



Published in final edited form as:

J Acquir Immune Defic Syndr. 2025 December 01; 100(4): 289–293. doi:10.1097/

QAI.0000000000003745.

Undetectable HIV-1 viral load among virally suppressed people living with HIV: implications for Undetectable equals Untransmittable (U=U) in resource-limited settings using dried spot testing

Gregory C. Chang^{1,2,3,§}, Trista Bingham¹, Hetal K. Patel¹, Elisabeth Mungai¹, Katrina Sleeman¹, Irene Benech¹, Dejana Selenic¹, Melissa Metz⁴, Yen T. Duong⁴, Suzue Saito⁴, Judith Shang¹, Emily K. Dokubo¹, Laura Eno¹, Tsietso Motsoane⁵, Caroline Ryan¹, Andrew Auld¹, Evelyn Kim¹, Alice Maida¹, Optatus Malewo¹, James M. Juma⁶, Anna Colletar Awor¹, Nzali Kanchea¹, Clement B. Ndongmo¹, Shirish Balachandra¹, Yimam Getaneh⁷, Sileshi Lulseged⁴, Frehywot Eshetu¹, Peter W. Young¹, Daniel B. Williams¹, Christine West¹, Jessica Justman⁴, Bharat S. Parekh¹, Andrew C. Voetsch¹

¹Division of Global HIV and TB, Global Health Center, CDC, Atlanta, GA, USA

²Public Health Institute, Oakland, California, USA

³The Ohio State University College of Public Health, Columbus, OH, USA

⁴ICAP at Columbia University, New York, New York, USA

⁵Ministry of Health Lesotho, Maseru, Lesotho

⁶Ministry of Health Tanzania, Dar es Salaam, Tanzania

⁷Department of HIV and Tuberculosis, Ethiopia Public Health Institute, Addis Ababa, Ethiopia

Abstract

Background: The Undetectable=Untransmittable (U=U) campaign, based on strong scientific evidence, posits that people living with HIV (PLHIV) with an undetectable viral load (VL), defined as ≤ 50 copies per milliliter (c/mL) or < 200 c/mL of HIV RNA, do not transmit HIV to sexual partners. In resource-limited settings, dried blood spot (DBS) VL testing, which has a limit of detection between 550–1000 c/mL, is commonly used. We report the proportion of PLHIV with VL < 1000 c/mL who have VL < 200 c/mL and ≤ 50 c/mL to assess DBS VL testing's interpretation under U=U.

Methods: We analyzed data from 13 cross-sectional nationally representative surveys (2015–2019), focusing on PLHIV aged 15–59 years receiving antiretroviral therapy (ART) with valid

[§]Corresponding author: Gregory C. Chang, 1841 Neil Ave, Building 293, Columbus, OH, chang.1582@osu.edu.

Authors' contributions

All authors have read and approved the final manuscript. DS, MM, YTD, SS, JS, EKD, LE, TM, CR, AA, EK, AM, OM, JMJ, ACA, NK, CBN, SB, YG, SL, F E, PW, DBW, CW performed the research data collection. BSP, HP, TB, IB, KS, GCC, and ACV designed the research study. GCC, EM, and MM analyzed the data. GCC, TB, BSP, JJ, and ACV wrote the paper.

These data are reported as a poster at the Conference on Retroviruses and Opportunistic Infections (CROI) 2020, Boston, MA.

Competing interests

The authors state that they have no competing interests.

plasma VL results. We estimated the proportion of participants with VL <200 c/mL and ≤50 c/mL among those with VL <1000 c/mL, overall, and among those on ART ≥12 months using survey-adjusted weights.

Results: Among 16,533 PLHIV across 13 countries, we estimated that 87.3% had VL <1000 c/mL, and varied by country. For PLHIV with VL <1000 c/mL, 95.4% had VL <200 c/mL and 84.9% had VL ≤50 c/mL. Restricting to those on ART ≥12 months, 96.6% had VL <200 c/mL, and 87.4% had VL ≤50 c/mL.

Conclusion: Most PLHIV with VL <1000 c/mL had a VL <200 c/mL and ≤50 c/mL, indicating no HIV transmission risk to their sexual partners. Our findings provide evidence that in areas relying on DBS VL testing, most PLHIV with VL <1000 c/mL likely fall below 200 c/mL or are undetectable based on the assay's lower limit of detection.

Keywords

HIV infection; viral load; dried blood spot testing; plasma; prevention; HIV transmission

Introduction

Antiretroviral therapy (ART) has played a crucial role in substantially decreasing Human Immunodeficiency Virus (HIV) viral load (VL) among people living with HIV (PLHIV), leading to reductions in HIV-associated morbidity and mortality.^{1,2} PLHIV who have VL below the level of 200 HIV RNA copies/milliliter (c/mL) do not transmit HIV to sexual partners, and there is further evidence of almost zero risk of sexual transmission of HIV with VL less than 1000 c/mL.³ In 2016, the Prevention Access Campaign launched the Undetectable equals Untransmittable (U=U) message to end the HIV pandemic and HIV-related stigma.⁴ U=U established that PLHIV who adhere to their ART regimen and achieve an undetectable VL of <200 c/mL and have risk of transmitting HIV to their sexual partners.⁵ The World Health Organization (WHO) initially defined undetectable as VL<200 (c/mL) in 2016 and later revised the definition to VL ≤50 c/mL in 2021. The actual undetectable VL value depends on the assay platform used and reflects no virus detection, as indicated in the 2023 WHO guidance.⁵

The process and validity when measuring an individual's HIV VL can vary depending on the method and platform used. In settings with high laboratory capacity, plasma VL testing is the gold standard, and instruments can have a lower limit of detection of 20–200 c/mL of HIV-1 RNA.⁶ Despite the benefit of having a low limit of detection, plasma VL testing may not be possible or feasible in all settings as it requires venous blood draw, plasma processing, and stringent storage and transport conditions.⁷ An alternative to plasma VL testing is using dried blood spots (DBS). The use of DBS eliminates the need for phlebotomy, is cost-effective for remote areas, and facilitates easy transport to central laboratories.^{8,9} Additionally, high concordance exists between DBS and plasma results for HIV viral load, indicating the viability of using DBS as an alternative to plasma.¹⁰⁻¹² However, the lower limit of VL detection for DBS is 550–1000 c/mL, depending on the platform being used.^{8,9,13-15} Due to this limitation, using DBS as a diagnostic tool for concluding that an individual has VL<200 c/mL and, therefore, is considered to have an

undetectable VL is not appropriate. Further, the use of DBS in VL testing can lead to reluctance among providers to advise patients that they cannot transmit HIV to sexual partners, as providers can only determine that a patient's VL is <1000 c/mL rather than undetectable. Understanding the population-based distribution of VL results among plasma samples can provide a proxy measure and counterfactual for the proportion of DBS samples that are likely to be undetectable. We describe the proportion of PLHIV with an undetectable HIV VL (<200 c/mL and ≤ 50 c/mL) among those with VL <1000 c/mL, using plasma VL data. We also assess how our findings can inform the interpretation of DBS VL testing results in resource-limited settings, where DBS is more commonly available, using data from 13 countries in sub-Saharan Africa.

Methods

To calculate the proportion of virally suppressed individuals who had an undetectable VL, we analyzed results from plasma-based VL testing completed for Population-based HIV Impact Assessment (PHIA) surveys conducted from 2015 to 2019. The PHIA survey's primary objectives were to measure national HIV incidence and viral load suppression (VLS) at the subnational level. The methods have been previously described.^{16,17} VL testing was conducted for participants with positive HIV tests, primarily using plasma samples. In rare instances, DBS was used to obtain VL results. Plasma VL testing was conducted using the Roche COBAS AmpliPrep/COBAS TaqMan (CAP/CTM) HIV-1 test, version 2.0 (Roche Diagnostics, Pleasanton, CA) on a Roche CAP/CTM with either a 48 or a 96 analyzer or the Abbott RealTime HIV-1 assay (Abbott Molecular, Des Plaines, IL) on the Abbott fully automated m2000 platform (m2000sp and m20000rt). All seroreactive samples were tested for the presence of antiretroviral (ARV) medications used in first- and second-line treatment regimens in the respective countries.^{14,16} ART use was defined by either self-report or qualitative detection of ARV. We included PHIA surveys from Cameroon (CAMPRIA, 2017–18), Côte d'Ivoire (CIPRIA 2017–18), Eswatini (SHIMS2, 2016–17), Ethiopia (EPRIA, 2017), Kenya (KENPRIA 2018–19), Lesotho (LePRIA, 2016–17), Malawi (MPRIA, 2015–16), Namibia (NAMPRIA, 2016–17), Rwanda (RPRIA, 2018) Tanzania (THIS, 2016–17), Uganda (UPRIA, 2016–17), Zambia (ZAMPRIA, 2016), and Zimbabwe (ZIMPRIA, 2015–16).¹⁸ The Ethiopia survey was limited to urban areas.

We conducted both pooled and individual country-specific data analyses from the 13 PHIA surveys. Survey weights were applied to all analyses to account for differences in sampling probabilities and to adjust for survey non-response.¹⁹ Data from participants aged 15–59 years whose plasma samples tested HIV positive and had plasma VL results were included in the analysis. Data from participants who only had a DBS VL result were excluded.

We assessed the proportion of participants with VL <1000 c/mL who met the 2016 and 2021 WHO definitions of undetectable VL, specifically VL <200 c/mL and ≤ 50 c/mL, respectively.⁹ We also assessed these proportions based on current ART use of any duration and current ART use for ≥ 12 months. Additionally, we stratified all analyses by sex (male/female), place of residence (urban/rural), and age group separately to identify any subgroup differences. All analyses were completed in SAS (Version 9.4; SAS Institute, Cary, NC). The PHIA surveys were approved by Institutional Review Boards at the CDC, Columbia University, Westat,

and in the respective countries (See 45 C.F.R. part 46; 21 C.F.R. part 56). All participants provided oral consent.

Results

Across the 13 countries, 303,400 participants aged 15–59 years were eligible for participation, and 281,188 (93.1%) completed the individual interview; of these, 266,187 (95.0%) consented to biomarker testing. Of the 16,989 participants with HIV-positive test results, HIV VL data from plasma samples were available for 16,533 (97.3%). Overall, 87.3% of PLHIV on ART had VL <1000 c/mL (Table). Of these, 95.4% had VL <200 c/mL. Restricting the analysis to participants who had VL <1000 c/mL and reported current ART ≥12 months, 96.6% had VL <200 c/mL. Using the updated 2021 WHO guidance threshold of ≤50 c/mL, 84.9% of PHIA participants with VL <1000 c/mL and 87.4% of those on ART for ≥12 months had VL ≤50 c/mL.

The proportion of PLHIV on ART with VL <1000 c/mL and ≤50 c/mL varied across countries. Eswatini, Kenya, Malawi, Namibia, and Rwanda had > 90% of PLHIV on ART with VL <1000 c/mL. Conversely, Cameroon and Côte d'Ivoire had 79.6% and 74.8%, of PLHIV on ART with VL <1000 c/mL, respectively. Among PLHIV on ART with VL <1000 c/mL, most countries reported between 82%–90% also having VL ≤50 c/mL. The exceptions were Côte d'Ivoire (72.3%), Uganda (75.9%), and Malawi (92.2%).

By demographic characteristics, a lower proportion of males compared to females had VL ≤50 c/mL, both among individuals on ART and those who reported being on ART for ≥12 months. A lower proportion of younger adults aged 15–24 years compared to older adults aged 25–59 years had VL <200 c/mL and VL ≤50 c/mL among individuals on ART. Among those who reported being on ART for ≥12 months, younger adults aged 15–24 years had the lowest proportion (94.9%), and older adults aged 45–59 years had the highest proportion (97.3%) with VL <200 c/mL. No differences in all VL outcomes were seen by place of residence.

Discussion

Although there was variation across countries in the percentage of individuals achieving VLS of <1000 c/mL and being undetectable at VL <200 c/mL, the vast majority of PLHIV who had VL <1000 c/mL and were on ART exhibited an undetectable VL <200 c/mL. Narrowing the study to individuals who reported taking ART for ≥12 months led to a modest increase in the proportion of undetectable individuals. This finding reinforced that among PLHIV who had been on ART for a period of ≥12 months, a small percentage of PLHIV (3.4%) were not undetectable at the level required for zero risk of sexual transmission, according to available scientific evidence.³ Lower VLS among the younger age group (15–24 years) may be due to new diagnosis and recent initiation of ART. By providing quantitative data on the very low frequency of having VL that exceeds 200 c/mL when the VL is confirmed as <1000 c/mL, patients, healthcare providers, and other stakeholders possess tangible evidence to adopt U=U messaging and initiatives, even in settings where only DBS VL testing is available. The recommendation to use DBS VL results is further

supported by evidence of almost zero risk of sexual transmission of HIV with VL <1000 c/mL.^{3,5}

Undetectable viral load was observed in the majority (95.4%) of PLHIV on treatment with viral load <1000 c/mL, providing convincing evidence that onward HIV transmission is effectively eliminated even in the most challenging Sub-Saharan African settings. For PLHIV who are recently exposed, newly diagnosed, or with known infection but not yet on treatment, U=U has the potential to reduce self-stigma, create optimism to seek HIV testing, initiate ART as soon as possible, and stay on ART.²⁰⁻²² To fully endorse U=U at both individual and population levels in resource-limited settings, PLHIV and clinicians seek assurance that an undetectable VL under currently accepted definitions has been both obtained and sustained over time.^{22,23} Accessibility and scale-up of VL testing and monitoring are therefore critical for PLHIV and HIV care providers, including clinicians, peer educators, HIV counselors, and allied health professionals. The scale-up of plasma-based VL testing is not only beneficial for ensuring no onward sexual transmission of HIV but also for treatment management for PLHIV who have VLS but have not attained VL ≤50 c/mL.

Several limitations exist in our analysis. First, these cross-sectional study results cannot provide longitudinal evidence of the durability of undetectable VL among PLHIV. However, these data are nationally representative across multiple countries and were collected using the same methods, thereby strengthening the inferences drawn from cross-sectional data. Second, since we restricted our analysis to participants aged 15–59 years, the results are not generalizable to PLHIV of all ages. Third, we relied on self-reported ART duration to determine whether participants were on treatment for 12 months and did not ascertain these data from clinical records. Because we observed a small but increased percentage of undetectable results in this self-reported sample, we posited that the duration of ART use was largely accurate. Despite these limitations, the results of this multinational PHIA analysis offer compelling support for the widespread adoption of the U=U message as a public health intervention across all countries, even in resource-limited settings that do not have universal access to plasma-based VL testing.^{3,5,24}

Conclusion

Nearly all PLHIV with VL <1000 c/mL from plasma samples in the PHIA surveys attained undetectable VL <200 c/mL and ≤50 c/mL, indicating no risk of transmitting HIV to their sexual partners. The finding provides indirect evidence that in regions with limited access to plasma VL testing, the majority of PLHIV with a DBS VL test result <1000 c/mL likely fall below 200 c/mL or are undetectable based on the assay's lower limit of detection. U=U messaging in resource-limited settings can motivate those who are unsure of their HIV-positive status to seek HIV testing promptly, enabling PLHIV to initiate treatment and effectively suppress their HIV VL.²¹ Further efforts must consider local context to ensure that U=U messaging is effectively communicated by health care providers and public health practitioners, particularly in low- and middle-income countries.²⁴ U=U applies to those with a suppressed VL <1000 c/mL, highlighting the importance of enhancing accessibility to VL testing and monitoring, even in remote areas using DBS testing.

Acknowledgments

We would like to acknowledge the study teams, Ministries of Health, field staff members, laboratorians, and survey participants from Cameroon, Côte d'Ivoire, Eswatini, Ethiopia, Lesotho, Malawi, Namibia, Rwanda, Tanzania, Uganda, Zambia, and Zimbabwe.

This research has been supported by the President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention (CDC) under the terms #U2GGH001271 and #U2GGH001226.

Disclaimer

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

Data Availability Statement

The data used in this manuscript are publicly available from the Population-based HIV Impact Assessment (PHIA) Project website <https://phia-data.icap.columbia.edu/>

References

1. Wada N, Jacobson LP, Cohen M, French A, Phair J, Muñoz A. Cause-specific life expectancies after 35 years of age for human immunodeficiency syndrome-infected and human immunodeficiency syndrome-negative individuals followed simultaneously in long-term cohort studies, 1984-2008. *Am J Epidemiol*. 2013;177(2):116–125. doi:10.1093/aje/kws321 [PubMed: 23287403]
2. Eisinger RW, Dieffenbach CW, Fauci AS. HIV Viral Load and Transmissibility of HIV Infection: Undetectable Equals Untransmittable. *JAMA*. 2019;321(5):451–452. doi:10.1001/jama.2018.21167 [PubMed: 30629090]
3. 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
4. Prevention Access Campaign. Why is U=U important? Accessed June 8, 2025. <https://preventionaccess.org/about-introduction/>
5. World Health Organization. The Role of HIV Viral Suppression in Improving Individual Health and Reducing Transmission.; 2023. Accessed October 2, 2024. <https://www.who.int/publications/i/item/9789240055179>
6. Weld ED. Limits of Detection and Limits of Infection: Quantitative HIV Measurement in the Era of U = U. *J Appl Lab Med*. 2021;6(1):324–326. doi:10.1093/jalm/jfaa176 [PubMed: 33438739]
7. Simushi P, Kalunga MN, Mwakyoma T, et al. Verification of dried blood spot as a sample type for HIV viral load and early infant diagnosis on Hologic Panther in Zambia. *BMC Res Notes*. 2023;16(1):75. doi:10.1186/s13104-023-06344-9 [PubMed: 37165436]
8. Smit PW, Sollis KA, Fiscus S, et al. Systematic Review of the Use of Dried Blood Spots for Monitoring HIV Viral Load and for Early Infant Diagnosis. *PLoS One*. 2014;9(3):e86461. doi:10.1371/journal.pone.0086461 [PubMed: 24603442]
9. World Health Organization. Consolidated Guidelines on HIV Prevention, Testing, Treatment, Service Delivery and Monitoring: Recommendations for a Public Health Approach. World Health Organization; 2021. Accessed October 1, 2024. <http://www.ncbi.nlm.nih.gov/books/NBK572729/>
10. Johannessen A, Garrido C, Zahonero N, et al. Dried Blood Spots Perform Well in Viral Load Monitoring of Patients Who Receive Antiretroviral Treatment in Rural Tanzania. *Clinical Infectious Diseases*. 2009;49(6):976–981. doi:10.1086/605502 [PubMed: 19663598]
11. Arredondo M, Garrido C, Parkin N, et al. Comparison of HIV-1 RNA Measurements Obtained by Using Plasma and Dried Blood Spots in the Automated Abbott Real-Time Viral Load Assay. *Journal of Clinical Microbiology*. 2020;50(3):569–572. doi:10.1128/jcm.00418-11
12. Zeh C, Ndiege K, Inzaule S, et al. Evaluation of the performance of Abbott m2000 and Roche COBAS Ampliprep/COBAS Taqman assays for HIV-1 viral load determination using

- dried blood spots and dried plasma spots in Kenya. PLOS ONE. 2017;12:e0179316. doi:10.1371/journal.pone.0179316 [PubMed: 28622370]
13. Kerschberger B, Ntshalintshali N, Mpala Q, et al. Field Suitability and Diagnostic Accuracy of the Biocentric Open Real-Time PCR Platform for Dried Blood Spot-Based HIV Viral Load Quantification in Eswatini. *J Acquir Immune Defic Syndr*. 2019;82(1):96–104. doi:10.1097/QAI.0000000000002101 [PubMed: 31408452]
 14. Pollack TM, Duong HT, Truong PT, Pham TT, Do CD, Colby D. Sensitivity and specificity of two dried blood spot methods for HIV-1 viral load monitoring among patients in Hanoi, Vietnam. Mohamed TJ, ed. *PLoS ONE*. 2018;13(1):e0191411. doi:10.1371/journal.pone.0191411 [PubMed: 29346431]
 15. Vubil A, Zicai AF, Siteo N, et al. Accurate HIV viral load measurement in primary health care settings using the cobas® plasma separation card. Andrei G, ed. *PLoS ONE*. 2020;15(5):e0232122. doi:10.1371/journal.pone.0232122 [PubMed: 32374748]
 16. ICAP at Columbia University. PHIA Data Use Manual. <https://phia-data.icap.columbia.edu/storage/Country/28-09-2021-22-01-17-615390ad6a147.pdf>
 17. Sachathep K, Radin E, Hladik W, et al. Population-Based HIV Impact Assessments Survey Methods, Response, and Quality in Zimbabwe, Malawi, and Zambia. *JAIDS Journal of Acquired Immune Deficiency Syndromes*. 2021;87:S6. doi:10.1097/QAI.0000000000002710 [PubMed: 34166308]
 18. ICAP at Columbia University. PHIA Project - Guiding the Global HIV Response. Accessed June 8, 2025. <https://phia.icap.columbia.edu/>
 19. Lin TH, Cervantes FI, Saito S, Bain R. Evaluating Nonresponse Weighting Adjustment for the Population-Based HIV Impact Assessment Surveys on Incorporating Survey Outcomes. *J Acquir Immune Defic Syndr*. 2021;87(Suppl 1):S52–S56. doi:10.1097/QAI.0000000000002636 [PubMed: 33512850]
 20. Ford OG, Rufurwadzo TG, Richman B, Green I, Alesi J. Adopting U = U to end stigma and discrimination. *J Int AIDS Soc*. 2022;25(3):e25891. doi:10.1002/jia2.25891 [PubMed: 35229483]
 21. Smith P, Bottenheim A, Schmucker L, Bekker L, Thirumurthy H, Davey D. Undetectable = Untransmittable (U = U) Messaging Increases Uptake of HIV Testing Among Men: Results from a Pilot Cluster Randomized Trial. *AIDS and behavior*. 2021;25(10). doi:10.1007/s10461-021-03284-y
 22. Calabrese SK, Mayer KH. Stigma impedes HIV prevention by stifling patient-provider communication about U = U. *J Int AIDS Soc*. 2020;23(7):e25559. doi:10.1002/jia2.25559 [PubMed: 32686324]
 23. Ngure K, Ongolly F, Dolla A, et al. “I just believe there is a risk” understanding of undetectable equals untransmissible (U = U) among health providers and HIV-negative partners in serodiscordant relationships in Kenya - PubMed. *J Int AIDS Soc*. 2020;23(3)(e25466). doi:10.1002/jia2.25466
 24. Centers for Disease Control and Prevention Division of Global HIV and TB. Implementing and Scaling Up Undetectable = Untransmittable (U=U): A Resource Guide. Published online 2024.

Table:

HIV viral load suppression and proportion with undetectable viral load (<200 c/mL and ≤50 c/mL) among people living with HIV aged 15–59 years on antiretroviral therapy (ART) from the Population-based HIV Impact Assessment Surveys in 13 African countries, 2015–2019 (N = 16,533)

Country	N	<1000 c/mL % (95% CI) †	<200 c/mL % (95% CI) ‡	≤50 c/mL % (95% CI) §	<200 c/mL, reported ART ≥12 months % (95% CI) ‡	≤50 c/mL, reported ART ≥12 months % (95% CI) §
Total	16,533	87.3 (86.6–88.0)	95.4 (94.9–95.8)	84.9 (84.2–85.7)	96.6 (96.2–97.0)	87.4 (86.6–88.2)
Country						
Cameroon	426	79.6 (75.6–83.5)	95.7 (94.7–96.6)	85.0 (82.5–87.6)	98.3 (96.9–99.7)	89.1 (86.9–91.4)
Côte d'Ivoire	188	74.8 (68.8–80.8)	92.4 (86.9–97.8)	72.3 (64.1–80.5)	95.7 (84.0–100)	80.3 (68.8–91.8)
Eswatini	2,101	91.0 (89.9–92.1)	95.8 (94.7–96.9)	86.6 (84.7–88.5)	96.7 (95.7–97.6)	89.0 (87.4–90.7)
Ethiopia	455	87.5 (84.6–90.4)	96.5 (95.0–97.9)	81.9 (78.5–85.3)	97.2 (96.0–98.5)	81.9 (78.3–85.5)
Kenya	1,073	90.2 (88.4–92.0)	95.4 (94.1–96.6)	82.5 (80.2–84.9)	95.9 (94.6–97.2)	83.2 (80.4–86.0)
Lesotho	2,349	87.9 (86.4–89.4)	95.9 (95.0–96.8)	87.3 (85.9–88.7)	96.9 (95.9–97.8)	90.1 (88.6–91.6)
Malawi	1,499	91.3 (89.4–93.1)	95.7 (94.4–97.0)	92.2 (90.5–94.0)	96.9 (95.9–97.9)	95.5 (94.2–96.8)
Namibia	1,922	91.7 (90.3–93.2)	95.7 (94.6–96.8)	83.5 (81.4–85.7)	96.7 (95.7–97.7)	84.8 (82.6–86.9)
Rwanda	722	90.2 (88.1–92.3)	96.3 (95.2–97.4)	88.6 (86.8–90.4)	97.2 (95.9–98.4)	90.5 (88.5–92.6)
Tanzania	939	87.3 (85.0–89.6)	95.9 (94.7–97.1)	85.0 (82.5–87.6)	97.9 (97.2–98.7)	89.5 (86.7–92.2)
Uganda	1,116	84.1 (82.2–86.1)	92.7 (90.8–94.5)	75.9 (73.0–78.8)	94.2 (92.3–96.0)	77.7 (74.5–81.0)
Zambia	1,465	88.9 (87.1–90.7)	95.9 (94.8–96.9)	88.5 (86.7–90.2)	97.2 (96.4–98.1)	91.1 (89.6–92.6)
Zimbabwe	2,278	85.1 (83.5–86.4)	96.4 (95.6–97.3)	89.7 (88.4–91.1)	97.0 (96.2–97.8)	91.4 (90.2–92.6)
Sex						
Male	4,742	85.7 (84.5–87.0)	94.7 (93.8–95.5) *	80.4 (79.0–81.9) *	96.1 (95.4–96.9)	83.3 (81.6–85.0) *
Female	11,791	88.0 (87.3–88.8)	95.7 (95.2–96.2)	87.0 (86.2–87.8)	96.8 (96.3–97.3)	89.2 (88.4–90.0)
Age (years)						
15–24	1,369	78.7 (75.8–81.7)	92.4 (90.4–94.4)	80.2 (76.9–83.5)	94.9 (92.9–96.9)	83.0 (79.1–86.9)
25–34	4,269	85.0 (83.6–86.5)	94.9 (94.0–95.7) *	84.6 (83.1–86.1) *	96.2 (95.3–97.0)	88.3 (86.8–89.8) *
35–44	5,850	87.3 (86.3–88.4)	95.2 (94.4–95.9) *	84.9 (83.7–86.2) *	96.4 (95.7–97.1)	87.2 (85.9–88.5) *
45–59	5,045	91.5 (90.6–92.5)	96.8 (96.2–97.3) *	86.4 (85.1–87.6) *	97.3 (96.8–97.9) *	87.6 (86.4–88.9) *
Residence						
Urban	6,821	86.9 (85.8–88.0)	95.6 (94.9–96.3)	84.6 (83.3–85.8)	96.8 (96.2–97.5)	86.8 (85.5–88.2)
Rural ††	9,712	87.6 (86.7–88.4)	95.2 (94.6–95.8)	85.2 (84.2–86.2)	96.4 (95.9–96.9)	87.8 (86.8–88.8)

ART=antiretroviral therapy; c/mL=copies/milliliter of HIV-1 RNA, CI=confidence interval

[†] Weighted percentage; 2016 World Health Organization (WHO) definition of viral load suppression <1000 c/mL

[‡] Weighted percentage among those with viral load suppression <1000 c/mL; 2016 WHO definition of undetectable viral load (<200 c/mL)

[§] Weighted percentage among those with viral load suppression <1000 c/mL; 2021 WHO definition of undetectable viral load (≤50 c/mL)

^{††} Data from the Ethiopia survey included urban areas only

^{*} p-value <0.05