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RESEARCH ARTICLE

The cost-effectiveness of Pre-Exposure Prophylaxis in HIV Prevention: Analysis from A Multicentre Intervention in Northern Nigeria

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ABSTRACT

Background: Pre-exposure prophylaxis (PrEP) is recommended for people at substantial risk of acquiring HIV to prevent new infections. The Nigeria PEPFAR program through USAID funded the implementation of PrEP for Key Population (KP) groups including Men Who Have Sex with Men (MSM), People who inject drugs (PWIDS), and Female sex Workers (FSW) in July 2020. We assessed the number of new infections averted and the financial resources saved because of this intervention.

Methodology: HIV-negative clients from the key population community in North-East Nigeria eligible for PrEP were enrolled over a 7-month period (July 2020 – February 2021). Eligibility criteria used include being at substantial risk for HIV infection based on a screening test administered. The person-month was calculated by using the duration the participants were retained on PrEP. The incidence 15.4/100 person-years of HIV among MSM at high risk of HIV infection in the TRUST study conducted in Nigeria was used to calculate the expected positive cases if PrEP was not provided for those enrolled using the formula $(15.4/100 * X)$ where X is number of person-years. We compared the expected positive to the actual positive seen among KPs while on PrEP within the study period. The cost-effectiveness of being on PrEP was calculated by multiplying the standard cost per HIV infection averted (\$13, 267 per HIV infection averted) by the No of HIV averted.

Results: We enrolled a total of 1,197 eligible HIV-negative KPs within the study period (189 were retained for seven months, 407 for four months, 585 for 3 months, and 18 for 1 month). A total of 4722 person-months (394 person-years) were accumulated over the period of the study. Using the incidence of 15.4/100 person-years, the expected positive cases if PrEP was not provided was 61 $(15.4/100 * 394)$. With the use PrEP, no client seroconverted to be HIV positive. This means that within the 7-month period, 61 HIV infections were averted. At the cost of \$13,267 per HIV infection averted for PrEP, the project saved \$809,287 for averting 61 HIV infections in seven months of using PrEP among HIV-negative KPs involved in high-risk behaviors.

Conclusion: This study shows that PrEP is effective in averting new infections among key population groups. Placing high-risk groups such as KPs on PrEP is cost-effective due to the money saved from new infections averted. Increased funding for proven and innovative strategies on PrEP enrolment, retention, and adherence of eligible clients should be expanded for KPs.

Keywords: Cost-effectiveness, HIV, Infection, Key Population, Nigeria, PrEP, Prevention, Saves.

Introduction

The Human Immunodeficiency Virus (HIV) continues to pose a significant public health challenge globally, with over 38 million people living with HIV/AIDS and an estimated 630,000 AIDS-related deaths recorded in 2022 alone¹. Nigeria is home to the second-largest number of people living with HIV globally, with a prevalence rate of 1.4% among adults aged 15-49 years, translating into 1.8 million people living with HIV². This high burden arises from the interplay of biological, social, cultural, behavioural, economic, and structural factors. Key populations (KP), including Men who have Sex with Men (MSM), People Who Inject drugs (PWIDs), and Female Sex Workers (FSWs), are among the most affected by HIV in Nigeria, with prevalence rates much higher than the national average. Factors such as high-risk behaviour, stigma, harassment, discrimination, and criminalization are responsible for the disproportionate level of infection among KP groups^{3,4,5,6}. To reduce the high infection rate among KPs, country programs should make intentional efforts to combat structural barriers that are responsible for fuelling HIV infection among KPs. Furthermore, biomedical prevention interventions such as PrEP should be prioritized for KPs and other high-risk groups^{7,25}.

PrEP is a highly effective HIV prevention method that involves pre-emptive use of daily (or event-based) antiretroviral drugs before exposure to HIV to prevent possible infection⁸. It is recommended for individuals at substantial risk of acquiring HIV, including KP groups^{9,2}. In 2015, the World Health Organization (WHO) included PrEP in its HIV prevention guidelines, and since then, various countries have implemented PrEP programs to reduce new HIV infections. Nigeria, a country with a high

burden of HIV, is implementing PrEP through the United States President's Emergency Plan for AIDS Relief (PEPFAR) program¹⁰. The PEPFAR program has prioritized high-risk KP groups and in July 2020, the program commenced PrEP for KPs in North-East Nigeria.

PrEP with its low toxicity is cost-effective in reducing new HIV infections among high-risk groups including KPs^{11,12}. A study conducted in South Africa found that providing PrEP to high-risk populations was cost-effective and resulted in significant reductions in HIV incidence¹³. Similarly, a modelling study conducted in Zimbabwe showed that providing PrEP to individuals at high risk of HIV was cost-effective and could reduce new HIV infections by up to 30% over 10 years¹⁴. A systematic review¹⁵ found that PrEP can be a cost-effective addition to HIV prevention programs, and that PrEP is more cost-effective within a combination prevention system, therefore, funding PrEP before expanding other prevention interventions is not cost-effective. A study¹⁶ shows that PrEP was found to be a cost-effective HIV-prevention intervention in high-risk MSM with HIV incidence of up to 2% in the USA (<US\$100 000 per quality-adjusted life year) using individual-level and population-level transmission models. However, the cost-effectiveness of PrEP programs in Nigeria, particularly for KPs, remains unclear. A study conducted in Nigeria evaluated the feasibility of implementing PrEP for MSM and FSWs but did not assess the cost-effectiveness of the program¹⁷. Another study conducted in Nigeria evaluated the cost-effectiveness of HIV prevention strategies generally, but did not specifically assess the cost-effectiveness of PrEP programs¹⁸. Further research is needed to determine the cost-effectiveness of PrEP programs in Nigeria,

particularly among KP groups to provide contextually sound evidence to policy and decision making.

In this study, we assessed the proportion of infection averted and financial resources saved in US dollars from administering PrEP to KPs in North-East Nigeria. We enrolled HIV-negative clients from the KP community who were eligible for PrEP using a screening tool. We calculated the expected number of positive cases based on the incidence of HIV among MSM at high risk of HIV infection in Nigeria and compared this to the actual number of positive cases seen among KPs while on PrEP within the study period. We also calculated the cost-effectiveness of PrEP by using the cost per HIV infection averted from a systematic review of PrEP cost-effectiveness in Sub-Saharan Africa.

This study provides valuable insight into the cost-effectiveness of PrEP programs in Nigeria for KPs. The findings from this study have significant implications for HIV prevention programs among KPs in Nigeria for policymakers and public health practitioners in settings with high HIV prevalence rates among KPs. Our study provides evidence of the effectiveness of PrEP in averting new infections among KPs and highlights the importance of enrolling all eligible clients for PrEP, retaining them in care, and ensuring good adherence.

Methodology

Study design, period, and population

This is a retrospective cost-effectiveness analysis focusing on HIV-negative clients from the key population community in North-East Nigeria who are eligible for PrEP and enrolled

over a 7-month period (July 2020 – February 2021).

Inclusion and exclusion criteria

HIV-negative KPs at substantial risk for HIV infection who were placed on PrEP within the 7-month period were included in the study. Clients who started PrEP outside the period under review were excluded from the study. HIV-positive KPs were also excluded.

Instruments, data collection sources, and analysis

The data source was the Data for Accountability, Transparency, and Impact Monitoring (DATIM), a PEPFAR data management platform. Data from the DATIM was compared with the source registers from the One Stop Shop (OSS) facilities, a safe place where KPs receive services to ensure consistency. The person-month was calculated by accounting for the duration the participants were retained on PrEP. Using the incidence 15.4/100 person-years of HIV among MSM at high risk of HIV infection established in the TRUST study conducted in Nigeria, we calculated the expected positive cases if PrEP were not provided for those enrolled. We compared the expected positive to the actual positive seen among KPs while on PrEP within the study period. The cost-effectiveness of being on PrEP was calculated using the cost per HIV infection averted from a systematic review of PrEP cost-effectiveness in Sub-Saharan Africa (\$13, 267 per HIV infection averted).

Data management and confidentiality

Strict confidentiality was maintained during data collection, collation analysis, and interpretation. Only authors had access to the information collected for this analysis.

Ethical consideration

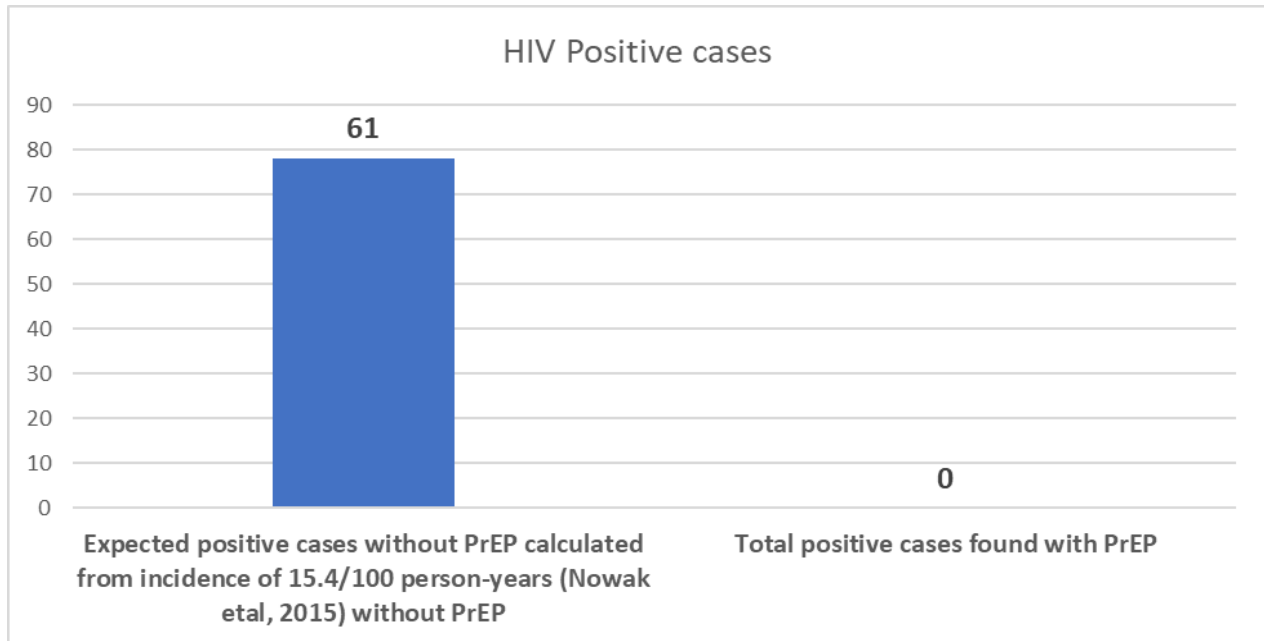
PrEP was offered to all clients as part of pre-test counselling, in line with the Nigeria operational guidelines for HIV prevention, care and treatment. Risk status assessment for HIV was conducted only for HIV-negative clients, and only those at substantial risk were offered PrEP. Clients placed on PrEP were properly counselled about their substantial risk status to make an informed decision about taking PrEP. Their risk level was also assessed after three months to determine whether they needed to continue taking PrEP. Clients' renal function was also assessed before the commencement of PrEP based on WHO and national guidelines. This research was conducted based on the national approval to offer PrEP to HIV-negative clients at substantial risk of HIV infection.

Results

We enrolled a total of 1,197 eligible HIV-negative KPs within the study period (189 were retained for seven months, 407 for four months, 585 for 3 months, and 16 for 1 month). 4722 person-months (394 person-years) were accumulated over the period of the study. Using the incidence of 15.4/100 person-years, the expected positive cases, if PrEP was not provided, was 61 (394/100) *15.4). With the use of PrEP, no client seroconverted to HIV-positive status using the serial algorithm for HIV testing. The clients were tested using the determine HIV rapid test kit. This means that within the 7-month period, 61 HIV infections were averted. At the cost of \$13,267 per HIV infection averted for PrEP, the project saved \$809, 287 for averting 61 HIV infections using PrEP among HIV-negative KPs.

Months retained on PrEP	Number of clients	Person-Months
7 months	189	1323
4 months	407	1628
3 months	585	1755
1 month	16	16
Total	1197	4722

Person-Year		
Total person-year	4722/12	394



Discussion

Nigeria has identified the need to scale up PrEP among priority population groups such as key populations (KP) due to the disproportionate level of new infection among them. Biomedical prevention strategies including PrEP were identified as a key strategy to address the disproportionately high level of infection among MSMs, FSW, PWID, transpersons, and people in prison. As a result, the country developed a national strategy for implementation and scale-up of PrEP, primarily among KPs. Some of the activities include the development of screening tools, SOPs, and guidelines for PrEP. Following the introduction and scale-up of PrEP, the PEPFAR program conducted an analysis to elucidate the cost-effectiveness of PrEP among KPs.

The present study aimed to evaluate the cost-effectiveness of PrEP in reducing new HIV infections among key population groups in North-East Nigeria. The findings demonstrate that the use of PrEP among high-risk KPs is highly effective in averting new HIV infections,

as none of the participants who were on PrEP seroconverted to be HIV positive during the 7-month study period, culminating in several dollars saved. This result is consistent with previous studies that have demonstrated the effectiveness of PrEP in reducing HIV incidence among key population groups, including MSM, PWID, and FSWs^{3,15,19,20}.

This study used a systematic review of PrEP cost-effectiveness in Sub-Saharan Africa to calculate the cost per HIV infection averted, which was \$13,267. Based on this cost-effectiveness analysis, the study demonstrated that the project saved \$809,287 by averting 61 HIV infections in seven months of using PrEP among HIV-negative KPs involved in high-risk behaviors. The significant dollar savings from infections averted underscores the importance of investing in proven and innovative strategies prioritising the enrolment, retention, and adherence of eligible KPs in PrEP programs, which can lead to significant cost savings while also reducing the burden of HIV among high-risk populations.

This study suggests that there is a need for increased funding for PrEP programs in Nigeria. The scale-up of PrEP programs for KPs should be prioritized and integrated into existing HIV prevention and treatment programs. This study also underscores the importance of KP engagement and involvement in the design and implementation of PrEP programs to improve enrolment, retention, and adherence. Given the high prevalence of HIV among KPs in Nigeria 21, the study findings have significant implications for public health policy and practice.

Furthermore, given the challenges in retaining KP clients in care, there is a need for innovative strategies to ensure good adherence to PrEP. These may include peer navigation, telemedicine, and community-based interventions. Finally, the findings of this study can be used to advocate for policy change towards the prioritization of the scale-up of PrEP programs for KPs and their integration into existing HIV prevention and treatment programs and the inclusion of PrEP in national HIV prevention guidelines for KPs to achieve the goal of ending the HIV epidemic among KPs in Nigeria.

One of the key strengths of the study is its focus on KPs, who are at the highest risk of HIV infection^{22,23,24} and often face significant barriers to accessing healthcare services. The study results highlight the need for targeted HIV prevention programs that focus on KPs in Nigeria and other high-burden countries. However, the study has some limitations, including the relatively short follow-up period and the potential for selection bias due to the non-randomized nature of the study.

Given additional funding, we hope to build on this research to conduct more comprehensive

and in-depth research on PrEP implementation for KPs in Nigeria, which could inform HIV prevention policy and improve the health outcomes of KPs. We could conduct an analysis of PrEP cost-effectiveness over a longer period, such as 5-10 years, to determine the long-term economic benefits of implementing PrEP for KPs in Nigeria and explore the feasibility of scaling up PrEP programs to reach a larger population of eligible KPs in different regions of Nigeria. Additionally, we could explore the impact of adherence interventions to improve the uptake and use of PrEP among KPs, such as behavioural counselling, adherence support groups, or innovative technology-based interventions. While this study focused on KPs, there are other high-risk populations, such as serodiscordant couples or individuals with multiple sexual partners, who may benefit from PrEP. We could also explore the cost-effectiveness and feasibility of implementing PrEP programs for these populations.

Conclusion

This study shows that PrEP is effective in averting new infections among key population groups. Placing these high-risk groups on PrEP is cost-effective due to the dollar saved from infections averted. This underscores the importance of enrolling all eligible clients for PrEP, retaining them in care, and ensuring good adherence. Increased funding for proven and innovative strategies on enrolment, retention, and adherence of eligible clients is strongly advised for KPs.

Conflict of Interest Statement:

None

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