AIDS Research and Therapy

https://doi.org/10.1186/s12981-026-00918-w

Article in Press

Brief communication: virological response and drug resistance patterns among men who have sex with men in Yaoundé-Cameroon

Received: 18 February 2026

Accepted: 25 June 2026

Published online: 09 July 2026

Cite this article as: Tadenfok C., Fokam J., Semengue E.N.J. *et al.* Brief communication: virological response and drug resistance patterns among men who have sex with men in Yaoundé-Cameroon. *AIDS Res Ther* (2026). https://doi.org/10.1186/s12981-026-00918-w

Carine Tadenfok, Joseph Fokam, Ezechiel Ngoufack Jagni Semengue, Antoine Silvère Olongo, Guy Fako, Grace Angong Beloumou, Alex Durand Nka, Desire Takou, Bouba Yagai, Jacques Ateba Ateba, Tanguy Kamgain, Bibiane Ndzié, Francois Badona, Biongolo Emmanuel, Elong Lobe Elise, Ariane Feukeng, David Anouar, Collins Chenwi Ambe, Rogers Ajeh Awoh, Justin Ndie, Anne-Cecile Bissek, Iliassou Njindam, Alexis Ndjolo, Nicaise Ndembi, Carlo-Federico Perno & Celine Nkenfou

Brief Communication: Virological Response and Drug Resistance Patterns among Men who have Sex with Men in Yaoundé-Cameroon

Carine Tadenfok[1,*] (tadenfokcarine@gmail.com), Joseph Fokam[1,2,3,4] (josephfokam@gmail.com), Ezechiel Ngoufack Jagni Semengue[1,2] (ezechiel.semengue@gmail.com), Antoine Silvère Olongo[5] (silvereolongo@gmail.com), Guy Fako[6] (fakohendji@yahoo.fr), Grace Angong Beloumou[1] (graceangong12@yahoo.fr), Alex Durand Nka[1] (nkaalexdurand@yahoo.com), Desire Takou[1,2] (dtakou@yahoo.com), Bouba Yagai[1,2,7] (romeobouba@yahoo.fr), Jacques Ateba Ateba[8] (jackflorent@yahoo.fr), Tanguy Kamgain [8](tanguykam@yahoo.fr), Bibiane Ndzié[8] (ndzieflavie6@gmail.com), Francois Badona[9] (badona2015@gmail.com), Biongolo Emmanuel[9] (biongoloemmanuel@yahoo.fr), Elong Lobe Elise[1](elongelise@yahoo.fr), Ariane Feukeng[1] (afeuken@gmail.com), David Anouar[10] (dkob_same@hotmail.fr), Collins Chenwi Ambe[1,2,11] (collinschen@yahoo.co.uk), Rogers Ajeh Awoh[3,4,12] (ajehrogers@gmail.com), Justin Ndie[13] (ndjust2002@yahoo.fr), Anne-Cecile Bissek[13] (annezkbissek@yahoo.fr, Iliassou Njindam[14] (imfochi1@jhu.edu), Alexis Ndjolo[2,15](andjolo@yahoo.com), Nicaise Ndembi[16,17] (nicaise.ndembi@gmail.com), Carlo-Federico Perno[1,18,&] (perno@uniroma2.it), Celine Nkenfou[1,19,&] (nkenfou@yahoo.com)

1. *Chantal BIYA International Reference Centre for research on HIV/AIDS prevention and management, Yaoundé, Cameroon;*
2. *National HIV Drug Resistance Prevention and Surveillance Working Group, Ministry of Public Health, Yaoundé, Cameroon;*
3. *Central Technical Group, National AIDS Control Committee, Ministry of Public Health, Yaoundé, Cameroon.*
4. *Faculty of Health Sciences, University of Buea, Buea, Cameroon;*
5. ***Faculté Universitaire de Théologie Protestante, Bruxelles, Belgique***
6. *Health Promotion Initiative, Yaoundé, Cameroon;*
7. *UniCamillus - Saint Camillus International University of Health Sciences, Rome, Italy;*
8. *Humanity First Cameroon Plus, Yaoundé Cameroon;*
9. *Laboratoire Dream Nkolondom, Yaoundé, Cameroon;*
10. *Joint United Nations Programme on HIV/AIDS (UNAIDS), Yaoundé, Cameroon;*
11. *Faculty of Medicine and surgery, University of Rome Tor Vergata, Rome, Italy;*
12. *Global Fund Subvention Coordination Unit for TB, HIV and Malaria, Ministry of Public Health, Yaoundé, Cameroon;*
13. *Division of Health Operational Research, Ministry of Public Health, Yaoundé, Cameroon;*
14. *Johns Hopkins Cameroon Program, Yaoundé, Cameroon;*
15. *Faculty of Medicine and Biomedical Sciences, University of Yaoundé I, Yaoundé, Cameroon;*
16. *International Vaccine Institute, Africa Regional office, Kigali, Rwanda;*
17. *Institute of Human Virology, University of Baltimore, Maryland, USA.*
18. *Bambino Gesu' Children's Hospital, Rome, Italy;*
19. *Department of Biological Sciences, Higher Teaching College, University of Yaoundé I, Yaoundé, Cameroon.*

*Corresponding authors and contributed equally: Carine Tadenfok (tadenfokcarine@gmail.com) and Joseph Fokam (josephfokam@gmail.com)

&: co-senior authors to this work.

Keywords: Men having sex with men; Antiretroviral therapy; Dolutegravir; Virological response; HIV drug resistance; Cameroon.

ABSTRACT (100/100)

Men having sex with men (MSM) in Cameroon are disproportionately affected by HIV. We evaluated virological response and HIV drug resistance (HIVDR) at a community-based organization between 2022-2023. Enhanced adherence counselling (EAC) sessions were conducted for all and cases with unsuppressed viral load (VL>1000copies/ml) underwent genotyping. From 502 treatment-experienced MSM enrolled, 95(18.9%) had unsuppressed VL with 82(86.3%) accepting to participate (ART-duration: 3 [2-5]years; 95.1%(78/82) under Tenofovir+Lamivudine+Dolutegravir). EAC led to 97.6%(80/82) suppression with 1/2 participant harboring HIVDR. High suppression rates and low HIVDR demonstrate the effectiveness of treatment strategies locally; supporting the possibility of global HIV elimination targets among key populations.

1. INTRODUCTION

Despite over 40 years into the HIV epidemic, AIDS remains a leading cause of death worldwide, with Sub-Saharan Africa (SSA) being the most affected region[1]. Notably, HIV has significant economic and social impacts, particularly on vulnerable population, such as children born to untreated HIV-infected mothers, people with occupational exposure to blood, those who have received blood transfusions, individuals who inject drugs, those having unprotected sex with multiple partners, and men who have sex with men (MSM) [2]. In Cameroon specifically, MSM face a disproportionately high HIV prevalence, estimated at 29.7% versus 2.6% in the general population [3][4]. Despite this high prevalence, HIV screening, prevention, and treatment are not prioritized locally, just as in most African countries due to societal discrimination [5][6]. Article 347 of the Cameroonian Penal Code for example, prohibits sexual contact between people of the same sex. Consequently, HIV prevention and management programs among key populations (KP) is often suboptimal due to disparities in access to care and treatment outcomes[7]. In effect,

despite the high burden of HIV among MSM in Cameroon, little is known about viral suppression and HIV drug resistance in this population, where stigma, discrimination, criminalization, and limited access to healthcare may adversely affect treatment outcomes. This study therefore aimed to determine the viral suppression rates and prevalence of HIV drug resistance (HIVDR) among MSM on antiretroviral treatment in Yaoundé, Cameroon. This is of paramount importance, considering that HIV acquisition/transmission among this sub-population is often as a result of suboptimal adherence among individuals under pre-exposure prophylaxis and/or emergence of acquired HIVDR among those already infected and under specific antiretrovirals protocols.

2. Methodology

2.1 Study Setting

The study was conducted between October 2022 and February 2023 at "Humanity First Plus", a community-based organization (CBO) in Yaoundé, Cameroon, which serves as a key clinical site for MSM in the city. A comprehensive clinical assessment was done, where demographic data and detailed antiretroviral therapy (ART) histories were meticulously documented through standardized questionnaires and medical record reviews. After obtaining ethical clearance from the National Committee on Research Ethics for Human Health (N°2022/08/1479/CE/CNERSH/SP) and securing written informed consent from each participant, we sought to evaluate the virological response among this vulnerable population.

2.2 Sample analysis

For participants with an initial viral load (VL) ≥ 1000 copies/mL, enhanced adherence counseling (EAC) sessions were initiated and specifically designed to identify and mitigate barriers to treatment adherence. A follow-up VL measurement was subsequently performed using the Abbott m2000rt platform (thresholds: 40 – >10.000.000 copies/ml) to assess the impact of these counseling sessions. For individuals with unsuppressed VL (VL>1000copies/ml) after EAC sessions, remnant plasma samples, preserved at -20°C were transported via a strict cold chain, and underwent genotypic resistance testing (GRT) through Sanger sequencing targeting

the protease and reverse transcriptase regions using an in-house protocol as published elsewhere[8]. Briefly, viral RNA was extracted from 1 mL of plasma using the QIAGEN extraction kit according to the manufacturer's instructions. The target region was amplified by reverse transcription PCR, followed by a semi-nested PCR. Amplification products were verified by 1% agarose gel electrophoresis. Successfully amplified samples were purified and sequenced using multiple overlapping primers covering the *pol* gene region of interest. Sequencing products were purified by Sephadex G50 size-exclusion chromatography and analyzed on the ABI 3500 Genetic Analyzer. HIVDR was then interpreted on validated sequences using the Stanford HIVdb algorithm v9.4.

As regarding HIV-1 subtyping, it was initially performed using online automated subtyping tools COMET (https://comet.lih.lu) and REGA (http://dbpartners.stanford.edu:8080/RegaSubtyping/stanford-hiv/typingtool/), and later confirmed by molecular phylogeny conducted on MEGA v11.

2.3 Data Entry and Statistical Analysis

Epi Info v7.2.2.6 was used to enter and analyzed the data. Categorical variables were described in frequency and percentage. To compare proportions of the qualitative variables Chi-squared or Fisher's exact tests were used. The different values were expressed with their 95% confidence interval. Threshold of statistical significance was set at 5%.

3. RESULTS

3.1 General Characteristics of Study Population

Of the 502 ART-experienced MSM at the CBO, 95 (18.9%) had unsuppressed viremia at enrolment and 82 (86.3%) further accepted to participate. They were all men (100%), their median [IQR] age was 23 [22-25] years and the majority of participants lived in Yaoundé. All participants had VL>1000 copies/mL and none had reported co-infection with tuberculosis, viral hepatitis, malaria, or any other comorbidity. All other socio-demographic and clinical characteristics of participants are presented in table 1.

Table 1: Virological characteristics of study participants

Characteristics	Overall N=82	Percentage/ IQR
Age, years, median (IQR)	23	[22-25]
Male	82	100%
Risk Factors		
MSM	82	100
Duration since HIV diagnosis, median (IQR), years	4	[2 – 8]
Number of sexual partners in the past 30 days, n (%)	2	[1-6]
ART regimens		
TDF+3TC+DTG	78	95.1%
TDF+3TC+EFV	2	2.4%
ATV/r+3TC+TDF	2	2.4%
Duration on ART, years	3	[2-5]
Viremia		
Median Viremia at enrolment	17147	[4321-56700]

3.2 Viral load testing

Following the first EAC session, viral load testing revealed 49 participants with an undetectable viremia (VL< 50copies/ml), 22 with suppressed but detectable viremia (VL [50-999] copies/ml) and 11 samples with unsuppressed VL. Following the second round of EAC sessions, we repeated the viral load testing for the 11 unsuppressed participants and found 02 participants still unsuppressed; yielding an overall rate of 97.6% (80/82) viral suppression.

3.3 Factors associated with Virological Response.

Following bivariate analyses, neither age, nor any of the risk factors, nor residence, ART regimen, duration on ART, VL at enrolment were found to be associated with virological response among MSM (all p>0.05) (table2).

Table 2: Factors associated to Virological Response

Variables	Viral Suppression	p-value
Age	**Yes**	
≥ 23	39	0.25
<23	41	
Sexual partners		
≥ 2	40	0.26
<2	40	
Duration since HIV diagnosis (years)		
≥ 4	40	0.26
<4	40	
Duration on treatment (years)		
≥ 3	41	0.74
<3	39	
Treatment type		
DTG-based	76	0.90
DTG-sparing	4	

3.4 Genotyping data

Of the two samples that were processed for GRT, one was harboring drug resistance mutations (DRMs; specifically, G190GE, L210W), indicating an overall rate of 1.2% (1/82) HIVDR at the CBO. Importantly, the drug resistance case (second year since HIV diagnosis) had previous exposure to Tenofovir/Lamuvidine/Efavirenz with contextual treatment being Tenofovir/Lamuvidine/Dolutegravir and viral loads of 13355 copies/ml and 104440 copies/ml respectively before and after EAC. Phylogenetic analysis indicated the presence of the HIV-1 subtypes A1 and CRF02_AG (HIVDR case).

4. DISCUSSION

KPs currently constitute the most important hot spot of HIV infection worldwide, as well as in SSA in general and Low and middle-income countries (LMICs) in particular where HIV burdens remain concerning [3,4,9-11]. We herein report a very high

level of viral suppression (>97%) among treatment experienced MSM residing in Yaoundé-Cameroon. Study population was made of virally unsuppressed participants, all aged 21 to 37 years, with the great majority having more than one sex partners; in line with studies recently conducted [12,13,14].

Even though this result is unsurprising, given that >95% of the MSMs screened were under dolutegravir-based regimen [15,16,17,18], it is important to notice that this result would have never been possible without active adherence support implemented among these MSM despite all legal restrictions [3,4,7]. In the same light, it is also worth noting that ART-strategy (i.e. DTG as first intention and EAC for those with VL>1000 copies/ml) among these KP follows the same recommendations as in the general population; highlighting the essential role of community-based organizations in managing KP accordingly without disclosing their identity. In effect, recent data revealed that active adherence support is essential to boost DTG's efficacy which optimizes viral suppression and prevents the development of resistance due to its high genetic barrier [17-18].

As regarding unsuppressed cases, all two cases were successfully amplified and sequenced, with one of these cases found with HIVDR. Surprisingly, drug resistance mutations observed were targeting specifically efavirenz (G190GE) and zidovudine (L210W) [19]; of which the later does not appear in the client's treatment history, supporting a potential transmission at the moment of infection hypothesis supported by the short time span since diagnosis. This is in line with findings reported in China, wherein transmitted HIVDR among MSM was low [20]. Furthermore, the presence of quasi-species such as G190GE suggests a very limited adherence or episodes of ART interruption, which may have turned out to the reversion of certain mutations to wild-type during these episodes, underscoring the possibility of other mutations present in minority variants or in viral reservoirs, which may further compromise the effectiveness of other antiretroviral molecules [19].

Interestingly, these findings altogether strongly advocate for the combination of EAC sessions with highly active antiretroviral regimens to achieve and potentially maintained long-term viral suppression among a sub-population highly at risk of HIV acquisition and transmission. This is all the more relevant considering summary findings from a systematic review recently published (including MSM couples), demonstrating that the risk of sexual transmission of HIV is almost zero when the index partner has a viral load <1000 copies per milliliter [21]. Therefore,

implementing such strategies among Cameroonian MSM or on a larger scale in other LMICs sharing the same programmatic features will inevitably greatly contribute to HIV elimination goals among KP.

5. STUDY LIMITATION

The relatively small number of participants may limit statistical power, particularly for subgroup analyses (e.g., by age group, duration on ART, or regimen type). This may have reduced our ability to detect significant associations. The effect of this was minimized by carefully choosing to use the Fisher's statistical exact test which is robust in dealing with small sample size.

In spite of the stringency in selecting/enrolling study participants, the procedure may have generated a certain degree of bias since many MSM were probably not referred to and/or attending this specific community-based organization. In effect, MSM who are engaged with community-based services are generally more likely to access HIV testing, receive regular follow-up, and adhere to antiretroviral therapy than those who remain outside such networks. Consequently, the study population may not be fully representative of the broader MSM population in Cameroon, particularly those with limited access to care.

Another limitation of this study is the lack of sequencing of the HIV-1 integrase region. As a result, resistance-associated mutations to integrase strand transfer inhibitors (INSTIs), particularly dolutegravir (DTG), have not be assessed.

6. CONCLUSION

Among ART-experienced MSM receiving predominantly DTG-containing regimens in Yaoundé, viral suppression rate is above the 95% UNAIDS-target, indicating optimal prevention of HIV transmission among this KP. Moreover, the low rate of HIVDR stresses the more on the high effectiveness of current ART regimens used, indicating efficient prevention of drug resistance following treatment failure. These findings therefore advocate for the extensive implementation of HIV screening and start of effective ART strategies, and re-enforcement of adherence measures among this sub-population in this setting and other LMICs sharing similar programmatic features, towards HIV elimination among KP at a global scale.

7. LIST OF ABBREVIATIONS

ART: Antiretroviral Therapy; **CBO:** Community Base Organization; **DRMs:** Drug Resistance Mutations; **DTG:** Dolutegravir; **EAC:** Enhanced Adherence Council; **EFV:** Efavirenz; **HIV:** Human Immunodeficiency Virus; **HIVDR:** HIV Drug Resistance; **KP:** Key Population; **LMICs:** Low and middle-income countries; **MSM:** Men who have Sex with Men; **TDF:** Tenofovir; **3TC:** Lamivudine; **EFV:** Efavirenz; **VL:** Viral Load; **GRT:** Genotypic Resistance Testing.

8. DECLARATION

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Following the ethical principles of the Helsinki Declaration, ethical clearance was obtained from the National Committee on Research Ethics for Human Health, N□2022/08/1479/CE/CNERSH/SP.

CONSENT FOR PUBLICATION

All participants provided written informed consent for participation in the study, and publication of anonymized data was approved by the Institutional Ethics Committee.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and/or analyzed during the current study are not publicly available due to confidentiality agreements and ethical restrictions but are available from the corresponding author upon reasonable request.

COMPETING INTERESTS: The authors declare no competing interests.

FUNDING: Authors have not received any funding for this study.

AUTHORS' CONTRIBUTIONS: CT, JF, ENJS designed the study and wrote the original manuscript under the senior guidance of CN. AO, GF, JAA and BN have conducted the enrolment and counseling of participants. TK Collected and sent samples for viral load and resistance test; FB and BE performed viral load tests, GAB, AND, DT, ENJS and CCA, performed resistance tests and interpreted data with support from JF. AF performed data abstraction. CT wrote the first manuscript draft and ELE, DAKYS, RA, HH, AZB, AAA, and IN, provided extensive edits to all manuscript drafts. NN, CFP and CN provided critical scientific input on the manuscript. All authors revised and approved the final version of the manuscript.

ACKNOWLEDGEMENTS: We thank the CBO Humanity First Plus participants and staff, Nkolondom Laboratory, and the CIRCB for making this study possible.

REFERENCES

1. UNAIS-ending AIDS epidemic. Forty years into the HIV epidemic, AIDS remains the leading cause of death of women of reproductive age—UNAIDS calls for bold action. Published online 2020.

2. Jaffe HW, Valdiserri RO, De Cock KM. The Reemerging HIV/AIDS Epidemic in Men Who Have Sex With Men. *JAMA*. 2007;298(20):2412. doi:10.1001/jama.298.20.2412

3.https://www.minsante.cm/site/sites/default/files/COMMUNIQUE%20RADIO%20PRESSE%20FRANCAIS-ANGLAIS.pdf

4. Cameroon factsheet. Country factsheets Cameroon 2022Change.pdf. Published online 2022.

5. 2016 Integrated Biological and Behavioral Survey among Key Populations in Cameroon: Published online 2016.

6. Central African Republic 2012 Human Rights Report. CENTRAL AFRICAN REPUBLIC 2012 HUMAN RIGHTS REPORT. Published online 2012.

7. Penal code. Penal code eng original.pdf. Published online 2016.

8. Fokam J, Salpini R, Santoro MM, et al. Performance evaluation of an in-house human immunodeficiency virus type-1 protease-reverse transcriptase genotyping assay in Cameroon. *Arch Virol*. 2011;156(7):1235-1243. doi:10.1007/s00705-011-0982-3

9. UNAIDS 2023_report.pdf. Published online 2023.

10. Global AIDS Monitoring. global-aids-monitoring_en.pdf. Published online 2021.

11. World Health Organization. *Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection: Recommendations for a Public Health Approach*. 2nd ed. World Health Organization; 2016. Accessed February 8, 2024. https://iris.who.int/handle/10665/208825

12. Joint United Nations Programme on HIV/AIDS. *Global AIDS update 2023: the path that ends AIDS*. Geneva: UNAIDS; 2023.

13. Stahlman S, Sanchez TH, Sullivan PS, Ketende S, Lyons C, Charurat ME, et al. The prevalence of sexual behavior stigma affecting gay men and other men who have sex with men across sub-Saharan Africa and in the United States. *JMIR Public Health Surveill*. 2016;2(2):e35. doi:10.2196/publichealth.5824

14. Behrens NE, Wertheimer A, Love MB, Klotz SA, Ahmad N. Evaluation of HIV-

specific T-cell responses in HIV-infected older patients with controlled viremia on long-term antiretroviral therapy. *PLOS ONE*. 2020;15(9):e0236320. doi:10.1371/journal.pone.0236320.

15. WHO. WHO HIV DR 2024.pdf. Published online 2024.

16. Semengue ENJ, Fokam J, Etame NK, Molimbou E, Chenwi CA, Takou D, et al. Dolutegravir-Based Regimen Ensures High Virological Success despite Prior Exposure to Efavirenz-Based First-LINE ART in Cameroon: An Evidence of a Successful Transition Model. Viruses. 21 déc 2022;15(1):18.

17. Ndjolo Ada ML, Fokam J, Kamgaing N, Ambe Chenwi C, Ngoufack Jagni Semengue E, Angong Beloumou G, Ndjeyep Djupsa SC, et al. Low Rates of Virological Failure and Acquired HIV-1 Drug Resistance Among Children in Cameroon: Evidence Following Transition to Dolutegravir-based Regimens in Pediatrics. Pediatr Infect Dis J. 2026 Jan 7. doi: 10.1097/INF.0000000000005118. Epub ahead of print. PMID: 41495920.

18. Phillips AN, Bansi-Matharu L, Venter F, et al. Updated assessment of risks and benefits of dolutegravir versus efavirenz in new antiretroviral treatment initiators in sub-Saharan Africa: modelling to inform treatment guidelines. *Lancet HIV*. 2020;7(3):e193-e200. doi:10.1016/S2352-3018(19)30400-X

19. International Antiviral Society-USA. Drug resistance mutations in HIV-1. Topics in Antiviral Medicine. 2022;30(4):559–574.

20. Lu X, Kang X, Chen S, et al. HIV-1 Genetic Diversity and Transmitted Drug Resistance Among Recently Infected Individuals at Men Who Have Sex with Men Sentinel Surveillance Points in Hebei Province, China. *AIDS Res Hum Retroviruses*. 2015;31(10):1038-1045. doi:10.1089/aid.2015.0160

21. Broyles LN, Luo R, Boeras D, Vojnov L. The risk of sexual transmission of HIV in individuals with low-level HIV viraemia: a systematic review. *The Lancet*. 2023;402(10400):464-471. doi:10.1016/S0140-6736(23)00877-2