated service delivery; HIV prevention; Kenya; post-exposure prophylaxis; pre-exposure prophylaxis; private pharmacies

Additional information may be found under the Supporting Information tab of this article.

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1 | INTRODUCTION

With shrinking donor support for HIV programmes [1], many governments in Africa are seeking strategies to sustain their HIV response, including leveraging the private sector [2–6]. In Kenya, one delivery channel of interest is its robust private pharmacy sector [7], which includes 7400 registered pharmacies predominantly owned and operated by the country's 11,000 licensed pharmaceutical technologists and 2600 licensed pharmacists [8, 9]. Embedded in local neighbourhoods, pharmacies have strong community reach, convenient opening hours and offer fast, discreet services [10, 11].

However, evidence is lacking on the uptake, feasibility, and acceptability of pharmacy delivery in Kenya, particularly of HIV post-exposure prophylaxis (PEP) and STI testing.

Pharmacy delivery of PEP and STI testing alongside pre-exposure prophylaxis (PrEP) is novel, as the current Kenya AIDS Strategic Framework only focuses on clinic-based PEP delivery [2] and national STI guidelines continue to recommend syndromic management [12]. At Kenyan public clinics, most providers continue to treat PEP as a last-resort emergency measure, rather than an additional prevention option for individuals with infrequent, unplanned HIV exposures [13, 14]. Early evidence from two pilots in East Africa suggest that pharmacy clientele may benefit from STI testing; among 428 adult pharmacy clients in Uganda, 11% tested positive for gonorrhoea (NG), 9% for chlamydia (CT), and 3% for syphilis [15], and among 495 female pharmacy clients age 15–24 in Kenya, 21% tested positive for CT, 6% for NG, and 3% for both [16].

From November 2020 to October 2021, our team evaluated a delivery model in which trained Kenyan pharmacy providers initiated and managed clients on PrEP under remote clinician supervision; we found high uptake among PrEP-naïve individuals, including populations that do not frequently access health services at public clinics [17]. We now report on a 6-month extension of this pilot in which we evaluated a modified version of the model featuring a package of implementation strategies, including PEP and STI testing. We assessed initiation and continuation, client engagement in implementation strategies, and client and provider perceptions of the model's acceptability and feasibility.

2 | METHODS

2.1 | Study design and setting

We conducted a single-arm pilot evaluation (ClinicalTrials.gov NCT04558554) at 12 pharmacies evenly split between Kisumu and Kiambu Counties, with population-level HIV prevalence of 15% and 2%, respectively [18]. We collaborated with county health officials to identify pharmacies meeting the following criteria: (1) current license and registration; (2) full-time licensed pharmacist or pharmaceutical technologist; and (3) private consultation room—all required by Kenya's pharmacy practice guidelines [19]; (4) private bathroom (if offering STI testing services); and (5) willing to have a research assistant (RA) stationed on site Monday through Friday to conduct research activities. Since the majority of pharmacies in Kenya are independently owned, we purposely excluded company-owned, retail chain pharmacies. To capture variation in pharmacy size, we recruited some pharmacies that served ~100 clients per day (n = 4), with the remainder (n = 8) serving ~50 clients per day.

2.2 | PrEP/PEP delivery model

Our modified delivery model (Figure S1) includes six new implementation strategies, detailed in Table 1. To meet the needs of clients reporting recent high-risk exposures to HIV or STIs, we added PEP and, at a subset of four pharmacies, STI testing. To address client discomfort discussing behaviours associated with HIV risk and undergoing HIV testing at the pharmacy, we added an option to self-screen for HIV risk and offered free HIV self-testing (HIVST) kits for at-home testing. To mitigate cost barriers, we eliminated the client fee. Lastly, to increase PrEP demand, we offered PrEP clients an incentive of 100 KES ($0.80 USD) of airtime to refer peers.

Pharmacy providers attended a 2-day, in-person training covering PrEP/PEP eligibility screening; counselling on HIV risk and adherence; assisting with HIVST; consulting a remote clinician for support and/or referrals; dispensing PrEP/PEP; and supporting self-sampling for STI testing. Throughout, RAs stationed at the pharmacy provided technical assistance, as needed.

2.3 | Participants

We enrolled pharmacy clients and providers. Eligible clients were ≥18 years and met the criteria on a standardized checklist (detailed below). Eligible providers were ≥18 years and willing to deliver study services. We trained pharmacy providers to recruit clients seeking sexual and reproductive health products and to display posters promoting PrEP and PEP.

The Kenya Scientific Ethics Review Unit and Institutional Review Board of the University of Washington approved this study. Participants provided written informed consent and received 500 KES (~$4.50 USD) per survey completed. Pharmacy owners received ~12,500 KES (~$109 USD) monthly for their time spent delivering PrEP/PEP and use of their space and utilities by RAs; this amount was decided through consultation with pharmacy owners.

2.4 | Procedures

Using a prescribing checklist (Figure S2), pharmacy providers conducted an HIV risk assessment, medical safety assessment, HIV testing, and drug dispensing. A remote clinician oversaw checklist implementation and was available for consultation 24/7 via phone call or SMS.

2.4.1 | PrEP/PEP eligibility assessment

For clients seeking PEP, providers confirmed that their potential exposure to HIV was high-risk (e.g., condom break, sexual assault, shared needles) and occurred within the past 72 hours. For clients seeking PrEP, providers assessed ongoing HIV risk using a 12-item modified version of Kenya's Risk Assessment Screening Tool (RAST) [20], which asks about engagement in select behaviours (e.g., transactional sex) in the past 6 months. Clients had the option to self-administer a paper version of the RAST for subsequent provider review.

Next, providers screened potential PrEP clients for signs of acute HIV acquisition and a history of kidney disease, liver disease, and diabetes—conditions that could contraindicate drug safety—and referred clients reporting these to nearby public clinics. Serum creatinine level and hepatitis B testing were not conducted, as national guidelines advise against delaying PrEP initiation if these tests are unavailable [21].

Clients then completed provider-assisted blood-based HIVST (Mylan Pharmaceuticals Private Limited, Hyderabad, India). Clients who tested HIV-negative could receive

Table 1. Package of implementation strategies deployed in the Pharm PrEP Pilot Extension to influence adoption (i.e., initiation, continuation; *client-level*), acceptability *(client- and provider-level)*, and feasibility *(provider-level)*

Strategy *ERIC equivalent*[a]	Actor(s), action(s) and *dose*	Target(s)	Justification	Number of pharmacies
Eliminate client fee *Alter patient fees*	Research team removes ~$3 USD fee clients paid in original pilot for pharmacy PrEP. *Dose: All study visits.*	Current and prospective PrEP clients	In original pilot, some participants said fee was a barrier to initiating and/or continuing PrEP at the pharmacy.	12 pharmacies
Offer self-screening for HIV risk behaviours *Intervene with patients to enhance uptake and adherence*	Pharmacy provider gives clients option to self-administer HIV risk screening tool. Client answers HIV risk questions. Pharmacy provider reviews responses. *Dose: Once per study visit*	Current and prospective PrEP clients	Several implementation studies in Kenya, including the original Pharm PrEP pilot, have documented client discomfort with provider-administered HIV risk screening; some clients have expressed interest in administering the screening tool themselves.	12 pharmacies
Offer optional HIVST *Intervene with patients to enhance uptake and adherence*	Pharmacy providers give clients option to take home a blood- or oral-fluid HIVST. *Dose: Once per study visit*	Current and prospective PrEP clients	In the original pilot, some clients declined or were hesitant to enrol because they were not comfortable undergoing HIV testing at the pharmacy (required for PrEP initiation). Offering such clients a free HIVST kit to learn their HIV status on their own first might increase their willingness to undergo HIV testing with a pharmacy provider.	12 pharmacies
Offer free PEP services *Increase demand*	Research team trains pharmacy providers to deliver PEP and procures commodities. Pharmacy providers offer PEP to eligible clients. *Dose: One-time offer*	Pharmacy clients reporting recent HIV exposure	In the original pilot, nearly half of female clients reported recurrent emergency contraception use, and clients reporting a recent exposure to HIV had to be referred to clinics for PEP. Making PEP available for free at pharmacies may fulfil a need for this service.	12 pharmacies
Offer free STI testing services[b] *Increase demand*	Research team trains pharmacy providers to deliver STI testing and procures commodities. Pharmacy providers offer free STI testing, with optional PrEP screening, to clients seeking STI testing or treatment. *Dose: One-time offer*	Clients seeking STI testing or treatment services	Kenyans commonly seek STI treatment at pharmacies; several studies have found high STI prevalence among Kenyan PrEP users, especially AGYW. Adding STI testing to these settings may help identify potential PrEP candidates and engage them in PrEP services.	Subset of four pharmacies
Incentivize peer referral[c] *Increase demand*	Research assistants introduce peer referral concept to PrEP clients at month 1 follow-up visit. PrEP clients refer peers (5 max) to pharmacy for PrEP/PEP screening and receive ~$0.80 USD airtime for each referred peer who completes screening. *Dose: One-time offer*	Peers of enrolled study participants	In the original pilot, clients commonly reported learning about pharmacy PrEP via informal word-of-mouth referral. PrEP clients may know others in their social networks who engage in similar behaviours and could benefit from PrEP. Incentivizing PrEP clients to tell peers about PrEP and encourage them to undergo screening at the pharmacy may enhance adoption, especially among AGYW.	12 pharmacies

Abbreviations: AGYW, adolescent girls and young women; HIVST, HIV self-testing; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; USD, US Dollars.
[a]From Powell et al.'s Expert Recommendations for Implementing Change (ERIC) compilation of discrete implementation strategies.
[b]Urine-based testing for *C. trachomatis* and *N. gonorrhoeae* implemented at a subset of four pharmacies. Samples are courier-delivered to an off-site laboratory. Clients with positive test results are notified via phone call and offered free treatment.
[c]Participants receive incentive regardless of their peer's screening outcome or decision to enrol in study.

same-day drug dispensing; clients who tested HIV-positive were referred to nearby public clinics for confirmatory testing.

2.4.2 | *Dispensing and follow-up*

PrEP clients received a 1-month supply of daily oral PrEP at initiation and 3-month supply (i.e., 90-day refill) at each follow-up; PEP clients received a 28-day supply of daily oral PEP. Providers scheduled PrEP/PEP clients for follow-up visits 1 month later and quarterly thereafter (PrEP clients only) to screen for severe side effects and to complete provider-assisted HIVST; clients who initiated PrEP/PEP in the final month of the study were referred to nearby clinics for follow-up. At their first follow-up visit, PrEP clients could opt to receive up to five referral slips to distribute to peers; for each referred peer who underwent PrEP/PEP screening at the pharmacy, the referring client received the incentive. All PrEP/PEP drugs were provided to pharmacies free of charge from government stock, in line with Kenya's Private Sector Engagement Framework [3].

2.4.3 | *STI testing*

At the four pharmacies providing STI testing, providers offered this service to clients ≥18 years who came to the pharmacy seeking STI testing or treatment. This service was not otherwise advertised in the pharmacy. Self-collected urine samples were courier-delivered same day to a nearby research lab for *C. trachomatis* and *N. gonorrhoeae* testing (Cepheid GeneXpert, Sunnyvale, USA). Within 1 day of sample collection, the study's remote clinician called clients who tested positive and issued an antibiotic prescription that could be filled at a study pharmacy for free.

2.5 | Data collection

The prescribing checklist was completed on paper by pharmacy providers at each visit and entered by RAs into CommCare (Dimagi, Cambridge, USA)—an electronic data collection platform. Also, in CommCare, RAs administered client surveys at the end of each pharmacy visit and provider surveys at study baseline and monthly.

2.6 | Study outcomes

2.6.1 | *Utilization outcomes*

Our primary outcomes were PrEP initiation and continuation; secondary outcomes included PEP initiation, HIV testing at PEP follow-up, PEP-to-PrEP transition, and STI prevalence. Clients initiated PrEP or PEP if they completed dispensing and continued PrEP if they completed refilling at least once. Clients transitioned from PEP to PrEP if they completed PrEP dispensing following PEP dispensing. We assessed PrEP and PEP continuation among clients who initiated these services more than 1 month prior to study endline and thus were eligible for follow-up during the study period. PrEP clients who refilled PrEP, and PEP clients who completed follow-up HIV testing at a study pharmacy within 15 days of their scheduled visit, were categorized as returning "on-time." Additionally, we assessed the timing of pharmacy PrEP/PEP visits and client engagement in STI testing, self-screening for HIV risk, free initial HIVST, and incentivized peer referral.

2.6.2 | *Implementation outcomes*

We captured client and provider perceptions of the model and its implementation strategies. We assessed different constructs of acceptability (e.g., affective attitude, burden) based on the Theoretical Framework of Acceptability [22], presenting participants with statements tailored to each implementation strategy. We assessed feasibility using two items from the Feasibility of Implementation Measure [23]. All items used a 5-point response scale ranging from "completely disagree" (1) to "completely agree" (5).

2.7 | Analysis

We report outcomes descriptively using summary statistics. To understand if participants returned on time, we plotted the percentage of participants who returned for follow-up over time and calculated median days from initiation to follow-up. We report continuation outcomes for the following subgroups: men <25, men ≥25, women <25 and women ≥25 years. To assess for statistically significant differences ($p<0.05$) in outcomes between subgroups, we conducted Chi-squared tests. For implementation outcomes, we decided a priori that services/strategies would be considered acceptable or feasible if ≥80% of participants "agreed" or "completely agreed" with a statement [24]. We conducted analyses in R (version 2023.03.1).

3 | RESULTS

From January to July 2022, 1028 clients began PrEP/PEP eligibility screening (Figure 1). Among 880 clients who tested HIV-negative, 699 (79%) were determined eligible for PrEP and 181 (21%) for PEP. Nineteen clients tested HIV-positive and were referred to public clinics. In the four pharmacies offering STI testing, 52 clients received this service. All providers ($n = 12$) completed surveys.

3.1 | PrEP and PEP initiation

PrEP initiation among eligible clients was 95% (661/699) and PEP initiation was 90% (162/181). Whereas the most common day for PEP initiation was Monday (37%, 60/162), PrEP initiations were evenly spread from Monday to Friday, Figure S3. The average monthly number of PrEP clients initiated at each pharmacy was 9.2 (standard deviation [SD] 4.5) and PEP clients was 2.3 (SD 2.1). Among PrEP/PEP clients, roughly half were men (48%, 394/823), <25 years (48%, 393/823) and had completed secondary school (50%, 408/823) (Table 2). Additionally, most were unmarried (78%, 640/823), PrEP-naïve (89%, 731/823) and said pharmacies are their first stop for non-urgent healthcare needs (75%, 619/823). Men comprised a significantly higher proportion of PEP (58%, 94/162) versus PrEP (45%, 300/661) clients ($p<0.01$).

Among PrEP clients, the most common behaviours associated with HIV acquisition risk in the past 6 months were inconsistent condom use (88%, 581/661), sex partner(s) of

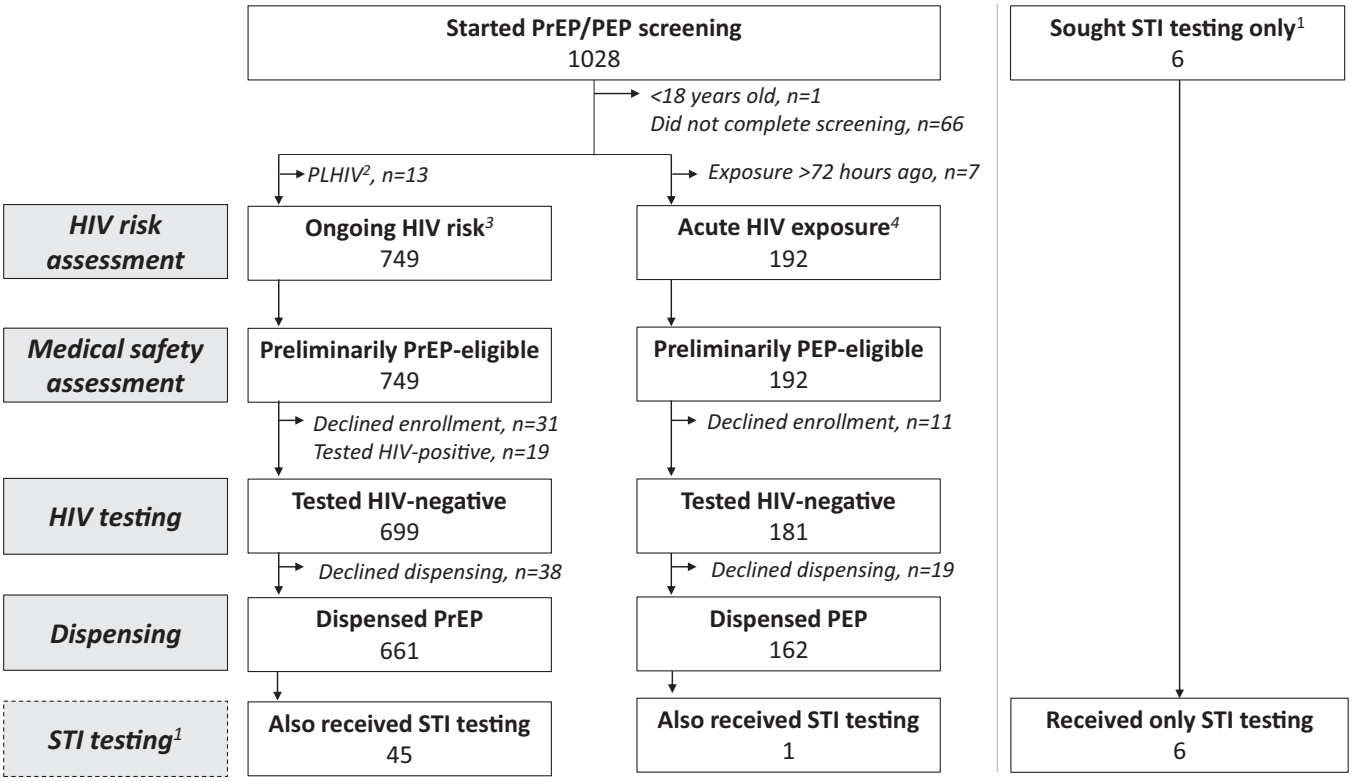

Figure 1. Participant flow chart.
Abbreviations: PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infections.
[1]STI testing offered at four study pharmacies; clients seeking STI testing were given the option to screen for PrEP/PEP eligibility; [2]Self-identified as a person living with HIV (PLHIV); [3]Self-reported behaviors in past 6 months; [4]Self-reported a high-risk exposure in past 72 hours.

unknown HIV status (70%, 460/661), and multiple sex partners (64%, 420/661); only 10% (65/661) reported having a sex partner living with HIV. Among PEP clients, the most common potential HIV exposures were condomless sex with a partner of unknown HIV status (48%, 78/162), and condom break (46%, 75/162); 4% of PEP clients (6/162) reported potential exposure from sexual assault.

3.2 | PrEP and PEP continuation

Over an observation period of 2464 person-months, no PrEP clients seroconverted or switched to PEP. Among PrEP clients eligible for follow-up, 73% (479/658) completed their first refill and 60% (197/328) their second refill (Figure 2a). Most PrEP continuation occurred on time: 93% (447/479) of first refills and 83% (163/197) of second refills. Median time from initiation to first refill was 30 days (interquartile range [IQR] 28–33) and to second refill was 120 days (IQR 115–125). Refilling PrEP twice was significantly higher among men ≥25 years (82%, 47/57) versus men under 25 (28%, 28/100; $p<0.01$) (Figure 2b).

Over 536 person-months of observation, no PEP clients seroconverted or had repeat PEP use. Among PEP clients eligible for follow-up, 42% (62/148) completed follow-up HIV testing and 20% (30/148) transitioned to PrEP (Figure 3a). Among those who returned for follow-up, most (85%, 55/65) did so on time. Median time from initiation to follow-up was 30 days (IQR: 28–34). Among PEP clients who declined PrEP eligibility screening at follow-up and completed surveys, common reasons for not transitioning to PrEP included no persistent HIV risk (77%, 10/13), anticipated disapproval from sex partners or family members (38%, 5/13), disinterest in a daily pill (31%, 4/13), and needing more time to decide (15%, 2/13). We did not find any significant differences by age and sex in the proportion of PEP clients who completed follow-up HIV testing or transitioned from PEP to PrEP (Figure 3b,c).

3.3 | STI testing

At the four pharmacies offering STI testing, 18% (52/289) of enrolled participants received this service (Figure 1). Uptake of STI testing varied by pharmacy, with over half (54%, 28/52) of STI testing clients enrolling at a single pharmacy (located near bars and sex-on-premises venues) and only 4% (2/52) at another pharmacy. Most clients who underwent STI testing (88%, 46/52) opted to screen for PrEP/PEP eligibility on the same day: 45 initiated PrEP and one PEP. STI prevalence among those who tested was 19% (10/52): five tested positive for gonorrhoea only, three for chlamydia only, and two for both. (For results by client sex, see Table S1.) All 10 clients who tested positive for an STI also completed STI treatment.

Table 2. Demographic characteristics of pharmacy clients and providers who received or delivered PrEP, PEP and/or STI testing at enrolment

Characteristic	PrEP clients *N* = 661	PEP clients *N* = 162	STI testing clients[a] *N* = 52	Providers *N* = 12
Male	300 (45%)	94 (58%)	18 (35%)	5 (42%)
Age, median (IQR)	25 (22–31)	25 (22–29)	31 (26–34)	37 (33–39)
<25 years	314 (48%)	79 (49%)	9 (17%)	0 (0%)
Ever attended school	647 (98%)	159 (98%)	49 (94%)	–
Highest level of school attended				
Primary	145 (22%)	11 (7%)	18 (35%)	0 (0%)
Secondary	329 (50%)	79 (49%)	11 (21%)	0 (0%)
Post-secondary	136 (21%)	69 (43%)	9 (17%)	12 (100%)
Unmarried	506 (77%)	134 (83%)	11 (21%)	
Monthly household income in Kenyan shillings, median (IQR)[b]	10,000 (5000–20,000)	15,000 (722–30,000)	10,000 (5000–15,500)	
Pharmacy is first stop for non-urgent healthcare	541 (82%)	78 (48%)	43 (83%)	
Pharmacy visits per month, median (IQR)	1 (1–1)	2 (1–2)	1 (1–1)	
Emergency contraception use, past 6 months	74 (11%)	37 (23%)	8 (15%)	
Ever tested for HIV	605 (92%)	132 (81%)	48 (92%)	
Months since last HIV test, median (IQR)	6 (3–12)	5 (3–12)	5 (2–12)	
HIV risk behaviours, past 6 months[c]				
Inconsistent condom use	581 (88%)		45 (87%)	
Partner(s) HIV status unknown	460 (70%)		40 (77%)	
Multiple sex partners	420 (64%)		39 (75%)	
Sex with drugs/alcohol	265 (40%)		26 (50%)	
Transactional sex	232 (35%)		35 (67%)	
Partner living with HIV	65 (10%)		4 (8%)	
Recent STI	128 (19%)		32 (62%)	
Recent HIV exposure, past 72 hours[d]				
Unprotected sex and partner status unknown		78 (48%)		
Condom break		75 (46%)		
Sexual assault		6 (4%)		
Other		3 (2%)		
PrEP awareness				
Had heard of PrEP prior to enrolling	573 (87%)	103 (64%)	44 (85%)	
Knows someone who takes PrEP	303 (46%)	18 (11%)	33 (63%)	
Participated in original pilot	10 (2%)	0 (0%)		
Prior PrEP use	89 (13%)	3 (2%)	12 (23%)	
How heard about pharmacy PrEP/PEP[e]				
From pharmacy provider	460 (70%)	63 (39%)		
Other word-of-mouth	366 (55%)	31 (19%)		
Saw poster at pharmacy	135 (20%)	27 (17%)		
Referral from nearby pharmacy	14 (2%)	45 (28%)		
Referral from nearby clinic	13 (2%)	17 (10%)		
Came to pharmacy seeking PrEP/PEP	391 (59%)	136 (84%)		
County where enrolled				
Kisumu	454 (69%)	43 (27%)	39 (75%)	6 (50%)
Kiambu	207 (31%)	119 (73%)	13 (25%)	6 (50%)

Abbreviations: IQR, interquartile range; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infections.
[a]Includes 45 clients who also received PrEP and one client who also received PEP.
[b]USD equivalent is $86.5 (43.2–173). Converted from KES to USD using conversion rate averaged from 1/2022 to 7/2022 ($1 USD = $115.6 KES); https://www.exchangerates.org.uk/USD-KES-spot-exchange-rates-history-2022.html.
[c]Asked only of clients who did not report one or more potential exposures to HIV in past 72 hours; percentages for clients who underwent STI testing are out of a denominator of 45.
[d]To qualify for PEP, client had to report experiencing within the past 72 hours a potential exposure to HIV that was "of high risk type" and involved "high risk material," as defined by Kenya national PEP guidelines.
[e]Select all that apply question.

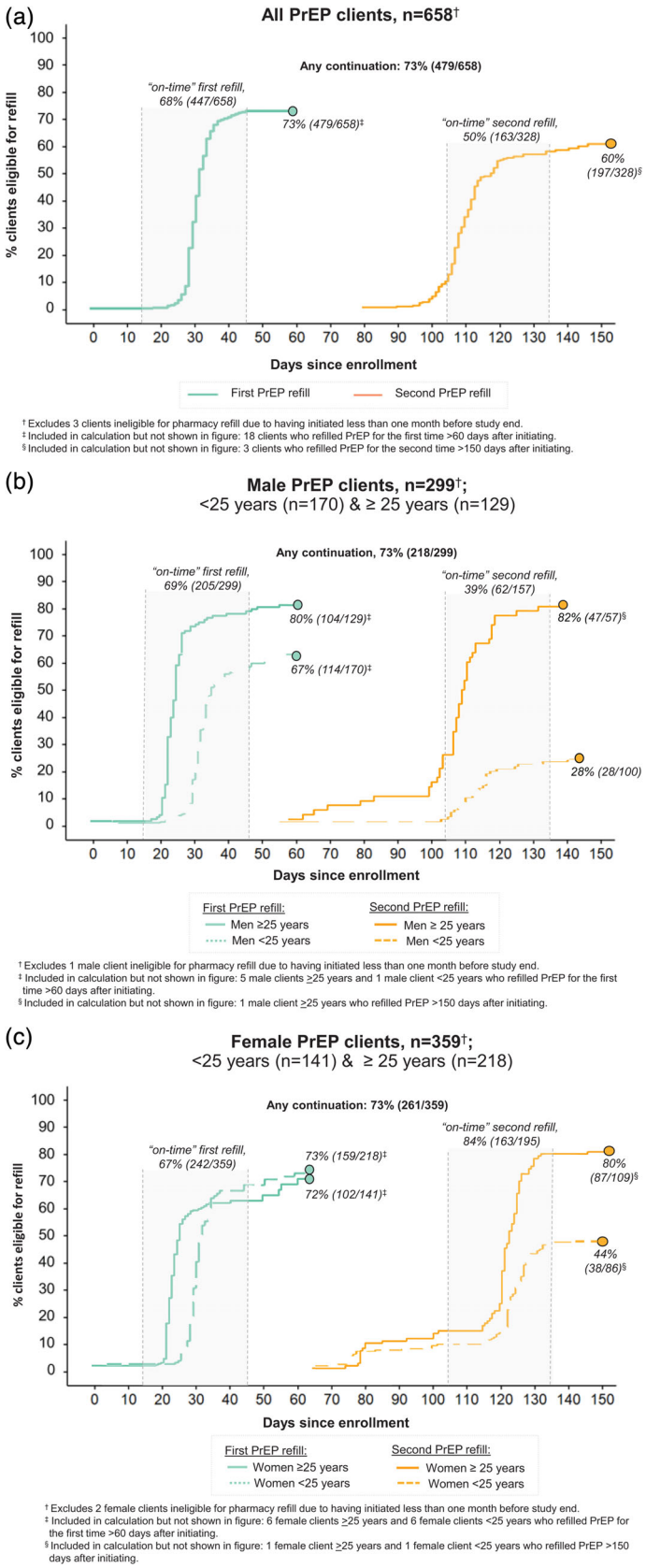

Figure 2. Continuation of pharmacy PrEP services over the pilot duration. PrEP continuation among (a) all PrEP clients; (b) male PrEP clients <25 years old and >25 years old; and (b) female PrEP clients <25 years old and >25 years old. Abbreviation: PrEP, pre-exposure prophylaxis.

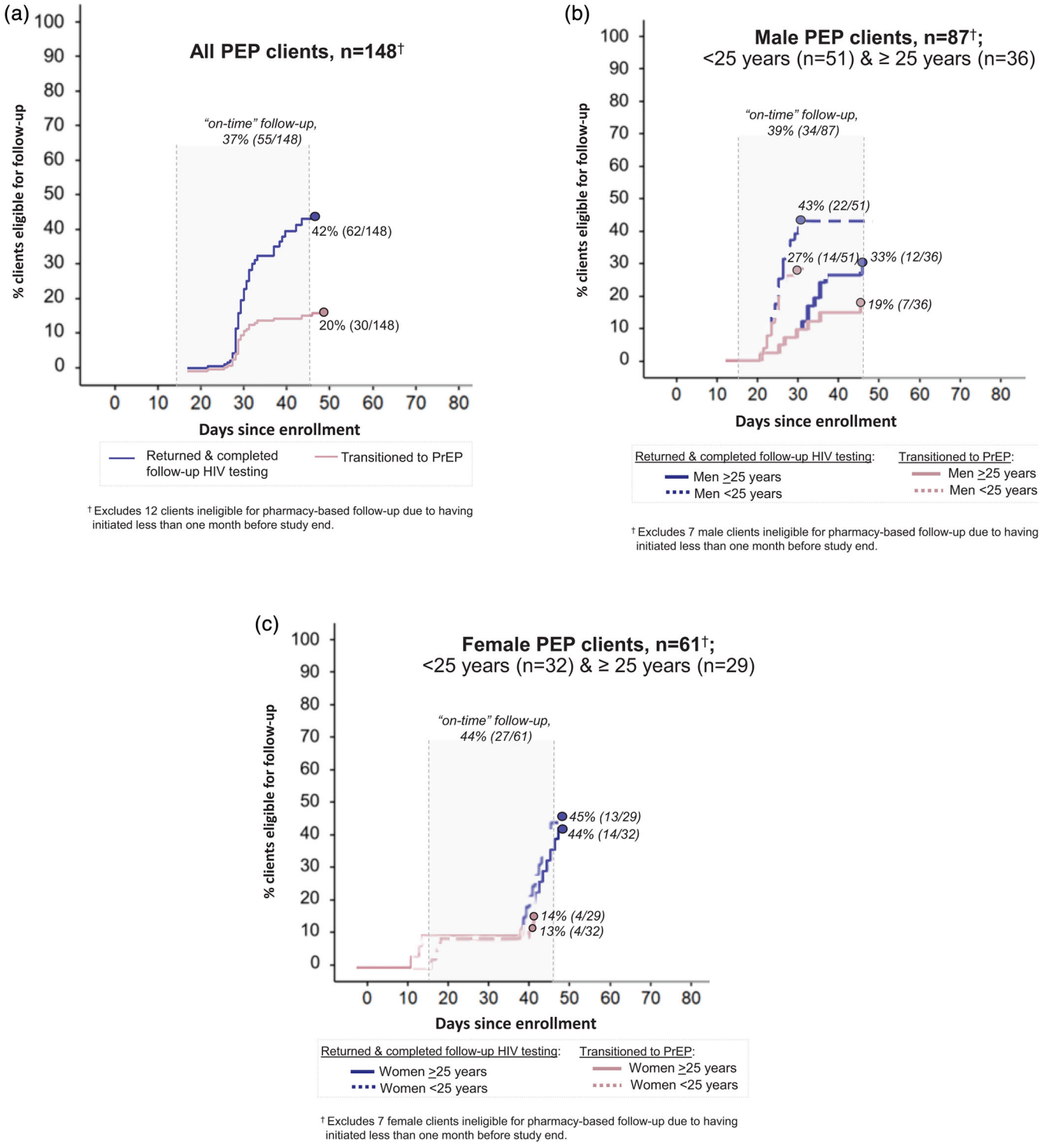

Figure 3. Completion of HIV testing at PEP follow-up visit and PEP to PrEP transition over the pilot duration. Completion of HIV testing at pharmacy-based follow-up visit and PEP-to-PrEP transition among (a) all PEP clients; (b) male PEP clients <25 years old and >25 years old; and (b) female PEP clients <25 years old and >25 years old. Abbreviations: PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis.

3.4 | Implementation strategies and outcome assessment

Client engagement in opt-in implementation strategies varied. Of the 476 PrEP clients who returned for follow-up, 15% (72/476) successfully referred one or more peers to a study pharmacy; 16% (132/829) of participants were referred to a pharmacy by an enrolled peer, and most referred clients (80%, 106/132) characterized the person who referred them as "a close friend." Among PrEP clients, nearly one-fifth (18%, 120/661) opted to self-screen for HIV risk. Few (<1%, 9/961) prospective PrEP/PEP clients who completed the HIV risk and medical safety assessments opted to receive a free HIVST for initial at-home testing.

Client acceptability of the implementation strategies was high among those who engaged. Almost all strategy-specific client acceptability assessments (20/21) reached our prespecified threshold of ≥80% agreement (Table 3); the one exception was clients' assessment of intervention burden for PEP, which only achieved 73% agreement.

Providers also rated each strategy's acceptability and feasibility as high, with 39 of 41 acceptability/feasibility assessments reaching the ≥80% agreement threshold. Three exceptions were providers' affective attitude towards offering clients free HIVSTs (75% agreement) and concerns about ease of implementing free HIVSTs (59% agreement) and incentivized peer referral (67% agreement) without ministry of health (MOH) assistance.

For the overall PrEP delivery model, ≥95% of clients and providers found the model acceptable, and ≥92% of providers thought pharmacy PrEP delivery was feasible.

4 | DISCUSSION

In this 6-month pilot study, we evaluated a model of pharmacy provider-led PrEP and PEP delivery in Kenya and observed high PrEP/PEP initiation and continuation and positive client and provider perceptions. Most participants were PrEP-naïve yet had asubstantial ongoing risk of HIV acquisition, highlighting the potential of private pharmacies to reach individuals with HIV risk who are not reached by traditional clinic-based programmes. PrEP continuation was high, suggesting that the implementation strategies added to the model supported client engagement.

Using pharmacies' existing staff and infrastructure, this model achieved PrEP outcomes that match or exceed those of several recent PrEP implementation projects in Kenya. The monthly PrEP initiation rate at our 12 study pharmacies (~9.2 initiations) surpassed those observed at 25 clinics in the Partners Scale-up Project (~7.5 initiations) [25] and 93 clinics in the Jilinde programme (~6.5 initiations) [26]. Additionally, the clients reached at pharmacies in this study—particularly those <25 years, unmarried, and not in known HIV serodifferent relationships—are often underrepresented in clinic-based PrEP programmes, where such subgroups typically comprise <20% of all PrEP clients [25]. This suggests that private pharmacies in Kenya may have different catchment populations than public clinics and that expanding PrEP services to private pharmacies might increase PrEP coverage, especially in counties with high HIV burden and public awareness of PrEP, like Kisumu County, where ~70% of this pilot's PrEP clients enrolled. Finally, PrEP continuation in this study (72%) exceeded that of our original pilot (53%) [17] and of clinic-based PrEP programmes in Kenya (where continuation rarely exceeds 50%) [25, 27, 28]. Possible contributing factors include the elimination of client fees and the availability of PEP, which allowed clients to initiate a biomedical prevention service better suited for their needs and appropriately discontinue if their HIV risk was not persistent.

To our knowledge, this is the first study to evaluate pharmacy provider-led PEP delivery in Africa. Our findings demonstrate a considerable need for PEP and the value of co-locating PrEP and PEP delivery to serve clients with dynamic HIV acquisition risk [29]. In Kenya, obtaining PEP at public clinics can be challenging due to limited opening hours, stock-outs and low provider PEP knowledge [30–33]. Recently recommended by the World Health Organization [34], community-based PEP delivery has the potential to help clients circumvent these barriers and meet the needs of those unwilling to access PEP at clinics [13, 35]. In our study, most clients sought PEP following engagement in condomless sex over the weekend, highlighting the important role pharmacies could play in delivering this time-sensitive service [35]. Our findings also indicate that pharmacies may reach a different subset of the PEP-eligible population than public clinics; compared to 124 clients who initiated PEP at public clinics in a recent SEARCH pilot [30], a greater proportion of PEP clients in our study were <25 years (49% vs. 24%) and unmarried (83% vs. 42%).

Our study highlights the importance of PEP as an HIV prevention choice. For some clients, PEP may serve as an "on-ramp" to PrEP, as illustrated by the 20% of PEP clients who opted to transition to PrEP. Other clients, however, may not want or need PrEP, especially if their potential exposures to HIV are infrequent or if they find adhering to a daily pill regimen difficult [31, 33]. Client preference for PEP over PrEP might also be common in areas with relatively low HIV burden—one possible explanation for why we observed substantially higher PEP uptake at pharmacies in Kiambu versus Kisumu County. A key area for improvement for this delivery model, however, is PEP follow-up, as over half of PEP clients did not return. Additional research is needed to identify implementation strategies that might support follow-up HIV testing in this population, such as dispensing PEP with an HIVST kit [36] or deploying community health workers for home-based testing [30].

Most participants engaged in one or more implementation strategies and found them acceptable, suggesting their potential to enhance implementation in real-world pharmacy settings. The uptake of STI testing was modest, possibly due to its lack of advertisement and/or provider hesitation to offer this service, especially to clients willing to pay for STI treatment without testing. Among clients who tested, STI prevalence was high (19%) and most (88%) clients also initiated PrEP/PEP, demonstrating the potential for STI testing to serve as a bridge to HIV prevention services. The type of STI testing conducted in this study—automated, real-time PCR-based nucleic acid amplification tests—may be difficult to implement at scale due to cost and logistical barriers (e.g.,

Table 3. Client and provider perceptions of acceptability and feasibility of implementation strategies they experienced or delivered

	Implementation strategy[a]												Overall acceptability of pharmacy-based PrEP delivery	
							Opt-in strategies							
	PEP services		STI testing (4 pharmacies)		Free PrEP		Incentivized peer referral		Initial HIV self-test		Self-screening for HIV risk			
	Clients N = 158[b]	Providers N = 12	Clients N = 51[b]	Providers N = 4	Clients N = 654[b]	Providers N = 12	Clients N = 132[c]	Providers N = 12	Clients N = 9	Providers N = 12	Clients N = 120	Providers N = 12	Clients N = 654[b]	Providers N = 12
Acceptability constructs: from the Theoretical Framework of Acceptability[d]														
Intervention coherence: Thinks the strategy is a good way to engage individuals at risk of HIV[e]	156 (99%)	12 (100%)	50 (98%)	4 (100%)	654 (100%)	12 (100%)	132 (100%)	11 (92%)	9 (100%)	11 (92%)	118 (98%)	12 (100%)	651 (99%)	12 (100%)
Affective attitude: Liked engaging in/delivering the strategy	158 (100%)	12 (100%)	50 (98%)	4 (100%)	651 (99%)	12 (100%)	132 (100%)	10 (83%)	9 (100%)	9 (75%)	120 (100%)	12 (100%)	647 (99%)	12 (100%)
Self-efficacy: Confident in their ability to engage in the strategy	157 (99%)	11 (92%)	50 (98%)	4 (100%)	644 (98%)	-	128 (97%)	-	-	-	119 (99%)	12 (100%)	646 (99%)	12 (100%)
Burden: Strategy was ***hard*** to engage in/deliver	42 (27%)	0 (0%)	5 (10%)	0 (0%)	-	-	2 (2%)	-	-	-	10 (8%)	1 (8%)	31 (5%)	0 (0%)
Ethicality: Strategy ***interferes*** with their other priorities	-	0 (0%)	-	0 (0%)	-	0 (0%)	-	-	-	-	-	0 (0%)	-	0 (0%)
Feasibility constructs: from the Feasibility of Implementation Measure[f]														
Seems possible to implement *(with MOH help)*[g]	-	12 (100%)	-	4 (100%)	-	11 (92%)‡‡	-	11 (92%)‡‡	-	12 (100%)‡‡	-	11 (92%)	-	12 (100%)
Seems ***hard*** to implement in Kenya *(without MOH help)*[h] *(even with MOH help)*[i]	-	0 (0%)	-	0 (0%)	-	0 (0%)¶¶	-	4 (33%)§§	-	5 (41%)§§	-	1 (8%)	-	1 (8%)

Abbreviations: Ministry of Health (MOH); pre-exposure prophylaxis (PrEP); post-exposure prophylaxis (PEP)

[a]Acceptability was only assessed among clients who received the indicated service or engaged in the indicated opt-in implementation strategy. Clients indicated level of agreement on a 5-point Likert scale ranging from "completely disagree" to "completely agree". We present the number who "agreed" or "completely agreed" with each statement.

[b]N is less than the total number of clients that received the indicated service due to 12 missing surveys: 4 from PEP clients, 1 from an STI testing client, and 7 from PrEP clients.

[c]We assessed acceptability of incentivized peer referral only among clients who were referred to the pharmacy by an enrolled participant. We did not assess it among clients who engaged in this strategy only as a referrer.

[d]Statements were derived from Sekhon et al.'s Theoretical Framework of Acceptability.

[e]We tailored statements for assessing perceptions of intervention coherence to the objective of each implementation strategy as follows: Pharmacy-based PEP services: "[…] is a good way to reach people who may have been recently exposed to HIV"; Pharmacy-based STI testing: "[…] is a good way to help people stay healthy"; Free PrEP: "[…] is a good way to get people who are at risk of HIV to take PrEP"; Incentivized peer referral: "[…] is a good way to connect people to PrEP"; Initial at-home HIV self-test: "[…] is a good way to help clients feel comfortable to get tested later at the pharmacy"; Self-screening for HIV risk: "[…] is a good way to help clients feel comfortable and complete the PrEP screening process".

[f]Feasibility statements were derived from Weiner et al.'s Feasibility of Implementation Measure. Clients answered using the same 5-point Likert scale.

[g]For these strategies, the statement posited a scenario in which the strategy was implemented with the help of the Ministry of Health as follows: Free PrEP: "If the Ministry of Health provides pharmacies with the PrEP drug, HIV self-test kits, and some compensation for delivering PrEP, it seems possible for pharmacies in Kenya to deliver free PrEP to clients"; Incentivized Peer Referral: "It seems possible for pharmacies to implement Peer Referral in Kenya with the help of the Ministry of Health"; Initial at-home HIVST: "It seems possible for pharmacies in Kenya to give prospective PrEP clients a free HIV self-test kit with the help of the Ministry of Health."

[h]For these strategies, the statement posited a scenario in which the strategy was implemented without the help of the Ministry of Health as follows: Incentivized Peer Referral: "Peer Referral seems hard to do in Kenya without the help of the Ministry of Health"; Initial at-home HIVST: "It seems like it would be hard for pharmacies in Kenya to give prospective PrEP clients a free HIV self-test kit without the help of the Ministry of Health."

[i]For this strategy, the statement specified MOH help: "Even if the Ministry of Health provided pharmacies with the PrEP drug, HIV self-test kits, and some compensation for delivering PrEP, it still seems like it would be hard for pharmacies in Kenya to deliver free PrEP to clients."

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need for off-site processing); however, new and forthcoming point-of-care rapid tests could potentially mitigate these challenges in the future [15].

Pharmacy PrEP and PEP initiations in this pilot were likely facilitated by the free cost to clients (previously 300 KES [~$3 USD] per visit in the original pilot); incentivized peer referral, which has had similar success for engaging clients in other health services [37, 38]; and self-screening for HIV risk, a strategy found to increase HIV testing rates in other populations [39]. Provider engagement in delivery was also likely influenced by the monthly compensation they received. Additional research is needed to assess the effect of different cost-sharing options (e.g., sliding scale fees; private or national health insurance coverage) that might increase the scalability of this package of implementation strategies, or a subset thereof. Few clients engaged in HIVST. Possible reasons for this include inconvenience (e.g., time/cost associated with a second trip to the pharmacy for PrEP/PEP); selection bias, with clients hesitant to HIV test at a pharmacy also hesitant to test at home; and fidelity issues, such as providers forgetting to offer the free HIVSTs or opting to instead sell HIVSTs from their pharmacy's stock.

Our study has limitations. Since we only tested this model at 12 purposively selected pharmacies in two counties, our findings are not generalizable to other pharmacy settings. Our study design—a single-arm pilot that only enrolled individuals interested in PrEP/PEP—precludes our ability to discern the effect of each implementation strategy on PrEP/PEP uptake or continuation. If pharmacy delivery becomes the standard of care, future studies could build upon this work and leverage factorial designs [40] to determine which strategies are most effective. Since our study did not include a control group, we cannot determine if the intervention led to greater initiations and/or continuation than the standard of care: pharmacy-based screening and referral to clinics; an ongoing cluster randomized controlled trial in Kenya is investigating this question [41]. We did not assess fidelity; thus, suboptimal delivery may have influenced some outcomes. For PEP clients, we did not collect information on number of hours since potential HIV exposure. Our study's short duration may have benefited our PrEP initiation outcome by capturing initial excitement among providers and clients; with a longer observation period, we might have observed a plateau in new initiations (e.g., due to saturation and/or provider burn-out). Since we did not assess outcomes among clients who never initiated PrEP/PEP or never returned for follow-up, we do not know whether or how the delivery model influenced these decisions and cannot assess factors associated with initiation. Lastly, our understanding of client and provider experiences with the model is limited, as we did not collect qualitative data.

5 | CONCLUSIONS

Ending HIV/AIDS as a public health threat by 2030 and achieving country ownership will require maximizing the use of existing healthcare delivery platforms and HIV prevention products [42]. Our study provides evidence for one potential path forward: allowing PEP and PrEP to be delivered at private pharmacies and giving PEP equal priority as other HIV prevention products. Pharmacies should be prioritized for demonstration studies and rollout to expedite implementation learnings, including the development of innovations that can help sustain pharmacy delivery at scale.

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COMPETING INTERESTS

PM is an employee of Novartis, outside of the present work. KN has received research funding from the Merck Investigators Studies Program. For the remaining authors, none were declared.

AUTHORS' CONTRIBUTIONS

KFO, EAB and KN contributed to the study conception and design of this pilot study. SDR and KFO led the development of the study protocol and data collection tools. VO, PM and PO led recruitment and study operations with support from JO, DW and KH. SDR, PB, MA and SG led data management. PB, SDR and KFO analysed the data. SDR wrote the first draft of the manuscript, and KFO provided senior author-level feedback. All authors provided additional feedback, edits, and insights and approved the final manuscript for publication.

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DATA AVAILABILITY STATEMENT

The data that support the study findings are available on request from the corresponding author and not publicly available due to privacy or ethical restrictions.

REFERENCES

1. PEPFAR. PEPFAR's Five-year Strategy: Fulfilling America's Promise to End the HIV/AIDS Pandemic by 2030. Washington, DC: U.S. Department of State; 2022.
2. Kenya Ministry of Health. National AIDS Control Council. Kenya AIDS Strategic Framework II 2020/21 - 2024/2025. Nairobi: Ministry of Health; 2021.
3. Kenya Ministry of Health. National AIDS & STI Control Program. Private Sector Engagement Framework for Delivery of HIV Services in Kenya 2023–2028. Nairobi: NASCOP; 2023.

4. World Health Organization. Updated recommendations on service delivery for the treatment and care of people living with HIV. Geneva: WHO; 2021.
5. Global Fund. HIV Information Note Allocation Period 2023–2025. Geneva: Global Fund; 2022.
6. PEPFAR. PEPFAR 2023 Country and Regional Operational Plan (COP/ROP) Guidance for all PEPFAR-Supported Countries. Washington, DC: U.S. Department of State; 2022.
7. National AIDS & STI Control Programme, Kenya Ministry of Health. Framework for the Implementation of Pre-exposure Prophylaxis of HIV in Kenya. Nairobi: NASCOP; 2022.
8. Pharmacy Board of Kenya. License Status—Facilities Register. Nairobi: PPB; 2024.
9. Kenya National Bureau of Statistics. Health and Vital Statistics. Nairobi: Kenya National Bureau of Statistics; 2023.
10. Roche SD, Wairimu N, Mogere P, Kamolloh K, Odoyo J, Kwena ZA, et al. Acceptability and feasibility of pharmacy-based delivery of pre-exposure prophylaxis in Kenya: a qualitative study of client and provider perspectives. AIDS Behav. 2021;25(12):3871–82. https://doi.org/10.1007/s10461-021-03229-5
11. Verde Hashim C, Llewellyn E, Wood R, Brett T, Chinyanga T, Webb K, et al. Harnessing private sector strategies for family planning to deliver the Dual Prevention Pill, the first multipurpose prevention technology with pre-exposure prophylaxis, in an expanding HIV prevention landscape. J Int AIDS Soc. 2024;27(8):e26346. https://doi.org/10.1002/jia2.26346
12. Kenya National AIDS and STI Control Programme. Kenya National Guidelines for Prevention, Management and Control of Sexually Transmitted Infections. Nairobi: NASCOP; 2018.
13. MOSAIC Consortium. Synthesis of Post-Exposure Prophylaxis (PEP) Policies in MOSAIC Countries (Policy Brief). 2022. Accessed 15 September 2024. Available from: https://www.prepwatch.org/resources/synthesis-of-post-exposure-prophylaxis-pep-policies-in-mosaic-countries/
14. Clifford Rashotte M, Yoong D, Naccarato M, Pico Espinosa OJ, Fisher K, Bogoch II, et al. Appropriate usage of post-exposure prophylaxis-in-pocket for HIV prevention by individuals with low-frequency exposures. Int J STD AIDS. 2024;35(6):446–51. https://doi.org/10.1177/09564624231215151
15. Kiragga AN, Onzia A, Nakate V, Bagaya I, Natuha E, Mande E, et al. Community pharmacies: key players in point-of-care diagnostics for STI screening in Africa. PLoS One. 2024;19(12):e0315191. https://doi.org/10.1371/journal.pone.0315191
16. Akingba O, Bukusi EA, Celum CL, Katz D, Kwena ZA, Lagat H, et al. Prevalence and correlates of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* among adolescent girls and young women seeking contraception at pharmacies in Kenya (Abstract 573). The 26th Conference of the International Society for Sexually Transmitted Diseases Research; 26–30 July 2025; Quebec, Canada.
17. Ortblad KF, Mogere P, Omollo V, Kuo AP, Asewe M, Gakuo S, et al. Standalone model for delivery of oral HIV pre-exposure prophylaxis in Kenya: a single-arm, prospective pilot evaluation. J Int AIDS Soc. 2023;26(6):e26131. https://doi.org/10.1002/jia2.26131
18. National Syndemic Diseases Control Council. HIV Estimates. Nairobi: NSDCC; 2024.
19. Kenya Ministry of Health, Kenya Pharmacy and Poisons Board. Guidelines for Good Pharmacy Practice in Kenya (draft). Nairobi: Pharmacy and Poisons Board; 2024.
20. Masyuko S, Mukui I, Njathi O, Kimani M, Oluoch P, Wamicwe J, et al. Pre-exposure prophylaxis rollout in a national public sector program: the Kenyan case study. Sex Health. 2018;15(6):578–86. https://doi.org/10.1071/SH18090
21. Kenya MOH. Kenya HIV Prevention and Treatment Guidelines, 2022. Kenya Ministry of Health; 2022.
22. Sekhon M, Cartwright M, Francis JJ. Development of a theory-informed questionnaire to assess the acceptability of healthcare interventions. BMC Health Serv Res. 2021;22:279. https://doi.org/10.1186/s12913-022-07577-3.
23. Weiner BJ, Lewis CC, Stanick C, Powell BJ, Dorsey CN, Clary AS, et al. Psychometric assessment of three newly developed implementation outcome measures. Implement Sci. 2017;12(1):108. https://doi.org/10.1186/s13012-017-0635-3
24. Ortblad KF, Sekhon M, Wang L, Roth S, van der Straten A, Simoni JM, et al. Acceptability assessment in HIV prevention and treatment intervention and service delivery research: a systematic review and qualitative analysis. AIDS Behav. 2023;27(2):600–17. https://doi.org/10.1007/s10461-022-03796-1
25. Irungu EM, Mugwanya KK, Mugo NR, Bukusi EA, Donnell D, Odoyo J, et al. Integration of pre-exposure prophylaxis services into public HIV care clinics in Kenya: a pragmatic stepped-wedge randomised trial. Lancet Glob Health. 2021;9(12):e1730–e9. https://doi.org/10.1016/S2214-109X(21)00391-0
26. Fogarty L, Musau A, Kabue M, Were D, Mutegi J, Ongwen P, et al. Using developmental evaluation to implement an oral pre-exposure prophylaxis (PrEP) project in Kenya. Gates Open Res. 2020;4(158):1–16.
27. Kinuthia J, Pintye J, Abuna F, Mugwanya KK, Lagat H, Onyango D, et al. Pre-exposure prophylaxis uptake and early continuation among pregnant and postpartum women within maternal and child health clinics in Kenya: results from an implementation programme. Lancet HIV. 2020;7(1):e38–e48. https://doi.org/10.1016/S2352-3018(19)30335-2
28. Roche SD, Were D, Crawford ND, Tembo A, Pintye J, Bukusi E, et al. Getting HIV pre-exposure prophylaxis (PrEP) into private pharmacies: global delivery models and research directions. Curr HIV/AIDS Rep. 2024;21(3):116–30. https://doi.org/10.1007/s11904-024-00696-y
29. Phillips AN, Sibanda E, Sikwese K, Bansi-Matharu L, Cambiano V, Rodger A, et al. Enabling timely HIV postexposure prophylaxis access in sub-Saharan Africa. AIDS. 2022;36(10):1473–5. https://doi.org/10.1097/QAD.0000000000003258
30. Ayieko J, Petersen ML, Kabami J, Mwangwa F, Opel F, Nyabuti M, et al. Uptake and outcomes of a novel community-based HIV post-exposure prophylaxis (PEP) programme in rural Kenya and Uganda. J Int AIDS Soc. 2021;24(6):e25670. https://doi.org/10.1002/jia2.25670
31. Restar AJ, Tocco JU, Mantell JE, Lafort Y, Gichangi P, Masvawure TB, et al. Perspectives on HIV pre- and post-exposure prophylaxes (PrEP and PEP) among female and male sex workers in Mombasa, Kenya: implications for integrating biomedical prevention into sexual health services. AIDS Educ Prev. 2017;29(2):141–53. https://doi.org/10.1521/aeap.2017.29.2.141
32. Ajema C, Mbugua C, Memiah P, Wood C, Cook C, Kotut R, et al. Addressing the dual health epidemics of HIV and sexual abuse among children and adolescents in Kenya: uptake of HIV counseling and post-exposure prophylaxis. Adolesc Health Med Ther. 2018;9:1–9. https://doi.org/10.2147/AHMT.S149416
33. Izulla P, McKinnon LR, Munyao J, Karanja S, Koima W, Parmeres J, et al. HIV postexposure prophylaxis in an urban population of female sex workers in Nairobi, Kenya. J Acquir Immune Defic Syndr. 2013;62(2):220–5. https://doi.org/10.1097/QAI.0b013e318278ba1b
34. World Health Organization. Guidelines for HIV post-exposure prophylaxis. Geneva: WHO; 2024.
35. Ayieko J, Petersen ML, Kamya MR, Havlir DV. PEP for HIV prevention: are we missing opportunities to reduce new infections? J Int AIDS Soc. 2022;25(5):e25942. https://doi.org/10.1002/jia2.25942
36. Ortblad KF, Bardon AR, Mogere P, Kiptinness C, Gakuo S, Mbaire S, et al. Effect of 6-month HIV preexposure prophylaxis dispensing with interim self-testing on preexposure prophylaxis continuation at 12 months: a randomized noninferiority trial. JAMA Netw Open. 2023;6(6):e2318590. https://doi.org/10.1001/jamanetworkopen.2023.18590
37. Campbell MB, Ratnayake A, Gomes G, Stoecker C, Kissinger PJ. Effectiveness of incentivized peer referral to increase enrollment in a community-based Chlamydia screening and treatment study among young Black men. J Racial Ethn Health Disparities. 2024;11(3):1173–81. https://doi.org/10.1007/s40615-023-01595-5
38. Thanel K, Pedersen B, Albert YK, Ouattara ML, Gbeke D, Ranebennur V, et al. Acceptability of an incentivized peer referral intervention to address COVID-19 vaccine hesitancy among adults in Yopougon-Est, Cote d'Ivoire. Glob Health Sci Pract. 2024;12(3):e2300468. https://doi.org/10.9745/GHSP-D-23-00468
39. Luo Q, Wu Z, Mi G, Xu J, Scott SR. Using HIV risk self-assessment tools to increase HIV testing in men who have sex with men in Beijing, China: app-based randomized controlled trial. J Med Internet Res. 2023;25:e45262. https://doi.org/10.2196/45262
40. Collins L, Kugler K. Optimization of behavioral, biobehavioral, and biomedical interventions: the Multiphase Optimization Strategy (MOST). Cham: Springer International Publishing; 2018.
41. Clinicaltrials.gov. Pharmacy-based PrEP delivery in Kenya (NCT05842122). National Institutes of Health; 2023.
42. Lancet HIV. Making the most of a fertile PrEP landscape. Lancet HIV. 2023;10(12):e755. https://doi.org/10.1016/S2352-3018(23)00303-X

SUPPORTING INFORMATION

Additional information may be found under the Supporting Information tab for this article:
Supporting Figure 1. Modified delivery model.
Supporting Figure 2a. Prescribing checklist for initiation visits.

Supporting Figure 2b. HIV Risk Assessment Screening Tool (RAST) for PrEP initiation and continuation visits.
Supporting Figure 2c. Prescribing checklist for follow-up visits.
Supporting Figure 3. PrEP and PEP initiations by day of week.
Supporting Table 1. Breakdown of positive STI testing results by client sex.

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RESEARCH ARTICLE

Online delivery of oral HIV pre- and post-exposure prophylaxis: findings from the ePrEP Kenya pilot

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Abstract

Introduction: The expansion of telecommunication networks and smartphones in many African countries could be leveraged to deliver HIV prevention products directly to consumers. In collaboration with a private e-commerce platform and online pharmacy in Kenya, MYDAWA, we piloted a new model of HIV pre- and post-exposure prophylaxis (PrEP/PEP) delivery.

Methods: In the ePrEP Kenya pilot (NCT05377138), individuals living in Nairobi and Mombasa Counties could complete a free telehealth visit with a remote clinician to assess eligibility for online PrEP/PEP (i.e. ≥18 years; no medical contraindications). Eligible individuals could order HIV testing services—courier delivered to clients' choice location—for a fee of 250 KES (~$2 USD) for self-testing or 150 KES (~$1 USD) for provider-administered rapid diagnostic testing. Following confirmation of clients' HIV-negative status (via an uploaded test result image), free PrEP/PEP drugs from government supply were courier delivered with or separately from HIV testing services. Clients paid a delivery fee ≤149 KES (~$1 USD) per courier visit.

Results: From October 2022 to December 2023, we screened 2257 individuals and enrolled 1915. Most PrEP/PEP clients were men (63%, 1428/1915), ≥25 years (72%, 1631/1915) and never married (80%, 1796/1915); few had ever used PrEP (3%, 48/1915) or PEP (14%, 263/1915). At enrolment, 227 (12%) were preliminarily eligible for PrEP and 1688 (88%) for PEP. Among PrEP-eligible clients, 89% (203/227) completed HIV testing and 92% (208/227) received PrEP; among PEP-eligible clients, 92% (1551/1688) completed HIV testing and 92% (1549/1688) received PEP. Most PrEP/PEP clients completed HIV testing within 6 hours of their telehealth visit (53%, 927/1757) and had drugs delivered with testing services (88%, 1546/1757). Among PrEP clients eligible for follow-up, 47% (120/256) continued PrEP and 4% (10/256) initiated PEP following PrEP discontinuation. Among PEP clients eligible for follow-up, 7% (99/1428) repeated PEP use and 6% (83/1428) transitioned from PEP to PrEP.).

Conclusions: Online PrEP/PEP delivery could expand access to prevention services by reaching individuals not engaged in existing delivery platforms. The uptake of online PEP was five times greater than PrEP, underscoring an unmet demand for PEP and highlighting the potential for online pharmacies to deliver time-sensitive PEP services.

Keywords: HIV prevention; pre-exposure prophylaxis; post-exposure prophylaxis; online delivery; differentiated service delivery; HIV self-testing

Additional information may be found under the Supporting Information tab of this article.

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1 | INTRODUCTION

In many African countries with high HIV incidence, e-commerce is increasing due to expanding telecommunication networks and smartphone coverage [1–5]. Companies providing direct-to-consumer health products could be leveraged to provide HIV prevention services [5, 6]. In Kenya, ~47 million individuals (>80% of the population) have smartphone access and there are >60 licensed, private e-commerce companies [7]. Online delivery of HIV prevention products—including HIV self-testing (HIVST) and pre- and post-exposure prophylaxis (PrEP and PEP) drugs—has potential advantages over clinic

delivery, including increased convenience and privacy [8–11], and could expand prevention services to eligible populations unrepresented in clinics (e.g. men, young people) [12]. When paired with telemedicine—which was effectively used in Kenya to maintain HIV service access during COVID-19 [13, 14]—e-commerce platforms could operate as one-stop shops for HIV service delivery.

Kenya, a leader in differentiated models of HIV service delivery [15], is an ideal setting to evaluate an online PrEP/PEP delivery model. In Kenya, most HIV acquisition occurs in urban areas [16] where there is a growing middle class [17] with access to technology and the ability to pay for products delivered via e-commerce platforms [18]. In 2022, Kenya identified private pharmacies as a target PrEP delivery platform [19] and, in 2023, established a private-sector framework for HIV service delivery [20]. Pilot studies of PrEP/PEP delivery at private, brick-and-mortar pharmacies in Kenya have demonstrated feasibility and high uptake among populations underserved at public clinics (i.e. unmarried individuals) [21], but no study to our knowledge has evaluated PrEP/PEP delivery via a private online pharmacy in the region.

Online pharmacies may be particularly well-suited to deliver PEP, which is most effective ≤24 hours (and up to 72 hours) of HIV exposure [22]. Compared to clinics and some brick-and-mortar pharmacies, online pharmacies have longer operating hours (including evenings and weekends) and can deliver discreet services quickly to clients' preferred settings, enabling clients to more easily initiate PEP within the recommended window [22]. While Kenya has recommended PEP use for all individuals with recent HIV exposure since 2016 [23], its use has not been widely promoted and access remains limited beyond cases of occupational exposure or sexual assault [23–25]. Bias among healthcare providers reporting moral conflicts also limits PEP provision [26].

To understand the potential for private online pharmacies to reach eligible individuals and deliver public HIV commodities, we partnered with MYDAWA [27], an online pharmacy and e-commerce platform in Kenya, to develop and evaluate the feasibility, uptake and acceptability of a novel online PrEP/PEP delivery model [28].

2 | METHODS

2.1 | Study design and setting

We conducted a single-arm, prospective pilot study of online oral PrEP/PEP delivery in Nairobi and Mombasa Counties (the latter was introduced 8 months into implementation). In 2022, these counties reported >2500 HIV incident cases, with Nairobi reporting 1999 cases—the most of any Kenyan county [16].

MYDAWA, established in 2017, is an e-commerce platform delivering prescription and non-prescription drugs and other products (e.g. shampoo, diapers) to clients in Nairobi and Mombasa Counties. In 2023, MYDAWA had ~68,000 clients and sexual and reproductive health (SRH) products comprised ~21% of sales [29]. To enable the delivery of prescription medication, MYDAWA is licensed as both an online pharmacy and medical facility; the latter of which occurred just prior to study implementation, enabling PrEP/PEP prescribing by MYDAWA clinicians via telehealth. During pilot implementation, MYDAWA telehealth visits were available from 8 AM to 10 PM, and orders placed from 8 AM to 7 PM had guaranteed delivery within 6 hours.

2.2 | Care pathway

In collaboration with PrEP implementors, researchers and MYDAWA leadership, we developed an online PrEP/PEP delivery care pathway adapted from one for brick-and-mortar pharmacy PrEP delivery in Kenya (Figure S1) [28, 30]. Prior to implementation, PrEP/PEP implementors and Kenya Ministry of Health trainers conducted a 3-day training for MYDAWA clinicians and pharmaceutical technologists ("pharm techs") that followed the national PrEP/PEP curriculum [31] and covered the pathway's core components: behavioural HIV risk and medical safety assessments—delivered by clinicians via telehealth visits—and HIV testing and drug dispensing—delivered by pharm techs via courier visits. Pharm techs completed practicum sessions on HIV testing in clinics. PrEP/PEP implementors provided technical assistance bi-monthly and consultations as needed.

2.3 | Participants

Eligible participants were ≥18 years old and met the prescribing checklist criteria (described below). To generate demand for online PrEP/PEP, MYDAWA created a "Gen-N community" marketing campaign—with Gen-N referencing an HIV-negative generation—to motivate individuals to engage in HIV prevention services and contribute to an AIDS-free future (Figure S2). MYDAWA marketed online PrEP/PEP via social media (e.g. Facebook, Instagram), search engines (e.g. Google) and their website using banners, pop-ups, stickers and landing pages that targeted clients purchasing SRH products. During pilot implementation, MYDAWA was one of the top Google hits for individuals searching "PrEP" or "PEP" in Nairobi. Additionally, MYDAWA hosted four in-person events between February and June 2023 to promote online PrEP/PEP on university campuses and in Nairobi neighbourhoods.

The study protocol was approved by the Scientific Ethics Review Unit at Kenya Medical Research Institute. Participants completed electronic informed consent (via email or SMS) during their initial telehealth visit and received 500 Kenyan Shillings (KES; ~$3.50 US Dollars [USD]) for completing behavioural surveys.

2.4 | Study procedures

2.4.1 | Telehealth visits

We worked with ClickMedix (Cambridge, USA)—a global mobile health social enterprise [32]—to integrate a secure telehealth portal into MYDAWA's platform. Interested clients could schedule free telehealth visits via MYDAWA's website.

At telehealth visits, clients provided their names and phone numbers; MYDAWA clinicians then utilized a prescribing checklist (Figure S3) to determine clients' online PrEP or PEP eligibility and guide counselling on the appropriate service. First, clinicans screened clients for HIV acquisition risk using a modified version of Kenya's HIV Risk Assessment Screening

Tool (RAST) [28], which asked about behaviours in the past 6 months (e.g. partners of unknown HIV status, transactional sex) and potential HIV exposures in the past 72 hours (condomless sex with someone who may have HIV; sexual assault; and exposure to blood/other bodily fluids). MYDAWA clinicians classified clients as potentially eligible for either PrEP or PEP based on clients' RAST responses, HIV risk perception and product preferences. Next, providers screened potential clients for symptoms of acute HIV acquisition and PrEP clients for medical conditions (e.g. history of liver or kidney disease) that might contraindicate PrEP safety. Serum creatine and hepatitis B/C testing were not conducted, as national guidelines state that the availability of these tests should not delay PrEP/PEP initiation [22].

Clients who met the checklist criteria for online PrEP/PEP received a conditional prescription (pending confirmation of HIV-negative status) and those who did not were referred to nearby clinics. To continue online PrEP, clients scheduled a free follow-up telehealth visit and repeated the prior steps, plus screening for potential drug side effects. Online PEP clients were encouraged to complete a follow-up telehealth visit 28 days post-initiation for repeat HIV testing and PrEP counselling.

2.4.2 | *Courier delivery*

Following telehealth visits, eligible clients could order HIV testing services and PrEP/PEP via MYDAWA and have these courier-delivered to their preferred location by a pharm tech on a motorcycle. Clients had two HIV testing options: (1) HIVST, for a subsidized fee of 250 KES (~$2 USD), or (2) provider-administered rapid diagnostic testing (RDT) by a pharm tech, for a non-subsidized fee of 150 KES (~$1 USD); the latter was introduced 8 months into implementation. Additionally, clients could choose to have HIV testing and PrEP/PEP delivered in the same (one-step) or separate (two-step) courier visits. Since we used government PrEP/PEP commodities, we did not charge clients for drugs; however, a delivery fee of up to 149 KES (~$1 USD) was applied per courier visit.

Strategies to confirm clients' HIV-negative status prior to PrEP/PEP dispensing varied by HIV test type. For HIVST, MYDAWA clinicians reviewed test result images uploaded to the online platform. We collaborated with Audere (Seattle, USA)—a digital health non-profit [33]—to incorporate an artificial intelligence (AI) algorithm into the platform that prompted clients to upload a new HIVST result image if the previous one was likely uninterpretable (e.g. was blurry, did not include the results window). For RDT, pharm techs interpreted and communicated test results to MYDAWA clinicians. Clients who tested HIV positive received post-test counselling from a MYDAWA clinician (via a scheduled telehealth visit) or pharm tech and were referred to nearby clinics for confirmatory testing and treatment.

After MYDAWA clinicians confirmed clients' HIV-negative status, pharm techs were approved (often via phone calls) to deliver oral PrEP/PEP per national guidelines [34]; clients initiating PrEP or PEP received a 30- or 28-day drug supply, respectively, and those refilling PrEP received a 90-day supply. Clients were advised to use oral PrEP daily and not counselled on event-driven PrEP, which was not included in national guidelines at the time.

2.5 | Data collection and management

We obtained data on all clients from MYDAWA pharmacy records and select clients from behavioural surveys, which all clients were invited to complete within 2 weeks of enrolment. From pharmacy records, we obtained clients' demographics, behaviours associated with HIV acquisition, HIV testing results, timing of their potential HIV exposure (PEP clients only), and date/time of their telehealth and courier visits (recorded by pharm techs following delivery). In behavioural surveys, we captured additional demographics, sexual behaviours, PrEP/PEP knowledge/prior use and perceptions of online PrEP/PEP delivery.

2.6 | Outcomes

Primary outcomes were PrEP and PEP initiation (any dispensing) and PrEP continuation (any refills) within 45 days of initiation. Additionally, we measured any PrEP continuation over the observation period and at scheduled follow-up visits; clients who refilled PrEP ≤15 days from a scheduled visit were considered "on-time" and those who refilled >15 days from a scheduled visit were considered to have "stopped and restarted" [35]. Secondary outcomes included PEP initiation following PrEP discontinuation, PEP-to-PrEP transition and repeated PEP use. Process outcomes included day/time and duration of telehealth visits, client selection of HIV test type and one- versus two-step delivery, information on HIVST images uploaded and the time between delivery steps.

Implementation outcomes [28] included clients' perceived acceptability, satisfaction and willingness to pay for various delivery steps (delivery fees excluded). Additionally, we assessed clients' experiences and perceptions of service quality. We measured acceptability and satisfaction using statements, with 5-point Likert scale responses, that assessed different components of the Theoretical Framework of Acceptability [36] and Client Satisfaction Questionnaire [37].

2.7 | Analyses

We used descriptive statistics for most outcomes, adjusting the sample to those eligible (based on the service dispensed or clients' follow-up duration). For continuation outcomes, we conducted subgroup analyses for: men ≥25, women ≥25, men <25 and women <25 years. For factors associated with any PrEP continuation (among PrEP clients), and repeated PEP use and PEP-to-PrEP transition (among PEP clients), we utilized negative binomial regression models with robust standard errors adjusted for a priori variables. For several implementation outcomes, we aggregated the two most positive response categories and considered a construct achieved if ≥80% of responses were in this aggregated category [38]. We conducted analyses in R (v6.1) [39].

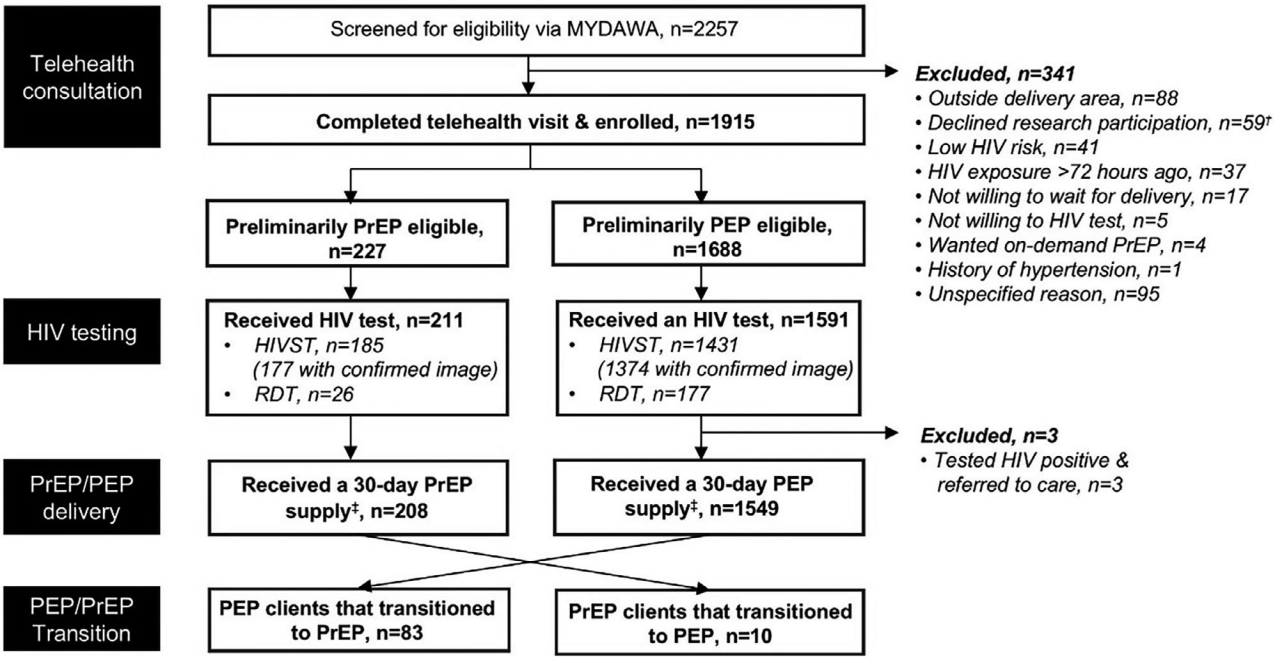

Figure 1. Flow of participants through the care pathway for online PrEP/PEP delivery. Abbreviations: HIVST, HIV self-testing; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis. †Thirty-three clients (6 PrEP; 27 PEP clients) received medicine from MYDAWA without participating in the study (i.e. paying the full price of PrEP/PEP after seeing a MYDAWA clinician in person or uploading a prescription from another facility). ‡Thirty-five clients (5 PrEP; 30 PEP) clients received PrEP/PEP delivery without having uploaded an image of their HIV test (due to clinician error).

3 | RESULTS

Between October 2022 and December 2023, 2257 individuals began a telehealth visit and 1915 enrolled in the study (Figure 1). Common exclusion reasons included living outside delivery area (26%, 88/341) and declining research participation (17%, 59/341). Among individuals enrolled, 227 (12%) were determined preliminarily eligible for PrEP and 1688 (88%) for PEP. Most clients learned of online PrEP/PEP from the MYDAWA website (45%, 867/1915), followed by Google ads (32%, 615/1915) (Table 1). At enrolment, 38% (736/1915) of eligible clients agreed to participate in behavioural surveys—41% (93/227) of PrEP and 38% (638/1688) of PEP clients; the characteristics of clients who did and did not participate in behavioural surveys were largely similar (Table S4).

3.1 | PrEP/PEP initiation

HIV testing uptake among preliminarily eligible online PrEP/PEP clients (including uploading HIVST test results) was 92% (1754/1915), and similar for PrEP and PEP clients (Figure 1). Three clients tested HIV positive prior to PrEP/PEP initiation; all were preliminarily PEP eligible. PrEP initiation among eligible clients was 92% (208/227), as was PEP initiation (92%, 1549/1688). A few PrEP/PEP clients (2%, 35/1688) were dispensed drugs without confirmed HIV testing results due to implementation errors; all were followed up and confirmed HIV negative. A few PrEP clients (n = 10) discontinued PrEP and later initiated PEP and a few PEP clients transitioned to PrEP (n = 83), resulting in 291 unique PrEP and 1559 unique PEP clients.

Table 1 shows the demographics of clients who enrolled in the study, initiated online PrEP/PEP and completed behavioural surveys. Among clients who initiated PrEP/PEP, most were ≥25 years (72%; 1273/1757), male (64%; 1121/1757) and unmarried (87%, 1537/1757). While few clients identified as members of priority populations, more male PrEP clients (29%, 45/155) reported sex with men than male PEP clients (3%, 26/966; p<0.01). While prior PrEP or PEP use was low among all clients, prior PrEP use was significantly higher among PrEP (17%, 35/208) compared to PEP clients (1%, 12/1549; p<0.01).

Prevalence of behaviours associated with HIV acquisition was high among those eligible for online PrEP/PEP; 87% (1537/1757) reported sexual partners with unknown HIV status and 48% (852/1757) reported multiple concurrent sexual partners in the past 6 months. Compared to eligible PEP clients, significantly more eligible PrEP clients reported multiple concurrent sexual partners (63%, 144/227 vs. 47%, 789/1688; p<0.01) and high self-perceived HIV acquisition risk (36%, 81/227 vs. 13%, 225/1688; p<0.01). Most eligible PEP clients reported condomless sex in ≤72 hours with someone who might have HIV (71%, 1201/1688); few reported a recent sexual assault (1%, 17/1688).

3.2 | PrEP continuation and repeat PEP use

We observed 9746 client months of follow-up: 1212 months for PrEP clients and 8534 months for PEP clients. Any

Table 1. Characteristics of online PrEP/PEP clients who enrolled, initiated services and completed behavioural surveys

Characteristic	Preliminarily eligible online PrEP/PEP clients		Clients who initiated online PrEP/PEP		Clients who completed behavioural surveys[a]	
	PrEP (*n* = 227)	PEP (*n* = 1688)	PrEP (*n* = 208)	PEP (*n* = 1549)	PrEP (*n* = 93)	PEP (*n* = 638)
Demographics						
Age: Median [IQR]	28 [24, 34]	27 [24, 33]	28 [25, 34]	27 [24, 33]	26 [19, 56]	27 [24, 31]
Age ≥ 25 years	162 (71%)	1222 (72%)	154 (74%)	1119 (72%)	59 (63%)	439 (69%)
Sex: *Male*[b]	169 (74%)	1066 (63%)	155 (75%)	966 (62%)	57 (61%)	396 (62%)
Married	26 (12%)	212 (13%)	24 (12%)	196 (13%)	5 (5%)	78 (12%)
Relationship status[c]						
Casual partners only	–	–	–	–	45 (48%)	319 (50%)
Primary partner only	–	–	–	–	29 (31%)	220 (34%)
Primary and casual partners	–	–	–	–	19 (20%)	71 (11%)
Occupation						
Professional[d]	–	–	–	–	40 (43%)	306 (48%)
Student	–	–	–	–	20 (22%)	50 (8%)
Trade/Sales	–	–	–	–	15 (16%)	140 (22%)
None	–	–	–	–	14 (15%)	91 (14%)
Other	–	–	–	–	4 (4%)	49 (8%)
Monthly income (KES) [USD][e]						
≤10,000 [≤$70]	–	–	–	–	32 (34%)	150 (23%)
10,001–70,000 [$71–$500]	–	–	–	–	32 (34%)	322 (51%)
70,001–150,000 [$501–$1070]	–	–	–	–	16 (16%)	109 (17%)
>150,000 [>$1070]	–	–	–	–	13 (14%)	52 (8%)
Special populations						
Men who have sex with men (/men)	47 (28%)	28 (3%)	45 (29%)	26 (3%)	15 (16%)	15 (2%)
Member of an HIV serodiscordant couple	10 (4%)	1 (0·1%)	10 (5%)	1 (0·1%)	3 (3%)	0 (%)
Health history[f]						
Currently using PrEP	22 (10%)	0 (0%)	22 (11%)	0 (0%)	6 (7%)	1 (0.2%)
Prior PrEP use	36 (16%)	12 (1%)	35 (17%)	12 (1%)	13 (14%)	6 (1%)
Prior PEP use	36 (16%)	227 (13%)	30 (14%)	211 (14%)	15 (16%)	100 (16%)
Prior emergency contraception use ≥2 times	–	–	–	–	32 (34%)	289 (45%)
Currently using LARC (/women)	–	–	–	–	11 (12%)	81 (33%)
Pregnant/breastfeeding (/women)	3 (1%)	23 (4%)	3 (1%)	23 (1%)	2 (6%)	9 (3%)
Prior pregnancy (/women)	–	–	–	–	18 (53%)	103 (42%)
Behaviours associated with risk of HIV acquisition[f]						
In the past 6 months						
Multiple concurrent sexual partners	144 (63%)	789 (47%)	136 (65%)	716 (46%)	56 (60%)	284 (44%)
Partner(s) of unknown HIV status	170 (75%)	1507 (89%)	153 (74%)	1384 (89%)	72 (78%)	573 (89%)
Partner(s) living with HIV	25 (11%)	43 (3%)	24 (12%)	42 (3%)	9 (10%)	16 (3%)

(*Continued*)

Table 1. (Continued)

Characteristic	Preliminarily eligible online PrEP/PEP clients		Clients who initiated online PrEP/PEP		Clients who completed behavioural surveys[a]	
	PrEP (*n* = 227)	PEP (*n* = 1688)	PrEP (*n* = 208)	PEP (*n* = 1549)	PrEP (*n* = 93)	PEP (*n* = 638)
Inconsistent condom use	112 (49%)	1231 (73%)	103 (50%)	1143 (74%)	45 (48%)	455 (71%)
Transactional sex	6 (3%)	45 (3%)	6 (3%)	41 (3%)	2 (2%)	21 (3%)
STI diagnosis	7 (3%)	47 (3%)	6 (3%)	41 (3%)	4 (4%)	20 (3%)
Needle sharing for drug use	0 (0%)	4 (0%)	0 (0%)	3 (0%)	0 (0%)	0 (0%)
Forced sex/sexual assault	5 (2%)	38 (2%)	3 (1%)	37 (2%)	1 (1%)	16 (3%)
Used PEP 2+ times	13 (6%)	62 (4%)	9 (4%)	61 (4%)	5 (5%)	24 (4%)
In the past 72 hours[f]						
Condomless sex and potential risk of HIV acquisition	7 (3%)	1201 (71%)	6 (3%)	1123 (73%)	5 (5%)	470 (73%)
Sexual assault	0 (0%)	17 (1%)	0 (0%)	15 (1%)	0 (0%)	3 (0.5%)
Exposure to bodily fluids: non-sexual	0 (0%)	70 (4%)	0 (0%)	62 (4%)	0 (0%)	23 (4%)
Exposure to bodily fluids: sexual	1 (0.4%)	360 (21%)	1 (0.5%)	316 (20%)	1 (1%)	138 (22%)
Self-assessment of HIV risk in the next month						
High	81 (36%)	225 (13%)	75 (36%)	204 (13%)	23 (25%)	81 (13%)
Medium	103 (45%)	1027 (61%)	96 (46%)	954 (62%)	48 (52%)	403 (63%)
Low	42 (19%)	428 (25%)	36 (17%)	387 (25%)	22 (24%)	152 (24%)
Knowledge of online PrEP/PEP						
How potential clients heard about online PrEP/PEP[f]						
MYDAWA website	86 (38%)	781 (46%)	84 (40%)	726 (47%)	40 (43%)	308 (48%)
Google ads	41 (18%)	574 (34%)	38 (18%)	535 (35%)	10 (11%)	219 (34%)
Social media	40 (18%)	169 (10%)	30 (14%)	149 (10%)	14 (15%)	67 (11%)
Peer/friend/sex partner	33 (15%)	110 (7%)	32 (15%)	96 (6%)	10 (11%)	41 (6%)
Healthcare provider	6 (3%)	62 (4%)	5 (2%)	55 (4%)	4 (4%)	14 (2%)
Campus event	28 (12%)	11 (1%)	25 (12%)	11 (1%)	20 (22%)	7 (1%)

Abbreviations: KES, Kenyan Shilling; LARC, long-acting reversible contraception; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; USD, United States Dollar.

[a]All enrolled individuals were invited to complete a behavioural survey 2 weeks after enrolling as a PrEP participant and 1.5 months after enrolling as a PEP participant; 41% (93/227) of individuals eligible for PrEP and 38% (638/1688) of individuals eligible for PEP agreed to participate.

[b]This includes two PrEP clients who identified as intersex (included in all PrEP categories) and one PEP client who identified as intersex; this individual did not participate in the behavioural survey.

[c]Among PEP clients, 33 (5%) chose not to answer the relationship status question and seven (1%) chose not to answer the monthly income question.

[d]Professionals included medical officers, lawyers, teachers, graphics designers and accountants.

[e]Average USD/KSH 2023 exchange rate during the implementation period was 140 KSH per 1 USD.

[f]Categories are not mutually exclusive.

PrEP continuation among clients eligible for follow-up (i.e. >1 month from initiation) was 34% (88/256) by 45 days and 47% (120/256) over the observation period (Figure 2). At 7 months post PrEP initiation, 11% (12/108) of eligible clients were still engaged in online PrEP services. Any PrEP continuation over pilot duration was similar among men and women, but significantly higher among those ≥25 years (53%, 102/191) compared to those <25 years (28%, 18/65; $p<0.01$). PEP initiation following PrEP discontinuation among eligible clients was 4% (10/256). At 28 days post PEP initiation, 18% (259/1428) of eligible clients completed repeat HIV testing and 16% (227/1428) completed a follow-up telehealth visit (median time from initiation: 34 days, IQR 30–53 days). Repeat PEP use among eligible clients was 7% (99/1428); men <25 years were significantly more likely to repeat PEP than other subgroups (12%, 29/236 vs. 6%, 70/1192; $p<0.01$). Transition from PEP to PrEP among eligible clients was 6% (83/1428). No online PrEP/PEP clients tested HIV positive at follow-up.

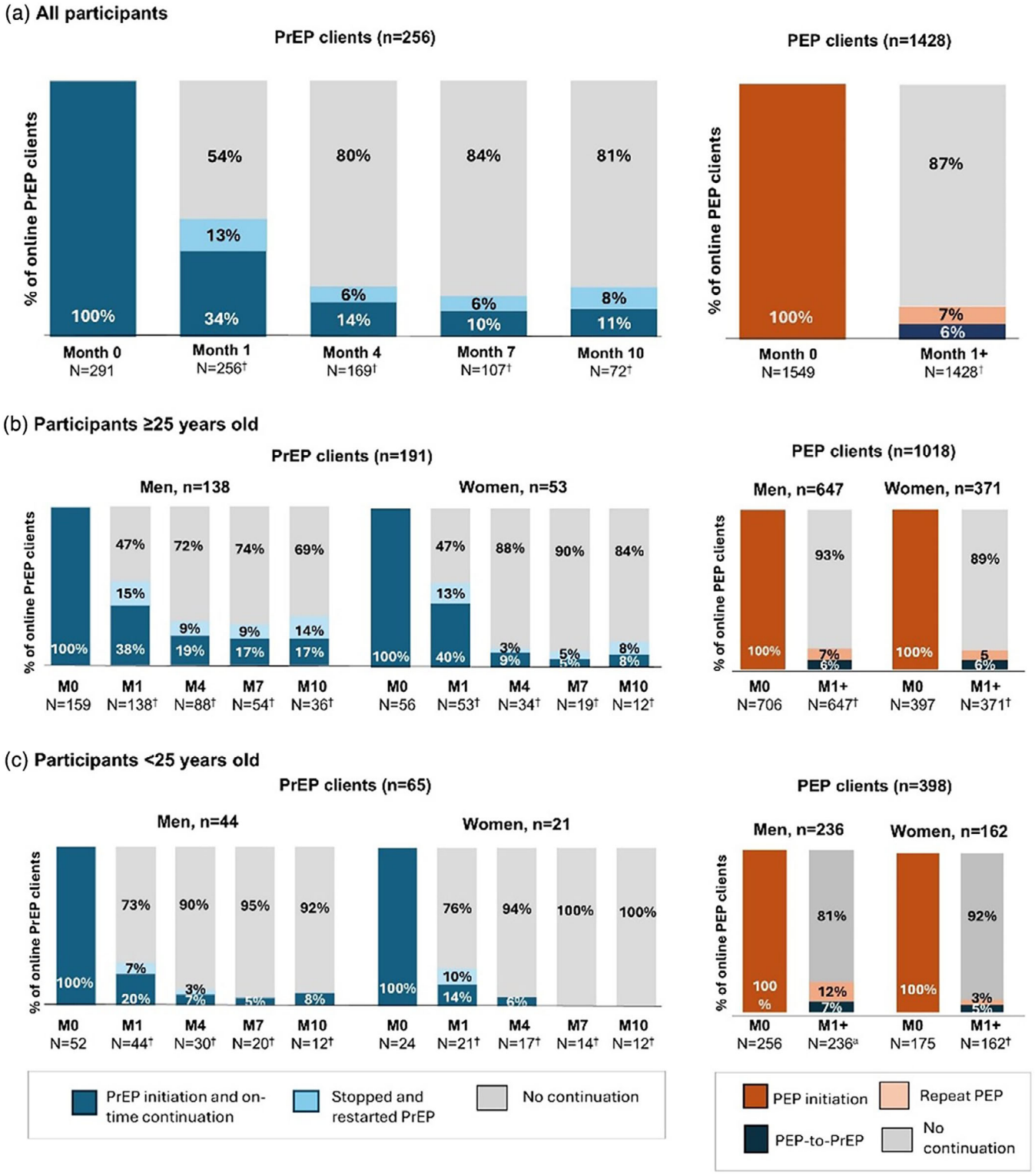

Figure 2. Online PrEP and PEP continuation over the pilot duration among eligible clients who initiated services, by age and sex. Abbreviations: M, month; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis. †Among those initiated, enrolled and eligible for a follow-up visit.

In adjusted models among PrEP clients, variables associated with higher likelihood of PrEP continuation were: age ≥25 years, males reporting sex with men and having a partner living with HIV (Table 2). Prior PEP use was associated with a 36% lower likelihood of PrEP continuation although it did not reach statistical significance ($p = 0.09$). Among PEP clients, variables associated with a higher likelihood of PEP-to-PrEP transition were: men reporting sex with men, prior PrEP use and prior PEP use; being married was associated with a 90% lower likelihood of PEP-to-PrEP transition ($p = 0.02$). Among PEP clients, a higher likelihood of repeat PEP use was associated with: being male and reporting prior PEP use. For unadjusted models, see Tables S1 and S2.

3.3 | Process outcomes

We observed 2608 telehealth visits (including initiation and continuation visits): 548 for PrEP and 2060 for PEP clients. On average, telehealth visits lasted 16 minutes (IQR 13–18 minutes), with PrEP/PEP initiation visits taking slightly longer than PrEP continuation visits (Table 3). Most telehealth visits occurred either on Mondays (17%, 455/2608) or Tuesdays (16%, 426/2608); 26% (670/2608) occurred after 5 PM and 26% (669/2608) on the weekends.

Most eligible clients (91%, 1734/1915) chose HIVST over RDT. Among clients receiving HIVST, most uploaded an image of an HIVST result (87%, 1509/1735) with few issues; the AI feature only prompted 8% (136/1734) of clients to re-upload an HIVST image. Few clients (18%, 341/1915) chose two- versus one-step delivery of HIV testing and PrEP/PEP and significantly fewer PEP clients (16%, 275/1688) compared to PrEP clients (29%, 66/227; $p<0.01$) selected this option. Overall, clients received services quickly, with a median of 5 hours (IQR 3–16) between telehealth visit and PrEP/PEP delivery. Most PEP clients (96%, 629/653) received PEP within 72 hours of their HIV exposure; the median time from reported exposures to delivery was 26 hours (IQR 18–44).

3.4 | Implementation outcomes

Clients who completed behavioural surveys perceived online PrEP/PEP delivery as acceptable, satisfactory and high-quality; most reported a willingness to pay for some or all model components (Table 4) (see Table S3 for details). Most clients (>90%) liked the model, were confident in their ability to access it and thought it could help prevent HIV spread in their community. Most clients (>93%) reported that MYDAWA providers were easy to understand, encouraged questions and were respectful. Many clients (>83%) reported "extremely positive" or "positive" experiences across the model components.

4 | DISCUSSION

Online PrEP/PEP delivery reached PrEP/PEP naïve individuals at HIV acquisition risk [40] and online PEP services were particularly in demand, with some clients returning for repeat PEP and few clients transitioning from PEP to PrEP. Online PrEP continuation was low, but still comparable to rates observed at Kenyan public clinics [41–46]. Taken together, these findings highlight a demand for periodic versus persistent use of online HIV prevention services. Additionally, online PrEP/PEP clients found the model acceptable, satisfactory and high-quality, and many were willing to pay for online PrEP/PEP—suggesting the sustainability of the model at scale. Further, almost all online PEP clients received drugs within 72 hours of a potential HIV exposure, demonstrating the ability of the model to reach clients with time-sensitive needs. These findings suggest the feasibility of a public-private partnership model that facilitates delivery of government HIV commodities on a for-profit e-commerce platform in Kenya.

In our pilot, the uptake of online PEP was five times greater than online PrEP. This underscores the unmet demand for PEP and the need for widespread PEP availability and interventions catered to periodic HIV prevention services (e.g. event-driven PrEP). Despite considerable PrEP scale-up efforts in Kenya, implementation challenges persist, including low PrEP uptake and continuation at public clinics (<35% at 6 months) [43–46]. The greater observed demand for PEP versus PrEP in this pilot is difficult to compare with that at Kenyan public clinics, as PEP dispensing is not documented in Kenya's clinic-based electronic reporting tool for antiretroviral drug dispensing. The few implementation projects in Kenya that have offered PrEP and PEP as equal HIV prevention options also observed high PEP uptake; in two implementation projects delivering PrEP/PEP in brick-and-mortar private pharmacies, 20% and 68% of clients initiated PEP over PrEP [47, 48], and in an implementation project delivering PrEP/PEP in the community, 58% of clients initiated PEP over PrEP [49].

The greater observed uptake of PEP versus PrEP in this pilot may have several contributing factors. First, the risk of a potential HIV exposure has already occurred for PEP clients but is hypothetical for many PrEP clients. Thus, PEP clients are seeking time-sensitive services (and potentially searching the internet for assistance), while potential PrEP clients may need prompting to consider prevention for future HIV risk (a conversation that is hard to initiate online). Second, community-level PEP awareness in Nairobi and Mombasa Counties might be higher than PrEP since PEP has been around longer and most PrEP programming in Kenya has targeted the Western region, where HIV prevalence is greatest. Third, extended operating hours of online pharmacies (including evenings and weekends) might better align with when potential PEP clients seek this time-sensitive service. Fourth, the speed and convenience with which online pharmacies can deliver services (≤6 hours) might be appealing to PEP clients with urgent prevention needs.

Online PrEP/PEP delivery may expand the reach of HIV prevention products to those not accessing clinic-based services. We found most online PrEP/PEP clients were PrEP and PEP naïve, unmarried, male and not in serodifferent relationships, whereas clients accessing PrEP at public clinics are largely married, female and in serodifferent relationships [42, 43]. Importantly, online PrEP reached many men reporting sex with men, highlighting the potential of online services to reach populations less likely to seek in-person services. Additionally, most online PEP clients reported a potential recent HIV exposure through consensual condomless sex versus sexual assault or exposure to a non-sexual bodily fluid, the

Table 2. Characteristics associated with PrEP continuation, PEP-to-PrEP transition and repeat PEP use, findings from adjusted multivariable models

	Initiated PrEP (n = 256)[a]				Initiated PEP (n = 1428)[b]							
	PrEP continuation:				PEP-to-PrEP transition:				Repeat PEP use:			
Characteristic	PrEP refills (n = 88)	No PrEP refills (n = 168)	aRR (95% CI)	p	PrEP transition (n = 82)	No PrEP transition (n = 1346)	aRR (95% CI)	p	Repeat PEP (n = 99)	No repeat PEP (n = 1329)	aRR (95% CI)	p
Demographics												
Age ≥25 years	**75 (85%)**	**114 (69%)**	**1.80 (1.04–2.99)**	**0.03**	57 (70%)	962 (72%)	1.07 (0.67–1.71)	0.77	66 (67%)	953 (73%)	0.75 (0.50-1.12)	0.16
Sex: Male	64 (73%)	118 (70%)	0.88 (0.60–1.30)	0.52	53 (65%)	838 (62%)	1.04 (0.65–1.66)	0.86	**75 (76%)**	**816 (62%)**	**1.77 (1.13-2.79)**	**0.01**
Married	–	–	–	–	**1 (1%)**	**174 (13%)**	**0.10 (0.01–0.73)**	**0.02**	–	–	–	–
Men who have sex with men	**21 (24%)**	**21 (13%)**	**1.74 (1.16–2.60)**	**0.01**	**8 (10%)**	**16 (1%)**	**4.25 (2.15–8.40)**	**<0.01**	–	–	–	–
Health history												
Prior PrEP use[c]	–	–	–	–	**3 (4%)**	**8 (1%)**	**2.96 (1.07–8.18)**	**0.04**	–	–	–	–
Prior PEP use[c]	14 (16%)	45 (27%)	0.64 (0.39–1.16)	0.09	**20 (25%)**	**175 (13%)**	**1.85 (1.13–3.01)**	**0.01**	**26 (26%)**	**169 (13%)**	**2.07 (135-3.18)**	**<0.01**
STI diagnosis	–	–	–	–	5 (6%)	35 (3%)	1.83	0.22				
Sexual behaviours												
1+ sex partner	58 (66%)	93 (56%)	1.25 (0.87–1.78)	0.23	–	–	–	–	–	–	-	–
Partner living with HIV	**12 (14%)**	**9 (5%)**	**2.00 (1.29–3.10)**	**<0.01**		–	–	–	5 (5%)	34 (3%)	1.66 (0.70-3.94)	0.25

Abbreviations: aRR, adjusted risk ratio; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infections. Bolded values indicate those that met our significance threshold of p<0.05.

[a]Included clients who initially initiated PrEP or transitioned from PEP to PrEP at least 30 days before the follow-up period ended. Excludes clients who initiated PrEP <1 month from pilot completion and thus were not eligible for follow-up.

[b]Included clients who initially initiated PEP at least 28 days before the follow-up period ended. Excludes clients who initiated PEP < 28 days from pilot completion and thus were not eligible for follow-up.

[c]Excludes clients who initiated PEP <1 month from pilot completion and thus were not eligible for follow-up.

Table 3. Process outcomes associated with online PrEP and PEP delivery

Process outcome	Eligible online PrEP clients (*n* = 227)	Eligible online PEP clients (*n* = 1688)
Telehealth consultation		
Duration (in minutes) of initial visit: median [IQR]	17 [15, 20]	15 [13, 18]
Duration (in minutes) of follow-up visit: median [IQR]	12 [10, 15]	–
Day of the week: (/total telehealth visits[a])		
Sunday	42/548 (8%)	290/2060 (14%)
Monday	68/548 (12%)	387/2060 (19%)
Tuesday	94/548 (17%)	332/2060 (16%)
Wednesday	93/548 (17%)	274/2060 (13%)
Thursday	87/548 (16%)	286/2060 (14%)
Friday	99/548 (18%)	219/2060 (11%)
Saturday	65/548 (12%)	272/2060 (13%)
Time of the day: (/total telehealth visits[a])		
Clinic hours: 8 AM–5 PM	421/548 (77%)	1517/2060 (74%)
After clinic hours: 5 PM–10 PM	127/548 (23%)	543/2060 (26%)
HIV testing services		
Received HIVST versus provider rapid diagnostic testing	202/227 (89%)	1532/1688 (91%)
Uploaded image of HIVST result (/HIVST clients)	168/202 (83%)	1341/1532 (88%)
Upload image of an HIVST result 1+ time (/HIVST clients)	66/202 (33%)	275/1532 (18%)
AI prompted image of an HIVST result to be reuploaded (/HIVST clients)	24/202 (11%)	112/1532 (7%)
Uploaded image of an unsupported HIVST type (/HIVST clients)	1/202 (1%)	7/1532 (1%)
Uploaded image of HIVST result uninterpretable[b]	2/202 (1%)	10/1532 (1%)
PrEP/PEP delivery		
Two-step delivery: received PrEP/PEP separate from HIV testing	66/227 (29%)	275/1688 (16%)
Elected to pick-up PrEP/PEP at MYDAWA offices (vs. courier delivery)	22/227 (10%)	140/1688 (8%)
Received PEP within 72 hours of potential exposure[c]	–	629/653 (96%)
Hours between delivery steps and potential HIV exposure		
Telehealth visit → HIV test result upload: median [IQR]	5 [0.5, 23]	5 [3, 15]
HIV test upload→ PrEP/PEP delivery: median [IQR] (/two-step delivery)	5 [2, 20]	3.5 [2, 9]
Telehealth visit→ PrEP/PEP delivery: median [IQR]	5.5 [3, 18]	5 [3, 12]
Potential HIV exposure → Telehealth visit: median [IQR][c]		26 [18, 44]
Potential HIV exposure → PEP delivery: median [IQR][c]	–	39 [25, 51]

Abbreviations: AI, artificial intelligence; HIVST, HIV self-testing; IQR, interquartile range; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis.
[a]Includes 2608 total telehealth visits over the pilot duration, 548 PrEP initiation and continuation visits and 2060 PEP initiation and repeat use visits.
[b]Test images deemed uninterpretable for reasons including: blood smear or object obstructing view of test and control lines; blurry image.
[c]Among PEP clients who reported the timing of their potential HIV exposure in their initial telehealth visit.

latter two of which have been the focus of most PEP programing in the region. Most online PrEP/PEP clients also preferred HIVST over provider-administered HIV testing, highlighting the importance of privacy and autonomy during the testing process.

Strengths of this study include collaboration of a multidisciplinary team of researchers, implementors, entrepreneurs and government officials; integration of AI to help ensure service quality; and assessment of implementation and willingness to pay outcomes. Limitations include utilizing subsidized HIVST kits and free telehealth visits, which may limit model sustainability; charging for products, which may have altered demand; changes in implementation midway through observation (i.e. delivery fees or HIV testing options), due to collaboration with a real-world e-commerce platform; relatively low participation in behavioural surveys, which may have biased findings towards positive perceptions; exclusion of event-driven PrEP; and insufficient information regarding how soon clients took their first PEP dose following courier delivery. Further, online PrEP/PEP delivery largely reached clients with high education, ability to pay for HIV testing and internet access/literacy; more research is needed to evaluate telehealth modalities to serve those with lower socio-economic status who could benefit from PrEP/PEP.

To optimize online PrEP/PEP delivery and support its scale-up in Kenya and similar settings, various implementation

Table 4. Implementation outcomes associated with online PrEP/PEP service delivery, as assessed in behavioural surveys[a]

Implementation outcomes	Outcome[b]	Online PrEP clients, *n* = 93	Online PEP clients, *n* = 638
Acceptability: Assessed with the TFA; 5-point Likert scale responses[c]			
Liked getting PrEP/PEP online (TFA: affective attitude)	Completely agree/agree	91 (98%)	614 (96%)
Took a lot of effort to get PrEP/PEP online (TFA: burden)	Completely disagree/disagree	70 (75%)	484 (75%)
Confident in ability to get PrEP/PEP online (TFA: self-efficacy)	Completely agree/agree	87 (94%)	620 (96%)
Getting PrEP/PEP online can help prevent the spread of HIV (TFA: perceived effectiveness)	Completely agree/agree	84 (90%)	572 (89%)
Getting PrEP/PEP online was acceptable	Completely agree/agree	89 (96%)	620 (96%)
Satisfaction: Assess with the CSQ-8; 8–32 total points.[d] Mean (SD)	8–32 points	31.6 (1.03)	31.4 (1.32)
Quality of the online PrEP/PEP services received	1–4 points	3.91 (0.29)	3.82 (0.42)
Got the online PrEP/PEP services wanted	1–4 points	3.96 (0.33)	3.97 (0.22)
The online PrEP/PEP programme met their needs	1–4 points	3.85 (0.39)	3.85 (0.37)
Would recommend online PrEP/PEP services to a friend in need	1–4 points	3.98 (0.15)	3.98 (0.17)
Satisfied with the amount of help received with online PrEP/PEP	1–4 points	3.97 (0.18)	3.95 (0.30)
Online PrEP/PEP helped addressed HIV prevention concerns	1–4 points	3.97 (0.18)	3.97 (0.20)
General satisfaction with online PrEP/PEP services received	1–4 points	3.95 (0.23)	3.93 (0.31)
Would seek online PrEP/PEP services again, if needed	1–4 points	3.97 (0.23)	3.95 (0.30)
Experiences with the intervention: 5-point Likert scale responses			
Learning about PrEP/PEP on MYDAWA's "My Health Center" page	Extremely positive/positive	78 (84%)	550 (87%)
Consulting remote clinician for PrEP/PEP prescription	Extremely positive/positive	88 (95%)	617 (96%)
Ordering HIVST from MYDAWA[e] (/HIVST users)	Extremely positive/positive	72 (77%)	552 (86%)
Getting HIVST delivered from MYDAWA[e] (/HIVST users)	Extremely positive/positive	73 (79%)	542 (84%)
Uploading HIVST result image to MYDAWA[e] (/HIVST users)	Extremely positive/positive	73 (79%)	492 (77%)
Having RDT administered by a MYDAWA provider[e] (/RDT users)	Extremely positive/positive	6 (100%)	49 (100%)
Getting PrEP/PEP delivered from MYDAWA	Extremely positive/positive	81 (87%)	593 (92%)
Quality of care received: 5-point Likert scale responses			
Call did not drop during remote consultation	–	77 (83%)	585 (91%)
Connection for remote consultation was stable	Strongly agree/agree	83 (89%)	608 (95%)
MYDAWA clinician used language that was easy to understand	Strongly agree/agree	92 (99%)	631 (98%)
MYDAWA clinician acted judgemental	Strongly disagree/disagree	89 (96%)	601 (94%)
MYDAWA clinician encouraged questions	Strongly agree/agree	90 (97%)	626 (97%)
MYDAWA clinician was respectful	Strongly agree/agree	92 (99%)	631 (98%)
MYDAWA clinician listened without interrupting	Strongly agree/agree	93 (100%)	629 (98%)
Participant willing to seek help from same MYDAWA clinician again	Strongly agree/agree	87 (94%)	629 (98%)

(*Continued*)

Table 4. (Continued)

Implementation outcomes	Outcome[b]	Online PrEP clients, *n* = 93	Online PEP clients, *n* = 638
Willingness to pay for online: *n* (%); Prices in USD, median (IQR)[f]			
Telehealth visit	–	76 (76%); $3.57 ($1.43–$5.18)	510 (80%); *$3.57 ($2.14 - $5.00)*
Blood-based HIVST	–	94 (94%); $1.79 ($1.43–$2.14)	581 (91%); $1.79 ($1.43 - $2.14)
PrEP drugs (3-month supply)	–	76 (76%); $8.21 ($4.11–$21.43)	529 (83%); $10.71 ($6.43 - $14.29)
PEP drugs (28-day course)	–	82 (82%); $3.57 ($2.14–$7.14)	507 (80%); $3.57 ($2.14 - $7.14)

Abbreviations: CSQ, Client Satisfaction Questionnaire; HIVST, HIV self-testing; IQR, interquartile range; -, not applicable; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; SD, standard deviation; TFA, Theoretical Framework of Acceptability; USD, United States Dollar.
[a]Questions asked only to subset of survey participants who initiated online PrEP and PEP.
[b]Response options listed here are the Likert-scale outcomes that were grouped together; for more detailed responses, see Table S3.
[c]The Theoretical Framework of Acceptability (TFA) defines acceptability as a multi-faceted construct, made up of several different component constructs.
[d]Client Satisfaction Questionnaire-8 (CSQ-8) is an 8-item standardized tool used to assess client satisfaction with services. The CSQ-8 assesses satisfaction on each of the 8 items with a 4-point scale and provides a general score ranging from 8 to 32 (with higher points equating to greater satisfaction).
[e]Among participants who ordered an HIVST (PrEP clients: 94%, 94/100; PEP clients: 92%, 585/638) or RDT (PrEP clients: 6%, 6/100; PEP clients: 8%, 49/638).
[f]Average USD/KSH 2023 exchange rate = 140 KSH per 1 USD. The median reported willingness to pay is among those who reported they were willing to pay something.

strategies could be evaluated. Integration of digital adherence support strategies—including personalized SMS messages [50], AI assistants [51] or digital rewards (i.e. badges) [52]—could improve follow-up. Allowing clients to schedule deliveries at specific times or pick up products at select locations (e.g. brick-and-mortar pharmacies) could improve privacy and convenience. Facilitating insurance coverage of online PrEP/PEP and distributing vouchers or discount codes [53] could decrease access barriers for clients unable to pay (e.g. adolescent girls and young women). Pharm tech couriers could be replaced with lower cadre healthcare workers—such as HIV testing service counsellors—to lower implementation costs. Additionally, remote clinicians could be leveraged for prescribing other medications to generate additional revenue. Finally, the development of automated reporting tools and integration of Kenya's electronic clinical records for antiretroviral dispensing into the online PrEP/PEP delivery platform could facilitate the distribution of public commodities at private online pharmacies.

5 | CONCLUSIONS

Our findings underscore the potential for online pharmacies to expand PrEP/PEP coverage to eligible clients not accessing clinic-based prevention services. The high PEP uptake, repeat PEP use and low PEP-to-PrEP transition suggest a high unmet demand for periodic HIV prevention services among online pharmacy clients. Our findings emphasize the need for choice in HIV prevention options, the importance of providing PEP as part of comprehensive HIV services and the role online pharmacies could play in the delivery of time-sensitive PEP.

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COMPETING INTERESTS

The authors declare no conflicts of interest.

AUTHORS' CONTRIBUTIONS

KFO, MS, MLM, KN and DW contributed to the study conception and design of this pilot study. MR, SA, EJ and NN led recruitment and implementation operations with support from CK, TK, NT, DW and JM. KFO and MS designed the analysis plan and PN analysed the data. CK, PN, KFO and MS wrote the first draft of this manuscript. All authors edited the draft, provided insights and approved the final manuscript for publication.

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DATA AVAILABILITY STATEMENT

The data from this pilot study are available on request from the corresponding author and not publicly available due to privacy and ethical restrictions.

REFERENCES

1. Holst C, Sukums F, Radovanovic D, Ngowi B, Noll J, Winkler AS. Sub-Saharan Africa—the new breeding ground for global digital health. Lancet Digit Health. 2020;2(4):e160–e2.
2. GSMA Intelligence. The mobile economy sub-Saharan Africa 2020 [Internet]. London: 2020 [cited 2024 May 28]. Available from: https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-economy/wp/content/uploads/2020/09/GSMA_MobileEconomy2020_SSA_Eng.pdf
3. GSMA Intelligence. The mobile economy sub-Saharan Africa 2023 [Internet]. London: 2023 [cited 2024 May 28]. Available from: https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=79790644&file=161023-Mobile-Economy-Sub-Saharan-Africa-2023.pdf.
4. International Trade Administration. The rise of eCommerce in Africa [Internet]. Washington, DC: 2024 [cited 2024 May 28]. Available from: https://www.trade.gov/rise-ecommerce-africa.
5. Salient Advisory. Advancing access to essential health products via online pharmacies in Africa: Regulatory Landscaping Report [Internet]. Melbourne: 2023 [cited 2024 May 28]. Available from: https://www.salientadvisory.com/report-media/online-pharmacy-in-africa-landscape-of-regulations-and-opportunities-for-action/.
6. Miller R, Wafula F, Onoka CA, Saligram P, Musiega A, Ogira D, et al. When technology precedes regulation: the challenges and opportunities of e-pharmacy in low-income and middle-income countries. BMJ Glob Health. 2021;6(5):e005405.
7. Gopaldas R. The growing pains of e-commerce business in Africa [Internet]. Singapore: 2023 [cited 2024 Sep 10]. Available from: https://www.ntu.edu.sg/cas/news-events/news/details/the-growing-pains-of-e-commerce-business-in-africa.
8. Patel RC, Stanford-Moore G, Odoyo J, Pyra M, Wakhungu I, Anand K, et al. "Since both of us are using antiretrovirals, we have been supportive to each other": facilitators and barriers of pre-exposure prophylaxis use in heterosexual HIV serodiscordant couples in Kisumu, Kenya. J Int AIDS Soc. 2016;19(1):21134.
9. Mack N, Odhiambo J, Wong CM, Agot K. Barriers and facilitators to pre-exposure prophylaxis (PrEP) eligibility screening and ongoing HIV testing among target populations in Bondo and Rarieda, Kenya: results of a consultation with community stakeholders. BMC Health Serv Res. 2014;14(1):1–12.
10. Nakambale H, Roche SD, Mogere P, Omollo V, Kuo AP, Stergachis S, et al. Barriers to and strategies for early implementation of pharmacy-delivered PrEP services in Kenya: an analysis of routine data. Front Reprod Health. 2023;5:1023568
11. Ongolly FK, Dolla A, Ngure K, Irungu EM, Odoyo J, Wamoni E, et al. "I just decided to stop:" understanding PrEP discontinuation among individuals initiating PrEP in HIV care centers in Kenya. J Acquir Immune Defic Syndr. 2021;87(1):e150.
12. Ortblad KF, Baeten JM, Cherutich P, Wamicwe JN, Wasserheit JN. The arc of HIV epidemics in sub-Saharan Africa: new challenges with concentrating epidemics in the era of 90-90-90. Curr Opin HIV AIDS. 2019;14(5):354–65.
13. Khoza M, Velloza J, Poovan N, Mills L, Chauke H, Gumede S. Feasibility and acceptability of remote PrEP provision among adolescent girls and young women in South Africa. 23rd International AIDS Conference Montreal, Canada and Virtually; 2022.
14. Madiang D. Viability of sustaining access to and uptake of HIV and sexual and reproductive health services for adolescent girls and young women through virtual interventions in Kenya: the PATH experience [Webinar]. [Accessed 2024 Apr 24.] Available from: https://www.who.int/news-room/events/detail/2021/06/29/default-calendar/virtual-interventions-global-innovations-and-approaches-across-the-hiv-cascade-for-key-populations
15. Irungu EM, Baeten JM. PrEP rollout in Africa: status and opportunity. Nat Med. 2020;26(5):655–64.
16. National Syndemic Disease Control Council (NSDCC). HIV estimates, 2022 [Internet]. Nairobi: 2022 [cited 2024 May 28]. Available from: https://nsdcc.go.ke/wp-content/uploads/2023/04/County-HIV-Posters_2022-Updated.pdf
17. African Development Bank. The middle of the pyramid: dynamics of the middle class in Africa [Internet]. Abidjan: 2011 [cited 2023 Jan 13]. Available from: https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/The%20Middle%20of%20the%20Pyramid_The%20Middle%20of%20the%20Pyramid.pdf.
18. World Bank Group. Kenya economic update: securing future growth, policies to support Kenya's digital transformation [Internet]. Nairobi: 2019 [cited 2023 Jan 13]. Available from: https://documents1.worldbank.org/curated/en/968481572468094731/pdf/Kenya-Economic-Update-Securing-Future-Growth-Policies-to-Support-Kenya-s-Digital-Transformation.pdf.
19. National AIDS & STI Control Program. Framework for the implementation of pre-exposure prophylaxis of HIV in Kenya [Internet]. Nairobi: 2022 [cited 2024 Sep 10]. Available from: https://www.prepwatch.org/wp-content/uploads/2023/04/Kenya-PrEP-Framework.pdf
20. National AIDS & STI Control Program. Private sector engagement framework for delivery of HIV services in Kenya [Internet]. Nairobi: 2023. Available from: https://assets-global.website-files.com/63ff2c1bed17e622bce9c2ea/651a8eba2d5bb9fc0740c66a_Private%20Sector%20Engagement%20%20Framework%20-Kenya.pdf
21. Ortblad KF, Mogere P, Omollo V, Kuo AP, Asewe M, Gakuo S, et al. Stand-alone model for delivery of oral HIV pre-exposure prophylaxis in Kenya: a single-arm, prospective pilot evaluation. J Int AIDS Soc. 2023;26(6):e26131.
22. National AIDS & STI Control Program MoH, Kenya. Kenya HIV prevention and treatment guidelines [Internet]. Nairobi: 2022 [cited 2024 May 7]. Available from: https://nphl.go.ke/wp-content/uploads/2022/11/Kenya-ARV-Guidelines-2022-2.pdf
23. Siika AM, Nyandiko WM, Mwangi A, Waxman M, Sidle JE, Kimaiyo SN, et al. The structure and outcomes of a HIV postexposure prophylaxis program in a high HIV prevalence setup in western Kenya. J Acquir Immune Defic Syndr. 2009;51(1):47–53.
24. Izulla P, McKinnon LR, Munyao J, Karanja S, Koima W, Parmeres J, et al. HIV postexposure prophylaxis in an urban population of female sex workers in Nairobi, Kenya. J Acquir Immune Defic Syndr. 2013;62(2):220–5.
25. Ayieko J, Petersen ML, Kabami J, Mwangwa F, Opel F, Nyabuti M, et al. Uptake and outcomes of a novel community-based HIV post-exposure prophylaxis (PEP) programme in rural Kenya and Uganda. J Int AIDS Soc. 2021;24(6):e25670.
26. Ayieko J, Petersen ML, Kamya MR, Havlir DV. PEP for HIV prevention: are we missing opportunities to reduce new infections? Afr J Reprod Gynaecol Endoscopy. 2022;25(5):e25942.
27. MYDAWA. [Internet]. Nairobi: 2024 [cited 2024 May 28]. Available from: https://mydawa.com/.
28. Kiptinness C, Naik P, Thuo N, Malen RC, Dettinger JC, Pintye J, et al. Online HIV prophylaxis delivery: protocol for the ePrEP Kenya pilot study. Front Pub Health. 2023;11:453.
29. MYDAWA. MYDAWA business data. 2024.
30. Ortblad KF, Mogere P, Roche S, Kamolloh K, Odoyo J, Irungu E, et al. Design of a care pathway for pharmacy-based PrEP delivery in Kenya: results from a collaborative stakeholder consultation. BMC Health Serv Res. 2020;20:1–9.
31. National AIDS and STI Control Programme. PrEP for the prevention of HIV: a toolkit for providers [Internet]. Nairobi: 2017 [cited 2024 May 28]. Available from: https://prep.nascop.org/wp-content/uploads/sites/2/2019/03/PrEP-for-the-prevention-of-HIV_-A-Toolkit-for-Providers.pdf.
32. ClickMedix. [Internet]. 2024 [cited 2024 May 28]. Available from: https://clickmedix.com/.
33. Audere. [Internet]. 2024 [cited 2024 May 28]. Available from: https://www.auderenow.org/.
34. National AIDS & STI Control Program. Guidelines on use of antiretroviral drugs for treating and preventing HIV infection in Kenya [Internet]. Nairobi: 2017 [cited 2024 May 7]. Available from: https://cquin.icap.columbia.edu/wp-content/uploads/2017/04/ICAP_CQUIN_Kenya-ARV-Guidelines-2018-Final_20thAug2018.pdf
35. Reed JB, Shrestha P, Were D, Chakare T, Mutegi J, Wakhutu B, et al. HIV PrEP is more than ART-lite: longitudinal study of real-world PrEP services data identifies missing measures meaningful to HIV prevention programming. J Int AIDS Soc. 2021;24(10):e25827.
36. Sekhon M, Cartwright M, Francis JJ. Acceptability of healthcare interventions: an overview of reviews and development of a theoretical framework. BMC Health Serv Res. 2017;17(1):88.

37. Larsen DL, Attkisson CC, Hargreaves WA, Nguyen TD. Assessment of client/patient satisfaction: development of a general scale. Eval Program Plann. 1979;2(3):197–207.
38. Ortblad KF, Sekhon M, Wang L, Roth S, van der Straten A, Simoni JM, et al. Acceptability assessment in HIV prevention and treatment intervention and service delivery research: a systematic review and qualitative analysis. AIDS Behav. 2023;27(2):600–17.
39. R Core Team. R: a language and environment for statistical computing. Version 6.1 [software]. 2017 [cited 2024 May 29]. Available from: https://www.r-project.org/
40. Masyuko S, Mukui I, Njathi O, Kimani M, Oluoch P, Wamicwe J, et al. Pre-exposure prophylaxis rollout in a national public sector program: the Kenyan case study. Sex Health. 2018;15(6):578–86.
41. Musau A, Were D, Mutegi J, Ongwen P, Wakhutu B, Reed J. Surveillance data from public and private primary care facilities uncover implementation successes and gaps during pre-exposure prophylaxis (PrEP) scale-up: results from the Jilinde project in Kenya. J Int AIDS Soc. 2021;24(S1):28–9.
42. Mugwanya KK, Palayew A, Schaafsma T, Irungu EM, Bukusi E, Mugo N, et al. Patterns of PrEP continuation and coverage in the first year of use: a latent class analysis of a programmatic PrEP trial in Kenya. J Int AIDS Soc. 2023;26(7):e26137.
43. Mugwanya KK, Kinuthia J. Integrating pre-exposure prophylaxis delivery in public health family planning clinics: lessons learned from a programmatic implementation project in Kenya. Front Reprod Health. 2021;3:683415.
44. Kinuthia J, Pintye J, Abuna F, Mugwanya KK, Lagat H, Onyango D, et al. Pre-exposure prophylaxis uptake and early continuation among pregnant and postpartum women within maternal and child health clinics in Kenya: results from an implementation programme. Lancet HIV. 2020;7(1):e38–e48.
45. Irungu EM, Mugwanya KK, Mugo NR, Bukusi EA, Donnell D, Odoyo J, et al. Integration of pre-exposure prophylaxis services into public HIV care clinics in Kenya: a pragmatic stepped-wedge randomised trial. Lancet Glob Health. 2021;9(12):e1730–e9.
46. Were D, Musau A, Mugambi M, Plotkin M, Kabue M, Manguro G, et al. An implementation model for scaling up oral pre-exposure prophylaxis in Kenya: Jilinde project. Gates Open Res. 2021;5:113.
47. Roche S, Omollo MP, Asewe M, Gakuo S, Banerjee P, Harkey K, et al. Pharmacy-based PrEP delivery in Kenya: findings from a pilot study extension. Themed discussion at CROI 2023: 30th Conference on Retroviruses and Opportunistic Infections, Seattle, USA, February 19–22, 2023. Abstract 978.
48. Ong'wen P, Roche SD, Omollo V, Kareithi T, Juma L, Kiptinness C, et al. Uptake of HIV post-exposure prophylaxis (PEP) in private retail pharmacies in Kenya: early findings from the Pharm PrEP study. Oral presentation at AIDS 2024: 25th International AIDS Conference July 22–26, 2024. Abstract OAE1202.
49. Kakande ER, Ayieko J, Sunday H, Biira E, Nyabuti M, Agengo G, et al. A community-based dynamic choice model for HIV prevention improves PrEP and PEP coverage in rural Uganda and Kenya: a cluster randomized trial. AIDS. 2023;26(12):e26195.
50. Watoyi S, Udren J, Akim E, Abuna F, Nyabiage J, Unger JA, et al. Engagement with an interactive adherence text messaging platform among women initiating PrEP during pregnancy in Kenya: The Mobile WACh-PrEP Study. Oral presentation at Continuum 2024, Puerto Rico, June 9–11, 2024.
51. Kamitani E, Mizuno Y, Khalil GM, Viguerie A, DeLuca JB, Mishra N. Improving HIV pre-exposure prophylaxis uptake with artificial intelligence and automation: a systematic review. AIDS. 2024;38(10);1560-69.
52. Ahonkhai AA, Pierce LJ, Mbugua S, Wasula B, Owino S, Nmoh A, et al. PEERNaija: a gamified mHealth behavioral intervention to improve adherence to antiretroviral treatment among adolescents and young adults in Nigeria. Front Reprod Health. 2021;3:656507.
53. Celum CL, Gill K, Morton JF, Stein G, Myers L, Thomas KK, et al. Incentives conditioned on tenofovir levels to support PrEP adherence among young South African women: a randomized trial. AIDS. 2020;23(11):e25636.

SUPPORTING INFORMATION

Additional information may be found under the Supporting Information tab for this article:

Figure S1. Care pathway for delivery of online PrEP/PEP services

Figure S2. Example of social media advertisement for MYDAWA's online PrEP/PEP services

Figure S3. Prescribing checklist for online PrEP/PEP service delivery

Figure S4. How online PrEP/PEP clients learned of online PrEP/PEP services

Table S1. Characteristics associated with PrEP continuation among online PrEP clients—bivariable regression outputs

Table S2. Characteristics associated with PEP-to-PrEP transition and repeat PEP use among online PEP clients—bivariable regression outputs

Table S3. Details on clients' perceived acceptability of, experiences with and quality of online PrEP/PEP services

Table S4. Differences in client characteristics between those who did and did not complete the behavioural surveys

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SHORT REPORT

Uptake and patterns of PEP use within the context of a dynamic choice HIV prevention model in rural Uganda and Kenya: SEARCH Study

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Abstract

Introduction: Post-exposure prophylaxis (PEP) remains underutilized despite being the only prevention option currently available that covers risk after an exposure. We sought to evaluate uptake and patterns of use of PEP among men and women in rural Uganda and Kenya.

Methods: We analysed PEP uptake from three randomized trials enrolling persons aged ≥15 years with HIV risk from antenatal clinics, outpatient departments and community settings from April through August 2021 (NCT04810650). In each trial, participants were randomized to a person-centred, dynamic choice HIV prevention (DCP) model or standard-of-care (SoC) arm. DCP offered choice of biomedical product (oral pre-exposure prophylaxis [PrEP] or PEP) with an option to switch over time; service location (clinic vs. out-of-clinic); testing option (rapid blood-based test or oral HIV self-test). The SoC offered HIV prevention services as per in-country guidelines. In both arms, PEP comprised a 28-day oral Tenofovir/Lamivudine/Dolutegravir course with HIV testing at start and end of the 28-day period. We described patterns of and predictors of self-reported PEP use over the 12 months of follow-up.

Results: A total of 1232 participants were enrolled, balanced by arm and country. Of the 1147 (93%) who completed at least one survey on self-reported use of biomedical prevention, the median follow-up time was 12 months [IQR: 11, 12]. Overall, a total of 104 courses of PEP were dispensed to 59 participants. PEP use was significantly higher among persons enrolled in the DCP arm (relative risk [RR] = 3.30; 95% CI: 1.58–6.91), from Uganda (RR = 3.17; 95% CI: 1.53–6.59), reporting alcohol use (RR = 2.20; 95% CI: 1.30–3.72) and men (RR = 2.08; 95% CI: 1.11–3.91). Of the 59 PEP users, 14 (24%) transitioned to PrEP and 28(47%) used PEP on more than one occasion. Multiple uses of PEP were more common among persons from Uganda versus Kenya (RR = 4.43; 95% CI: 1.10–17.80) and persons enrolled from the community (RR = 4.45; 95% CI: 1.89–10.45) versus clinic. There were no seroconversions reported among PEP users. No serious adverse events were reported.

Conclusions: PEP reaches groups such as men and those who use alcohol who are more likely to benefit from this short-term prevention modality than PrEP. There is a need to make PEP accessible within a context of person-centred delivery to optimize its benefits.

Keywords: biomedical prevention; choice; HIV prevention; post-exposure prophylaxis; person-centred; prevention coverage

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1 | INTRODUCTION

Marked progress has been made in the response against HIV globally [1]. Antiretroviral medications have been a large part of this success both for treatment and prevention [2]. Over the last decade, many countries have rolled out pre-exposure prophylaxis (PrEP) as part of efforts to reduce incident cases following WHO recommendations [3].

Despite these efforts, 1.3 million (1–1.7m) new HIV acquisitions were reported in 2023 with 630,000 (500,000–820,000) people dying from AIDS-associated illnesses in the same year [4]. A vast majority of these HIV acquisitions continue to occur in sub-Saharan Africa with adolescent girls and young women being disproportionately affected (UNAIDS 2024). This gap highlights the need to expand and optimize the use of prevention options to impact HIV incidence.

PrEP access and use is expanding; however, it may not reach or appeal to all persons at risk for acquiring HIV. New injectable long-acting HIV prevention agents including

cabotegravir and lenacapavir provide highly effective, new options for persons at risk for HIV [5–7]. However, PrEP still requires acknowledgement of HIV risk and willingness to take regimens that start before an exposure. Because these requirements can pose barriers to many individuals, there is a need for additional prevention options [8].

Post-exposure prophylaxis (PEP) is highly efficacious and recommended in the WHO guidelines [9, 10]; yet, PEP remains underutilized despite being the only prevention option currently available that covers risk after exposure. Past restrictive policies may have limited the use of PEP to those with occupational exposure or sexual assault (including rape) [10] with little use among other high-risk sexual exposures that would be responsible for a substantial burden of new HIV acquisitions. Our previous work conducted in rural Uganda and Kenya showed that it was feasible to deliver PEP for sexual exposures and highly acceptable in these settings [11]. PEP was well tolerated, and we observed high PEP completion rates with no seroconversion reported among participants in the study.

In this analysis, we move further to evaluate uptake and patterns of PEP use within the context of a dynamic choice HIV prevention (DCP) model as well as the current standard-of-care (SoC). Our analysis focuses on PEP use among men and women recruited from diverse settings in rural Uganda and Kenya.

2 | METHODS

We conducted a secondary analysis of three randomized trials that enrolled men and women aged ≥15 years and reporting HIV risk from antenatal clinic, outpatient department and community settings within the SEARCH-SAPPHIRE trial in rural Southwestern Uganda and Western Kenya from April to August 2021 (NCT:04810650) [12–14]. As described elsewhere [12], the DCP arm comprised choice of a biomedical product (oral PrEP or PEP with an option to switch over time), service location (clinic vs. out-of-clinic) and testing option (provider-administered rapid blood-based test or oral HIV self-test). Participants randomized to SoC were referred to clinics for HIV prevention services as per in-country guidelines. PEP regimen comprised oral Tenofovir/Lamivudine/Dolutegravir administered over a 28-day period in both countries and both study arms. Blood-based rapid antibody testing was administered prior to PEP start and at the end of the 28-day period in line with country guidelines.

Using structured surveys administered every 6 months after enrolment, we asked about the use of oral PrEP or PEP. Specifically, for each month in the previous 6 months, we asked the participants if they had swallowed PrEP pills and if they had swallowed PEP pills.

We calculated biomedical HIV prevention coverage, defined as the proportion of follow-up time covered by a biomedical prevention option. Coverage was calculated among all participants (i.e. irrespective of PEP eligibility), and follow-up time was censored during months without data on biomedical HIV prevention use. Additionally, among participants with any time covered by a biomedical HIV prevention product, we calculated the proportion attributable to PEP. We emphasize that neither measure captured the proportion of post-exposure time during which a person eligible for PEP actually took PEP.

We described patterns of PEP use over 12 follow-up months. To evaluate predictors of PEP use, we used targeted minimum loss-based estimation (TMLE) [15], a doubly robust approach that generates estimates of risk ratios (RR), instead of odds ratios, for binary outcomes. Among PEP users, we generated an alluvial graph to summarize biomedical prevention use (PEP, PrEP, no product or no data) in 3-month periods. To understand predictors of multiple uses of PEP, we conducted additional predictor analyses with TMLE. We accounted for clustering by community.

2.1 | Ethical approval

Ethical approval to conduct the trials was received from the University of California, San Francisco Committee on Human Research, Makerere University School of Medicine Research and Ethics Committee, and the Scientific Ethical Review Unit of the Kenya Medical Research Institute. All participants involved provided written consent to participate in the study.

3 | RESULTS

The studies enrolled a total of 1232 participants, balanced by country and randomization arm (Table 1). Women comprised nearly three-quarters of all participants, who were recruited from antenatal clinics (32%), the outpatient department (33%) and the community (35%). The median age of participants was 26 [IQR: 21, 35] years and 41% of all participants were aged 15–24 years. A total of 281 (23%) reported alcohol use.

Of the 1232 participants, 1147 (93%) completed at least one survey on self-reported use of biomedical prevention. Among those surveyed, 990 (86%) completed both surveys; the median follow-up time was 12 months [IQR: 11, 12], and biomedical HIV prevention coverage was 32.3% on average (median = 9.3%).

Overall, a total of 104 courses of PEP were dispensed, accounting for 7.2% of covered time. These courses were dispensed to 59 participants (Table 1). Of the 59 courses of PEP dispensed, 45 (76%) were in the DCP arm and the remaining 14 (24%) in the SoC arm. DCP participants were significantly more likely to use PEP (RR: 3.30 [95% CI: 1.58–6.91]; $p<0.01$). Ugandan participants had higher uptake of PEP than Kenyan participants (RR: 3.17 [1.53–6.59]; $p<0.01$). Persons reporting any alcohol used were significantly more likely to use PEP (RR: 2.20 [1.30–3.72]; $p<0.01$), but there were no differences between younger (15–24 years) and older (25+ years) persons (RR: 0.98 [0.61–1.57]; $p = 0.92$). Men were more than twice as likely to use PEP as compared to women (RR: 2.08 [1.11–3.91]; $p = 0.02$). As compared to recruitment from clinical sites, participants recruited from the community tended to be more likely to use PEP (RR: 1.85 [0.77–4.43]; $p = 0.17$).

Among PEP users, Figure 1 provides a visual summary of the trajectories of biomedical prevention use in 3-month windows over follow-up. This alluvial plot demonstrates that

Table 1. Characteristics of participants at enrolment, among those who used PEP and among those who used PEP multiple times

	Overall *N* = 1232	Used PEP *N* = 59	Used PEP multiple times *N* = 28
Arm			
Dynamic choice HIV prevention	612 (50%)	45 (76%)	24 (86%)
Standard-of-care	620 (50%)	14 (24%)	4 (14%)
Country			
Kenyan	612 (50%)	15 (25%)	2 (7%)
Ugandan	620 (50%)	44 (75%)	26 (93%)
Sex			
Women	888 (72%)	33 (56%)	14 (50%)
Men	344 (28%)	26 (44%)	14 (50%)
Recruitment setting			
Antenatal clinic	400 (32%)	6 (10%)	0 (0%)
Outpatient department	403 (33%)	23 (39%)	5 (18%)
Community	429 (35%)	30 (51%)	23 (82%)
Age, median [Q1, Q3]	26 [21, 35]	27 [22, 38]	31 [22, 41]
Age 15–24 years	506 (41%)	24 (41%)	8 (29%)
Age 25 years+	726 (59%)	35 (59%)	20 (71%)
Marital status			
Single (never married)	310 (25%)	18 (31%)	9 (32%)
Married/cohabitating	872 (71%)	39 (66%)	19 (68%)
Divorced/separated/widowed	48 (4%)	2 (3%)	0 (0%)
Occupation			
Farmer	448 (36%)	27 (47%)	15 (56%)
Student	169 (14%)	8 (14%)	3 (11%)
Shopkeeper/market vendor	113 (9%)	6 (10%)	1 (4%)
Manual labour/construction	59 (5%)	2 (3%)	2 (7%)
Transportation	29 (2%)	4 (7%)	0 (0%)
Bar/hotel/restaurant	35 (3%)	0 (0%)	0 (0%)
Fishing/fishmonger	16 (1%)	0 (0%)	0 (0%)
Alcohol use	281 (23%)	22 (37%)	11 (39%)
Pregnant (women only)	178 (20%)	5 (16%)	0 (0%)
Circumcised (men only)	202 (59%)	14 (56%)	7 (50%)

Note: Unless noted, metrics are in *N* (column %).
Abbreviations: PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis.

choice and use of biomedical prevention are highly dynamic. Over the 12 months of follow-up, 10 PEP users transitioned to oral PrEP immediately after finishing a PEP course, while a total of 14 participants transitioned to PrEP sometime after finishing a PEP course. Furthermore, 12 PEP users were previously on PrEP.

Of the 59 PEP users, 28 participants used PEP on more than one occasion (Table 1). One was more likely to use PEP on more than one occasion if they were from Uganda versus Kenya (RR: 4.43 [1.10–17.80]; $p = 0.04$) or recruited from the community versus clinical sites (RR: 4.45 [1.89–10.45]; $p<0.01$). Use of multiple PEP courses were not significantly different by trial arm (RR: 1.87 [0.76–4.59]; $p = 0.17$), alcohol use (RR: 1.09 [0.66–1.81]; $p = 0.74$), age (RR: 0.58 [0.26–1.29]; $p = 0.18$) or sex (RR: 1.27 [0.71–2.27]; $p = 0.41$).

There were no seroconversions reported among PEP users. No serious adverse events were reported.

4 | DISCUSSION

PEP remains a crucial HIV prevention option that merits increasing attention to realize its potential to reduce HIV incidence and maintain clients in prevention programmes. A portion of our study population only chose and used PEP over the study period despite the availability of other options. These are individuals who would likely have lacked biomedical prevention had PEP not been available, and instead received prevention for high-risk periods. This finding confirms patterns seen in other studies [16] and further underscores the importance of provision of particular client-preferred options

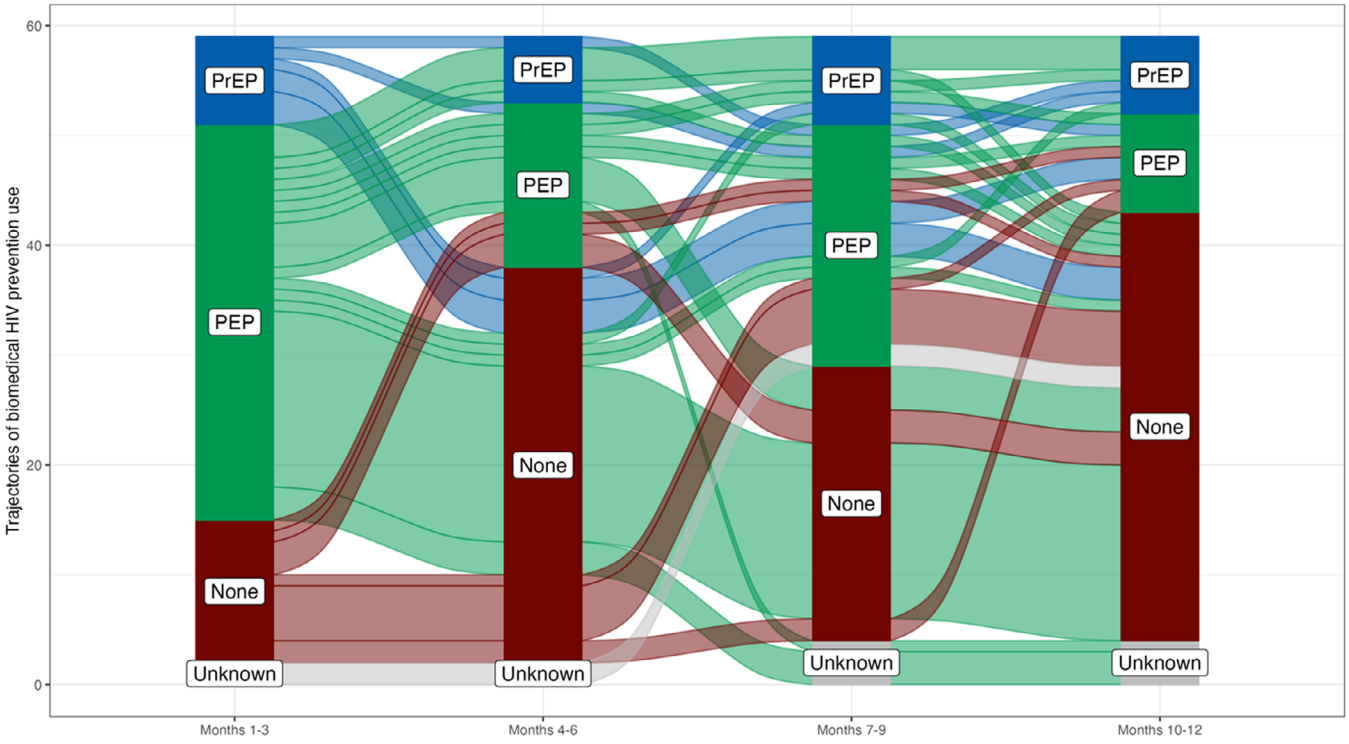

Figure 1. Alluvial plot of the trajectories of biomedical HIV prevention use among participants who used PEP. Abbreviations: PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis.

regardless of the volume of uptake if the effectiveness of HIV prevention options is to be optimized.

Beyond this benefit, it is important to consider that PEP is a unique avenue for the expansion of HIV prevention coverage time when persons are at risk of HIV acquisition. Globally, PEP use has been low, this has largely been driven by low levels of awareness of clients and providers, inaccessibility and stigma [17, 18]. Sensitization, provider training and increased access of PEP, therefore, become crucial elements in expanding PEP use. Other studies have shown low use of this effective option among groups at elevated risk such as men-who-have-sex-with-men due to other barriers such as the 28-day oral pill burden [19]; long-acting PrEP agents could overcome this limitation.

PEP remains an important entry point to other HIV prevention options. We observed transitions from PEP to other options based on risk assessment and client preference over time. PEP should, therefore, not be viewed as stand-alone but as part of a comprehensive HIV prevention package. The WHO HIV prevention guidelines envision these transitions for individuals selecting options over time [10]. However, periods of transition present the risk of disengagement. We posit that person-centred provider–guided delivery of PEP among other HIV prevention options, would keep persons engaged in the care system as shown by the higher uptake and engagement in our DCP arms compared to the SOC. Our person-centred provider-guided DCP model was designed to ensure client–provider engagement even in periods when clients felt that they were not at risk or preferred not to select an option [12–14]. This approach facilitated a safe start and stoppage of prevention options over time while maintaining open communication to allow for future selection of other options. HIV prevention models should, therefore, be deliberate in optimizing engagement through approaches that are person-centred.

Certain groups in our studies were more likely to utilize PEP. Men were more likely to use PEP than women. It is possible that this is due to women having higher risk aversion than men in social risk-taking [20, 21], or that men are more hesitant to commit to a daily PrEP pill, or that men engaged in unplanned sex more than women. We further noted that those who took alcohol were more likely to use PEP consistent with prior reports of high-risk behaviour during alcohol use [22, 23]. This finding delineating certain groups as being at elevated-risk helps to highlight areas that can be intervened upon. Innovative programmes have been successfully designed to modify behaviour, influence choices and improve the uptake of health initiatives [24–26]. Behavioural initiatives have also been used to reduce alcohol use and impact health outcomes [27]. All these approaches should be integrated in designing and delivering effective HIV prevention approaches. Settings of delivery also determine uptake as shown by higher uptake in the community supporting the WHO recommendation on the expansion of delivery of PEP to community settings [10].

We observed a number of PEP repeat users in our study. Within the context of choice and patient-centred provider-guidance, repeated use of PEP is not a "failure." Previous studies among groups at elevated risk have shown repeated use as well as intention for repeat use [18, 28] similar to

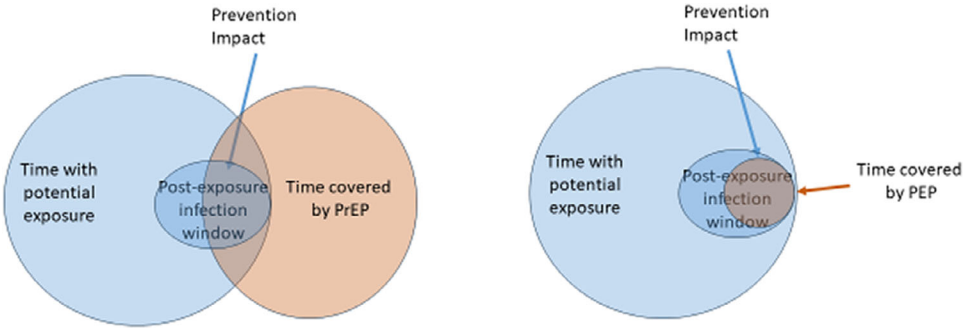

Figure 2. Venn diagrams on post-exposure prophylaxis (PEP) and pre-exposure prophylaxis (PrEP) covered time with potential exposure versus potential prevention impact.

what was observed in our study. Indeed, repeat use could be seen as an extremely effective approach for aligning coverage with true risk. Conceptually, coverage of "true" risk and potential impact of PEP is markedly different from coverage with pre-exposure options. PEP covered time is highly focused on post-exposure window when an HIV acquisition can occur. The Venn diagrams included here (Figure 2) help conceptualize this idea. If time with potential exposure is the circle in blue, it is preferred that prevention options overlay this area to the greatest extent possible to have the desired effect. Whereas for PrEP one would take medication continuously for prevention, the medication would cover even periods without risk. PEP, on the other hand, follows a high-risk exposure and for this brief period of time is likely to have high prevention coverage and impact for the known risk. This would further suggest that when comparing with pre-exposure options, the magnitude of the time covered may not be as important as the events targeted by PEP. Therefore, the magnitude of coverage time is not a measure of the impact or success of PEP use. As metrics of measuring HIV prevention continue to be refined, PEP should be understood as distinct and unique from other prevention options used prior to risk exposure.

The study had limitations. First, our assessment of PEP use relied on self-report, which may be subject to recall bias. However, our structured surveys have been previously validated using objective biomarkers in the same study settings [13, 14]. Second, our survey evaluated any PEP use in each month over a 6-month period, limiting the granularity of the data. Additionally, we did not collect data on PEP completion nor did we report exposure or reason for PEP choice. However, these data limitations should not induce bias in our analyses to assess predictors of PEP use or patterns over time. Qualitative research would help explore mechanisms of choice of PEP over PrEP given risk exposure. Finally, our trials did not compare PEP use in the context of on-demand PrEP for men, dapivirine ring for women or injectable PrEP which are options that may appeal to some individuals.

5 | CONCLUSIONS

PEP reaches groups who are more likely to benefit from this short-term prevention modality than PrEP, such as men and those who use alcohol, and contributes to averting new HIV acquisitions. PEP remains an important prevention option to be assessed even as PrEP options continue to expand. There is an urgent need to train providers on choice models and make PEP accessible within a context of person-centred delivery to optimize its benefits.

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COMPETING INTERESTS

The authors have no conflicts of interest to disclose.

AUTHORS' CONTRIBUTIONS

All authors participated in the conduct of the study. JA, LBB, CA, HS, EK, JK, GC, MRK and DVH designed and participated in the implementation of the study. JA, CK, DVH, MLP and LBB evaluated data integrity. JA and DVH drafted the first version of the manuscript which was reviewed and approved by all authors.

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DISCLAIMER

The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

REFERENCES

1. Joint United Nations Programme on HIV/AIDS. Understanding Fast-Track: accelerating action to end the AIDS epidemic by 2030. 2015. (Accessed September 16, 2024.) unaids.org/sites/default/files/media_asset/201506_JC2743_Understanding_FastTrack_en.pdf.
2. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Prevention of HIV-1 infection with early antiretroviral therapy. N Engl J Med. 2011;365(6):493–505.
3. https://www.who.int/teams/global-hiv-hepatitis-and-stis-programmes/hiv/prevention/pre-exposure-prophylaxis (Accessed 16 Sept 2024).
4. UNAIDS. Global HIV & AIDS Statistics-Fact Sheet. 2024. https://www.unaids.org/en/resources/fact-sheet (Accessed 16 Sept 2024).
5. Landovitz RJ, Hanscom BS, Clement ME, Tran HV, Kallas EG, Magnus M, et al. Efficacy and safety of long-acting cabotegravir compared with daily oral tenofovir disoproxil fumarate plus emtricitabine to prevent HIV infection in cisgender men and transgender women who have sex with men 1 year after study unblinding: a secondary analysis of the phase 2b and 3 HPTN 083 randomised controlled trial. Lancet HIV. 2023;10(12):e767–78.
6. Delany-Moretlwe S, Hughes JP, Bock P, Ouma SG, Hunidzarira P, Kalonji D, et al. Cabotegravir for the prevention of HIV-1 in women: results from HPTN 084, a phase 3, randomised clinical trial. Lancet. 2022;399(10337):1779–89.
7. Bekker LG, Das M, Abdool Karim Q, Ahmed K, Batting J, Brumskine W, et al. Twice-yearly lenacapavir or daily F/TAF for HIV prevention in cisgender women. N Engl J Med. 2024;391(13):1179–92.
8. Ahmed N, Pike C, Bekker LG. Scaling up pre-exposure prophylaxis in sub-Saharan Africa. Curr Opin Infect Dis. 2019;32(1):24–30.
9. Ford N, Mayer KH, Barlow L, Bagyinszky F, Calmy A, Chakroun M, et al. World Health Organization guidelines on postexposure prophylaxis for HIV: recommendations for a public health approach. Clin Infect Dis. 2015;60 suppl_3:S161–4.
10. Guidelines for HIV post exposure prophylaxis. Geneva: World Health Organisation; 2024.
11. Ayieko J, Petersen ML, Kabami J, Mwangwa F, Opel F, Nyabuti M, et al. Uptake and outcomes of a novel community-based HIV post-exposure prophylaxis (PEP) programme in rural Kenya and Uganda. J Int AIDS Soc. 2021;24(6):e25670.
12. Kabami J, Kakande E, Chamie G, Balzer LB, Petersen ML, Camlin CS, et al. Uptake of a patient-centred dynamic choice model for HIV prevention in rural Kenya and Uganda: SEARCH SAPPHIRE study. J Int AIDS Soc. 2023;26(Suppl 1):e26121.
13. Kakande ER, Ayieko J, Sunday H, Biira E, Nyabuti M, Agengo G, et al. A community-based dynamic choice model for HIV prevention improves PrEP and PEP coverage in rural Uganda and Kenya: a cluster randomized trial. J Int AIDS Soc. 2023;26(12):e26195.
14. Koss CA, Ayieko J, Kabami J, Balzer LB, Kakande E, Sunday H, et al. Dynamic choice HIV prevention intervention at outpatient departments in rural Kenya and Uganda. AIDS. 2024;38(3):339–49.
15. Laan M, Rose S. Targeted learning: causal inference for observational and experimental data. 2011. https://doi.org/10.1007/978-1-4419-9782-1.
16. O'Byrne P, Orser L, MacPherson P, Valela N. The patient rationale for seeking HIV PEP: qualitative results from a nurse-led program. Public Health Nurs. 2018;35(5):386–95.
17. Jin J, Sun R, Mu T, Jiang T, Dai L, Lu H, et al. Awareness and use of post-exposure prophylaxis for HIV prevention among men who have sex with men: a systematic review and meta-analysis. Front Med (Lausanne). 2022;8:783626.
18. Restar AJ, Tocco JU, Mantell JE, Lafort Y, Gichangi P, Masvawure TB, et al. Perspectives on HIV pre- and post-exposure prophylaxes (PrEP and PEP) among female and male sex workers in Mombasa, Kenya: implications for integrating biomedical prevention into sexual health services. AIDS Educ Prev. 2017;29(2):141–53.
19. O'Byrne P, Orser L, Jacob JD. The "side effects" of HIV PEP use: forced reflections and introspections on sexual decision-making. Res Theory Nurs Pract. 2019;33(2):196–208.
20. Reniers RLEP, Murphy L, Lin A, Bartolomé SP, Wood SJ. Risk perception and risk-taking behaviour during adolescence: the influence of personality and gender. PLoS One. 2016;11(4):e0153842.
21. Friedl A, Pondorfer A, Schmidt U. Gender differences in social risk taking. J Econ Psychol. 2019;77:1–17.
22. Kiene SM, Ediau M, Schmarje KA, Kintu M, Tumwesigye NM. Exploring the potential of savings-led economic strengthening HIV interventions among high-risk economically vulnerable fishing communities in Uganda: associations between use of commitment savings, sexual risk behavior, and problematic alcohol use. AIDS Behav. 2019;23(9):2347–60.
23. Chavez K, Palfai TP, Cheng DM, Blokhina E, Gnatienko N, Quinn EK, et al. Hazardous alcohol use, impulsivity, and HIV-risk behavior among HIV-positive Russian patients with a history of injection drug use. Am J Addict. 2021;30(2):164–72.
24. Osingada CP, Siu G, Amollo M, Muwanguzi P, Sewankambo N, Kiwanuka N. Acceptability of HIV testing for men attending televised football venues in Uganda. BMC Public Health. 2019;19(1):1136.
25. Madut DB, Manavalan P, Mtalo A, Peter TA, Ostermann J, Njau B, et al. Increasing the uptake of HIV testing among men in Tanzania: a novel intervention for bar patrons. AIDS Behav. 2021;25(7):2014–22.
26. Lin Y, Ren C, Liao M, Kang D, Li C, Jiao K, et al. Digital, crowdsourced, multilevel intervention to promote HIV testing among men who have sex with men: cluster randomized controlled trial. J Med Internet Res. 2023;25:e46890.
27. McQueen J, Howe TE, Allan L, Mains D, Hardy V. Brief interventions for heavy alcohol users admitted to general hospital wards. Cochrane Database Syst Rev. 2011;2011(8):CD005191.
28. Beymer MR, Bolan RK, Flynn RP, Kerrone DR, Pieribone DL, Kulkarni SP, et al. Uptake and repeat use of postexposure prophylaxis in a community-based clinic in Los Angeles, California. AIDS Res Hum Retroviruses. 2014;30(9):848–55.

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