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Comparison of HIV prevalence, incidence, and viral load suppression in Zambia population-based HIV impact assessments from 2016 and 2021

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Conflicts of interest

There are no conflicts of interest.

Abstract

Background: The Zambian government has implemented a public health response to control the HIV epidemic in the country. Zambia conducted a population-based HIV impact assessment (ZAMPHIA) survey in 2021 to assess the status of the HIV epidemic to guide its public health programs.

Methods: ZAMPHIA 2021 was a cross-sectional two-stage cluster sample household survey among persons aged ≥15 years conducted in Zambia across all 10 provinces. Consenting participants were administered a standardized questionnaire and whole blood was tested for HIV according to national guidelines. HIV-1 viral load (VL), recent HIV infection, and antiretroviral medications were tested for in HIV-seropositive samples. Viral load suppression (VLS) was defined as <1000 copies/ml. ZAMPHIA 2021 results were compared to ZAMPHIA 2016 for persons aged 15–59 years (i.e., the overlapping age ranges). All estimates were weighted to account for nonresponse and survey design.

Results: During ZAMPHIA 2021, of 25 483 eligible persons aged ≥15 years, 18 804 (73.8%) were interviewed and tested for HIV. HIV prevalence was 11.0% and VLS prevalence was 86.2% overall, but was <80% among people living with HIV aged 15–24 years and in certain provinces. Among persons aged 15–59 years, from 2016 to 2021, HIV incidence declined from 0.6% to 0.3% (*P*-value: 0.07) and VLS prevalence increased from 59.2% to 85.7% (*P*-value: <0.01).

Discussion: Zambia has made substantial progress toward controlling the HIV epidemic from 2016 to 2021. Continued implementation of a test-and-treat strategy, with attention to groups with lower VLS in the ZAMPHIA 2021, could support reductions in HIV incidence and improve overall VLS in Zambia.

Keywords

Africa; HIV; incidence; prevalence; viral suppression; Zambia

Background

The HIV epidemic in Zambia contributed to a significant decline in life expectancy at birth from 55 years in 1978 to 45 years in 2000 [1,2]. To respond to this epidemic, the Zambian government adapted and implemented various guidelines from the World Health Organization to reduce new infections, and HIV-related morbidity and mortality. Two key guidelines implemented by Zambia are the ‘Treat All’ and ‘test-and-treat’ strategies introduced in 2016 [3,4], which focuses on scaling up antiretroviral therapy (ART) to all people living with HIV (PLHIV) as quickly as possible irrespective of their immune status to reduce new HIV infections and to provide life-saving therapy. Furthermore, Zambia adopted integrase inhibitors-containing first line ART regimens during 2018–2019, given evidence of superior VLS performance [5].

Zambia, with the support of the U.S. government President’s Emergency Plan for AIDS Relief (PEPFAR), started offering ART in the public sector in 2003 to PLHIV with advanced illness (e.g., $CD4^+$ cell count of <200 cells/mm^3, WHO clinical stage 3/4 conditions). Over the next decade, treatment criteria were expanded incrementally and, before the rollout of

Treat All in 2016, approximately 60% of PLHIV in Zambia were on ART [6]. With the adoption of the Treat All and test-and-treat strategies, there has been substantial expansion of ART treatment throughout Zambia, with an estimated 1.2 million PLHIV receiving ART in 2022 [7,8].

Understanding the status of the HIV epidemic in Zambia is critical to assess the impact of programmatic interventions implemented by the government and its partners and to assess the country's progress towards the Joint United Nations Programme on HIV/AIDS (UNAIDS) 90–90–90 targets [9]. To measure the status of the HIV epidemic and the impact of the public health response, Zambia implemented one of the first Population-Based HIV Impact assessments (PHIAs) in 2016 which provided direct measures HIV prevalence and viral load suppression (VLS) prevalence. The Zambia Population-based HIV Impact Assessment (ZAMPHIA) 2016 demonstrated an HIV prevalence of 12.0% among persons aged 15–59 years and HIV treatment coverage of 61.1% [6]. Nationally, less than two-thirds (59.2%) of PLHIV aged 15–59 years were virally suppressed (defined as HIV viral load [VL] <1000 copies/ml), meaning a large portion of PLHIV with unsuppressed VLs remained capable of transmitting the virus to other persons [10,11]. ZAMPHIA 2016 also highlighted gaps in different sub-populations and regions, especially among adolescents and young adults aged 15–24 years and in Western Province. In response to the findings from ZAMPHIA 2016, Zambia has substantially expanded its treatment program, began transitioning to integrase inhibitors-containing first line therapy regimens, and established the 'undetectable = untransmittable (U = U)' campaign.

Population-based surveys, such as ZAMPHIA, provide data transparency that offers evidence to support major public health programs led by host and donor governments. Additionally, monitoring HIV epidemic control using rigorous survey methods informs policymakers to guide additional public health interventions and close gaps in sub-populations. No similar nationally representative surveys of the HIV program have been conducted since the first ZAMPHIA in 2016. In 2021, the Government of the Republic of Zambia conducted a second ZAMPHIA survey among persons aged ≥15 years to assess the status of the HIV epidemic in Zambia. Here in, we report on HIV prevalence, VLS prevalence, and HIV incidence among participants and compare these findings to ZAMPHIA 2016.

Methods

ZAMPHIA 2021 was a population-based cross-sectional two-stage cluster sample design household survey among persons aged ≥15 years conducted in Zambia from May to December 2021. The primary objective of ZAMPHIA 2021 was to measure provincial level VLS prevalence. Secondary objectives included estimating HIV prevalence, national HIV incidence, and provincial-level progress towards UNAIDS' targets (the last of which are reported elsewhere [12]).

Nationally, 404 (1.6%) standardized enumeration areas (EAs) out of 25 631 EAs from the 2010 census were randomly selected as primary sampling units using probability proportional to size. The EAs per province ranged from 29 EAs in Southern Province to

57 in Muchinga Province. A total of 403 EAs were completed during the survey, with one EA being excluded after having been found to be located in the Democratic Republic of Congo following border re-demarcation. All households within each of the 403 EAs were listed and depending on the growth or decline of the EA since the census, an average of 30 households (ranging between 10 and 60 households) from each EAwere randomly selected for the survey, using an equal probability method. The ZAMPHIA 2021 was scheduled to begin in March 2020, however due to the COVID-19 pandemic, data collection was delayed until May 2021, when it eventually commenced and ended in December 2021.

All individuals aged ≥15 years who had slept in the house the night (i.e., de facto) before the survey team visited the household were eligible for participation in the survey. Participants provided informed consent (or assent, with parental/guardian permission) for inclusion in the study. All methods were carried out in accordance with relevant guidelines and regulations.

Participants were administered a standardized electronic questionnaire and whole blood was drawn for HIV testing and associated laboratory tests. The questionnaire contained information about demographics, HIV risk behaviors, and HIV care and treatment (for PLHIV). The questionnaires were administered in English, Bemba, Kaonde, Lozi, Lunda, Luvale, Nyanja, and Tonga depending on the participant's preferred language.

Rapid testing for HIV-antibodies was conducted during the survey according to the national guidelines, which uses two third-generation serological assays to confirm a diagnosis, namely Determine HIV-1/2 (Abbott, California, USA), as the first test and SD Bioline HIV-1/2 (Abbott, California, USA) as a second test. In addition, Geenius HIV-1/2 confirmatory test (Bio-Rad, California, USA) was conducted for all HIV-seropositive diagnosis and inconclusive samples. For confirmed HIV-seropositive samples, additional laboratory testing was done, including VL (HIV RNA copies/ml) and qualitative detection of antiretroviral (ARV) medications (i.e., atazanavir, dolutegravir, efavirenz, lopinavir, and nevirapine) using a high-resolution liquid chromatography tandem mass-spectrometry method developed and validated at the International Laboratory Branch, CDC (Atlanta, Georgia, United States). Additionally, an incidence testing algorithm (HIV-1 limiting antigen avidity enzyme immunoassay [LAg] with correction for VL and detectable ARVs) was used to distinguish recent from long-term HIV infection [13].

The main outcome measures for this analysis were HIV prevalence, HIV incidence, and VLS prevalence. HIV prevalence was calculated as a weighted estimate based on the number of participants who tested HIV seropositive divided by the total number of participants with HIV tests done during the PHIA survey. HIV incidence (HIV infections per year) and 95% confidence intervals (CIs) were calculated using the formula recommended by WHO [14]. VLS prevalence was calculated as a weighted estimate based on the number of PLHIV with a VL <1000 copies/ml divided by the total number of PLHIV with a VL result during the PHIA survey. Participants were considered aware of their HIV diagnosis if they stated so in the questionnaire or had the presence of detectable ARVs in their blood [15].

Sampling weights were calculated based on the sampling selection probabilities and nonresponse (for household and individual questionnaires and blood draw/test).

Additionally, each set of weights was calibrated to the population estimates at the national level by age and sex (based on 2010 Zambia Census projections for 2021 [16]). CIs were computed by the jackknife method with replicate weights. Variance estimation accounted for clustering at province and standardized enumeration areas when calculating 95% CIs and during hypothesis testing.

Logistic regression was used to assess the association between HIV prevalence and VLS prevalence and demographic and behavioral (i.e., HIV risk) characteristics. Multivariable models for HIV and VLS prevalence were constructed with variables with a *P*-value for their association with the outcome of <0.2 in bivariable analysis. We excluded from the multivariable model the variables pregnancy status, male circumcision status, and age at first sex since these questions only applied to a subset of the study participants. Furthermore, history of ever testing for HIV was excluded from VLS prevalence multivariable model because PLHIV who never tested were not expected to be virally suppressed. Additionally, for VLS prevalence, we did a sub-analysis restricted to PLHIV who were aware of their HIV status.

Comparisons were made between the ZAMPHIA 2016 and 2021 surveys for PLHIV aged 15–59 years, which were the overlapping age ranges in both surveys. Differences in HIV prevalence and VLS prevalence from 2016 to 2021 were compared using a chi-square test. In order to assess whether there were significant changes in HIV incidence between ZAMPHIA 2016 and 2021, risk ratios (RR = p1/p2) and were estimated using data from the two surveys and 95% confidence intervals were calculated under the assumption that the ln(RR) was normally distributed as RR*exp (−1.96*seln_ratio) to RR*exp(1.96*seln_ratio[‡]). Methods for the ZAMPHIA 2016 were reported elsewhere [6].

Analyses were done using the survey package in R (version 4.2.2) and Microsoft Excel (version 2208). Since survey weights were used for all estimates, raw frequencies were not reported in this analysis except for overall enrollment and response rates. Where 95% CIs appear in tables, they are omitted from the text. *P*-values <0.05 were considered statistically significant.

The study protocol was approved by the University of Zambia Biomedical Research and Ethics Committee in Lusaka, Zambia, and the Institutional Review Boards of the University of Maryland, Baltimore, and CDC. Detailed methods are available in the ZAMPHIA Technical Report, which can be found online: https://nada.zamstats.gov.zm/index.php/catalog/1/related-materials

Results

Of 12 245 households selected, 11 553 were eligible and 10 627 (92.0%) households were enrolled in ZAMPHIA 2021 (Figure 1, Supplemental Digital Content, http://links.lww.com/QAD/D107). Among 25 483 eligible adults aged ≥15 years, 18 804 (73.8%)

[‡]The seln_ratio was calculated as sqrt[(var(p1)/p1^2) + (var (p2)/p2^2)] using the identities that var[ln(p1/p2)] = var[ln(p1) — ln(p2)] = var(ln(p1)) + var(ln(p2)), and using the Delta method to calculate var(ln(p1)) and var(ln(p2)). The z-statistic was calculated as Z = ln(p1/p2) /seln_ratio and the p-value (probability ln(p1/p2) = 0) was calculated using the cumulative standard normal distribution.

were interviewed and tested for HIV. Of participants tested for HIV, the mean age was 33.0 years (range: 15–95) and 51.1% were female (Table 1); PLHIV differed in demographic characteristics compared to persons who were HIV negative.

HIV prevalence among persons aged ≥15 years in Zambia was 11.0% in 2021, ranging from 5.8% (Northern province) to 14.4% (Lusaka province) (Table 2). HIV prevalence was higher among women than men (13.9% vs. 8.0%, respectively; adjusted odds ratio [aOR]: 2.3) and HIV prevalence was highest among persons aged 45–59 years (25.1%). In the multivariable model, most factors were associated with HIV status, including sex, age group, province, urban/rural designation, marital status, wealth quintile, number of lifetime sexual partners, ever testing for HIV, alcohol use frequency, and having visited a health facility in the past 12 months (Table 2). Additionally, age at first sex, pregnancy status, and male circumcision status were associated with HIV status in bivariable regression.

The decrease in HIV prevalence among persons aged 15–59 years from 2016 (12.0%) to 2021 (11.1%), was not statistically significant ($P = 0.07$) (Table 3). HIV prevalence among men aged 15–59 years declined from 2016 to 2021 (9.3–7.8%; P-value = 0.02) while among women the decline was not statistically significant (14.6–14.2%; P-value = 0.54). Although the mean age of PLHIV increased from 2016 to 2021 (37.0 years to 38.7 years; P-value < 0.01), there was a corresponding decline in HIV prevalence among persons aged 15–24 years (3.8–2.8%; P-value: 0.01) and 25–44 years (16.6–13.8%; P-value < 0.01) and a nonsignificant increase in HIV prevalence among those aged 45–59 years (21.7–25.1%; P-value: 0.07). HIV prevalence did not decline significantly in most provinces (Northern Province being an exception).

Overall, HIV incidence was 0.3% among persons aged ≥15 years in Zambia in 2021 (0.6% in women and 0.1% in men). Among persons aged 15–59 years, the decline in HIV incidence from 2016 (0.6%) to 2021 (0.3%) was not statistically significant (risk ratio: 0.55; P-value: 0.07) (Table 4).

Among PLHIV aged ≥15 years in Zambia, 86.2% were virally suppressed in 2021 (Table 2). In the multivariable model, VLS prevalence increased with age. VLS prevalence was also greater among PLHIV in rural areas and among those who visited a health facility in the past year. Luapula, Muchinga, and Northern Provinces all had lower odds of VLS prevalence compared to Lusaka Province. In the sub-analysis restricted to PLHIV who were aware of their status, statistically significant differences by province were not observed, although persons in rural areas still had higher VLS compared to urban areas (Table 1, Supplemental Digital Content, http://links.lww.com/QAD/D108). VLS prevalence among PLHIV aged 15–24 years varied from 34.1% (Muchinga Province) to 82.0% (Luapula Province), albeit with very wide confidence intervals (Table 2, Supplemental Digital Content, http://links.lww.com/QAD/D109). Nearly all (96.3% [95% CI: 95.0–97.3]) PLHIV on ART were virally suppressed. PLHIV who were on dolutegravir-based regimens had greater odds of VLS than those on other ART regimens (OR: 4.9) (Table 3, Supplemental Digital Content, http://links.lww.com/QAD/D110).

VLS prevalence among PLHIV aged 15–59 years increased from 59.2% in 2016 to 85.7% in in 2021, a 26.5 percentage points absolute increase in VLS (*P*-value < 0.01) (Table 3). VLS prevalence increased for both sexes, all age groups, all provinces, and among urban and rural dwelling PLHIV during this period. Among participants aged 15–24 years, VLS prevalence significantly increased from 34.3% in 2016 to 70.9% in 2021. In 2016, Western Province had the lowest VLS prevalence in Zambia (47.3%), but by 2021, Western Province had made the greatest gain, with VLS prevalence of 87.1% among PLHIVaged 15–59 years in the province (Table 3, Fig. 1). Gains in VLS prevalence ranged by province from 12.9 percentage points (Muchinga Province) to 39.8 percentage points (Western Province).

Discussion

Zambia has made substantial progress toward controlling the HIV epidemic in the country since 2016. VLS prevalence increased across age, sex, and geographic location in Zambia in the context of implementing test- and-treat and U= U strategies coupled with the adoption of dolutegravir-based ARV regimens and differentiated service delivery models (e.g., multimonth ART dispensing). Zambia's public health response to HIV coincided with an increase in life expectancy from a nadir of 45 years in 2000 to 63 years in 2019 (the most recent estimate) [1]. The adoption of test-and-treat in Zambia also corresponded with a substantial decline (~50%) in advanced HIV disease from 2016 to 2021 [17]. The findings from ZAMPHIA 2021 findings provide evidence of the Zambia HIV program's achievements that has changed the trajectory of declining life expectancy when HIV treatment was not widely available to recovering and increasing life expectancy with the scale-up of life-saving ART throughout the country [18]. The country is likely on target to achieve HIV epidemic control by the end of this decade.

From 2016 to 2021, HIV incidence decreased by 50% among persons aged 15–59 years, although the difference did not reach the statistically significant threshold of $P < 0.05$. This is likely because of the small number of observed HIV recent infections – which serve as the numerator in the incidence calculation [19] – in both surveys. The drop in HIV prevalence among persons aged 15–24 years, which could be a surrogate for HIV incidence, support that the drop in incidence is real. This is potentially a result of successful package of HIV prevention programs provided in Zambia, including widespread HIV testing, prevention of mother-to-child programs (PMTCT), voluntary medical male circumcision (VMMC), oral preexposure prophylaxis (PrEP), and consistent condom use [20]. The drop in HIV prevalence among men could reflect the impact of VMMC services in Zambia resulting in lower HIV incidence and prevalence among younger males [21,22].

The aging of PLHIV in Zambia between 2016 and 2021 suggest improved long-term survival due to improved access to treatment with more efficacious and safer HIV treatment regimens and evidence-based prevention programs. Looking forward, the successes of the country's HIV program in treating HIV and suppressing VLs is likely to contribute to a new challenge of managing noncommunicable diseases brought on by the increasing number of PLHIV living longer lives in Zambia and complications associated with long term ART [23]. For example, hypertension is common among older PLHIV in Zambia [24]. Additional exploration of HIV and chronic comorbidities in Zambia is warranted.

Zambia's progress in controlling HIV is in-line with other countries in Africa experiencing generalized HIV epidemics [25–29]. VLS prevalence significantly increased across demographic variables and, notably, in some groups it is very high. Greater VLS translates to less onward HIV transmission, demonstrating the impact of government-led public health programs supported by PEPFAR and the Global Fund for HIV, Tuberculosis, and Malaria. A multipronged, evidence-based approach anchored by a robust, Zambian-led HIV care program – including evidence-based targeted HIV case finding (e.g., sexual contact and social networks testing), early initiation of ART for all PLHIV who test positive, robust roll out of the dolutegravir-based ART replacing efavirenz or nevirapine based ART, patient-centered service delivery models that bring services to patients wherever they are, and combination prevention programs (i.e., PMTCT, DREAMs, PrEP, condoms, and VMMC) – is likely responsible for Zambia's major progress toward controlling HIV [30].

Despite the achievements of the Zambian HIV program, additional work is needed to end the HIV epidemic in the country. In particular, younger age groups have lower VLS, and combined with lower HIV status awareness and higher HIV incidence [12,31–33], represent a major area of challenge. Strengthening HIV prevention services among this group including scale up of PrEP and strengthening case finding using successful strategies from within and outside Zambia, and scaling up youth-friendly HIV service delivery models might help reduce overall incidence in this age group. Further, introduction of long-acting injectable PrEP might increase uptake and continuation, especially among this age group.

Furthermore, the HIV epidemic in Africa is not monolithic; studies of HIV genomes in Africa demonstrate a mosaic of epidemics occurring in different geographic and epidemiologic subgroups [34]. While the ZAMPHIA studies focused on HIV among the general population in Zambia, key populations such as persons who inject drugs (PWIDs), men who have sex with men (MSM), transgender women, female sexual workers, fisherfolk, and prisoners experience high HIV disease burden, often with worse engagement in prevention and treatment programs. For example, biobehavioral studies done among MSM and PWID during 2021–2022 demonstrated elevated HIV prevalence and low VLS prevalence in several towns in Zambia [35,36], pointing to a need to scale and enhance evidence-based prevention and treatment strategies catered to these marginalized groups.

Zambia's progress on VLS prevalence is particularly notable given it is the main predictor of disease transmission and progression [37]. However, there was substantial variability by province in both HIV and VLS prevalence, which is sometimes explained by the geographic remoteness of populations in some of lower performing provinces. However, the variability in VLS prevalence gains might not be attributed to remoteness, as Western Province – which is vast, sparsely populated, and difficult to traverse – saw the greatest gains from 2016 to 2021. Service delivery models for HIV care vary in Zambia, with a pattern from ZAMPHIA 2021 indicating that government-delivered HIV care services might have advantages to services delivered by third-party nongovernmental organizations [38]. Further interrogation of programmatic differences in higher and lower performing provinces could reveal important lessons to scale throughout Zambia. For example, province with government-led HIV services reach all districts, and technical support from donor governments can yield notable improvements over short periods [30].

The ZAMPHIA 2016 and 2021 surveys were robust studies that provided representative data to inform public health programming in Zambia by directing resources for HIV prevention and treatment to who and where they are needed. These studies, supported by PEPFAR and CDC, have provided unparalleled insight into the global HIV pandemic which provides transparency for the public to understand the impact of public health investments. However, PHIAs are expensive. Continued, systematic collection of high-quality programmatic data can serve as an important compliment to rigorous epidemiologic studies like ZAMPHIA.

This study had several limitations. As an observational study, causality cannot be inferred from associations. Subnational HIV incidence estimates were not possible given the small number of recent infections. The COVID-19 pandemic and social disruptions related to unsubstantiated reports of gassing for surreptitious blood collection [39] could have affected participation or biased enrollment in unmeasured ways. However, the overall response rate for the survey was sufficient to produce robust population-based estimates. Lastly, the ZAMPHIA 2021 did not include children aged 0–14 years because a lower HIV prevalence in this group would have necessitated a very large sample size to achieve survey objectives. However, this population is of great programmatic significance given overall lower awareness of HIV serostatus, lower HIV treatment coverage levels among those who are positive, and lower HIV VLS among those who are on treatment [6]. Alternative strategies are needed to rigorously and precisely determine key HIV indicators in this group.

Continued implementation of test-and-treat and U = U strategies, with increased attention to groups with lower VLS prevalence in the ZAMPHIA 2021, could further reduce the force of infection. Enhancing case finding through strategies that have worked well in provinces that have achieved high VLS prevalence among all age groups could help identify remaining PLHIV who are unaware of their status in provinces with lower VLS prevalence. Additionally, robust tracking of VL test result coupled with decentralized laboratory systems help strengthen care for PLHIV in Zambia. As PLHIV age and acquire more chronic medical problems, Zambia might need to revisit its core package of HIV services. Scaling up evidence-based combination prevention activities – including long-acting injectable preexposure prophylaxis – can further help prevent new infections. Lastly, ensuring high quality programmatic data supplemented by periodic population-representative studies can help Zambia continue to closely monitor progress towards ending HIV.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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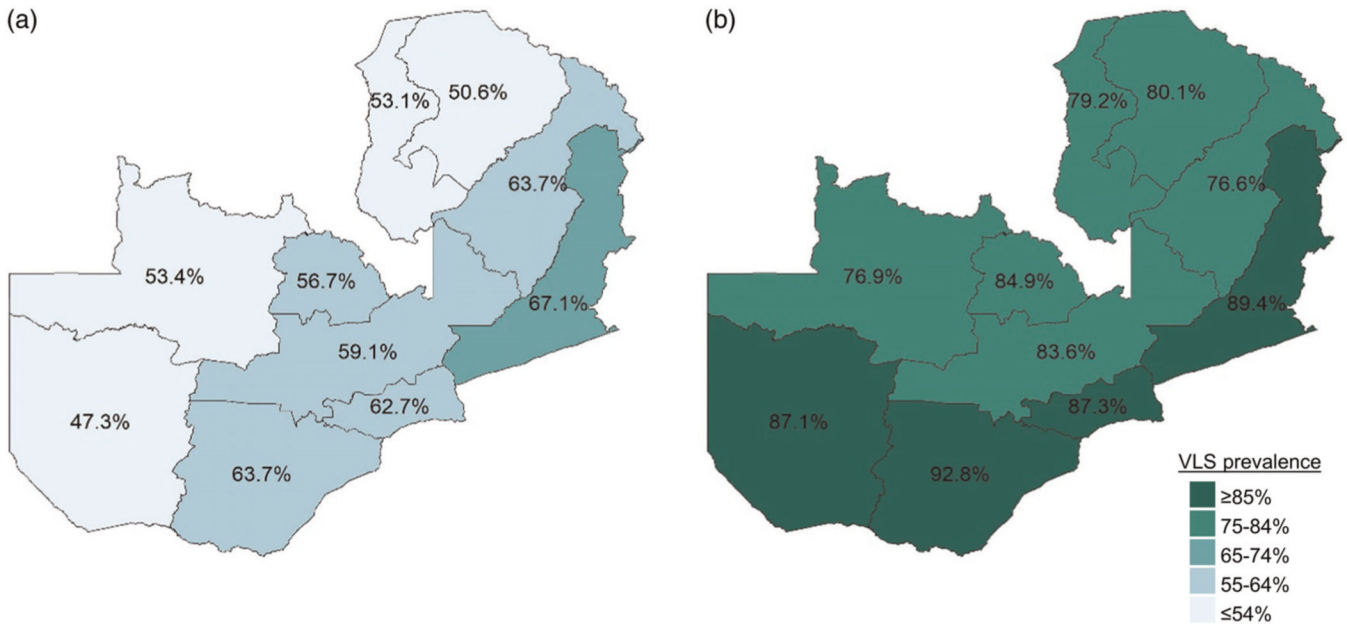

Fig. 1. HIV viral load suppression prevalence by province among persons living with HIV aged 15–59 years – Zambia 2016 (a) and 2021 (b).

VLS, viral load suppression.

Table 1.

Demographic characteristics of participants in ZAMPHIA 2021.

	Overall, % (*N* = 18 804)	HIV-positive, % (*N* = 2205)	HIV-negative, % (*N* = 16 599)	*P*-value
Sex				<0.01
Men	48.9	35.3	50.5	
Women	51.1	64.7	49.5	
Age group				<0.01
15–24	36.7	9.4	40.1	
25–44	42.7	53.2	41.4	
45–59	13.4	30.6	11.3	
≥60	7.2	6.8	7.2	
Province				<0.01
Central	11.6	12.3	11.5	
Copper belt	18.1	19.6	17.9	
Eastern	11.6	9.7	11.8	
Luapula	8.2	6.1	8.4	
Lusaka	16.9	22.1	16.2	
Muchinga	5.0	3.0	5.3	
Northern	6.3	3.3	6.6	
Northwestern	5.4	3.3	5.6	
Southern	8.9	10.7	8.7	
Western	8.1	10.0	7.8	
Urban/rural EA				<0.01
Urban	42.6	52.3	41.4	
Rural	57.4	47.7	58.6	

Estimates were weighted to account for nonresponse and survey design.

Table 2.

HIV prevalence and viral load suppression (VLS) prevalence by demographic characteristics and associated factors among persons aged ≥15 years in Zambia, 2021.

	HIV prevalence				VLS prevalence			
	% (95% CI) (*N* = 18 804)	OR (95% CI)	*P*-value*	aOR (95% CI)	% (95% CI) (N = 2205)	OR (95% CI)	*P*-value*	aOR (95% CI)
Zambia	11.0 (10.3–11.7)				86.2 (84.3–87.9)			
Sex			<0.01				0.59	
Men	8.0 (7.1–9.0)	Ref.		Ref.	85.5 (82.2–88.4)	Ref		
Women	13.9 (13.1–14.8)	1.87 (1.64–2.13)		2.30 (1.94–2.73)	86.6 (84.2–88.7)	1.09 (0.80–1.49)		
Age group			<0.01				<0.01	
15–24	2.8 (2.3–3.4)	Ref.		Ref.	70.9 (61.9–78.7)	Ref.		Ref.
25–44	13.8 (12.7–14.9)	5.47 (4.45–6.72)		3.36 (2.71–4.16)	85.1 (82.6–87.4)	2.35 (1.52–3.63)		2.05 (1.28–3.31)
45–59	25.1 (22.8–27.5)	11.49 (9.46–13.95)		7.53 (5.75–9.86)	91.4 (88.9–93.5)	4.38 (2.76–6.92)		4.14 (2.50–6.85)
≥60	10.4 (8.9–12.2)	3.99 (3.15–5.05)		2.71 (2.02–3.64)	92.5 (86.9–96.3)	5.10 (2.34–11.13)		4.99 (2.14–11.60)
Province			<0.01				0.01	
Central	11.7 (10.2–13.2)	0.78 (0.62–0.99)		1.09 (0.79–1.52)	84.1 (79.9–87.8)	0.73 (0.44–1.23)		0.71 (0.42–1.18)
Copperbelt	11.9 (10.9–13.0)	0.80 (0.65–0.99)		0.96 (0.75–1.23)	85.3 (78.6–90.6)	0.80 (0.44–1.48)		0.80 (0.45–1.42)
Eastern	9.2 (7.5–11.1)	0.60 (0.46–0.79)		0.94 (0.65–1.36)	89.7 (83.6–94.2)	1.21 (0.62–2.35)		1.03 (0.52–2.05)
Luapula	8.2 (7.0–9.6)	0.53 (0.41–0.68)		0.98 (0.69–1.38)	79.4 (70.6–86.5)	0.53 (0.28–1.00)		0.51 (0.27–0.93)
Lusaka	14.4 (12.1–17.1)	Ref.		Ref.	87.9 (82.3–92.2)	Ref.		Ref.
Muchinga	6.6 (5.5–7.8)	0.42 (0.32–0.54)		0.82 (0.58–1.16)	78.3 (71.3–84.2)	0.50 (0.28–0.87)		0.50 (0.27–0.95)
Northern	5.8 (4.8–7.1)	0.37 (0.28–0.48)		0.67 (0.47–0.95)	80.2 (69.5–88.4)	0.56 (0.27–1.16)		0.56 (0.26–1.20)
Northwestern	6.8 (5.3–8.5)	0.43 (0.32–0.59)		0.71 (0.50–1.01)	77.5 (69.3–84.5)	0.48 (0.26–0.87)		0.49 (0.27–0.88)
Southern	13.2 (9.6–17.7)	0.91 (0.62–1.32)		1.05 (0.69–1.62)	92.6 (87.8–95.9)	1.72 (0.85–3.50)		1.53 (0.74–3.17)

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	HIV prevalence				VLS prevalence			
	% (95% CI) (*N* = 18 804)	OR (95% CI)	*P*-value*	aOR (95% CI)	% (95% CI) (N = 2205)	OR (95% CI)	*P*-value*	aOR (95% CI)
Western	13.6 (11.2–16.3)	0.94 (0.71–1.24)		1.45 (1.06–1.99)	87.9 (83.4–91.5)	1.00 (0.57–1.76)		1.20 (0.65–2.23)
Urban/rural EA			<0.01				0.06	
Urban	13.5 (12.8–14.4)	Ref.		Ref.	84.6 (82.3–86.8)	Ref.		Ref.
Rural	9.2 (8.1–10.3)	0.64 (0.55–0.75)		0.70 (0.53–0.93)	87.9 (85.0–90.4)	1.32 (0.98–1.78)		1.40 (1.01–1.95)
Worked in past 12 months			0.28				0.64	
No	10.7 (10.0–11.5)	Ref.			85.9 (83.6–87.9)	Ref.		
Yes	11.5 (10.2–13.0)	1.08 (0.94–1.26)			86.8 (83.3–89.7)	1.08 (0.78–1.49)		
Marital status			<0.01				<0.01	
Never married	4.1 (3.5–4.9)	Ref.		Ref.	77.5 (71.1–83.1)	Ref.		Ref.
Married or living together	12.2 (11.1–13.3)	3.21 (2.72–3.77)		1.33 (1.12–1.58)	89.1 (87.2–90.9)	2.38 (1.60–3.54)		1.40 (0.87–2.25)
Divorced or separated	24.8 (21.9–27.9)	7.62 (5.99–9.70)		2.30 (1.79–2.95)	83.9 (78.2–88.6)	1.51 (0.92–2.48)		0.87 (0.51–1.50)
Widowed	30.3 (27.2–33.5)	10.03 (7.98–12.61)		3.70 (2.88–4.76)	85.2 (79.6–89.8)	1.68 (0.97–2.89)		0.73 (0.38–1.39)
Wealth quintile			<0.01				0.34	
1st	7.6 (6.7–8.6)	Ref.		Ref.	81.9 (76.8–86.3)	Ref.		
2nd	9.4 (8.2–10.7)	1.25 (1.05–1.50)		1.26 (1.00–1.59)	88.0 (84.0–91.3)	1.61 (1.09–2.39)		
3rd	11.7 (10.1–13.4)	1.60 (1.31–1.95)		1.50 (1.19–1.88)	86.1 (81.8–89.8)	1.37 (0.89–2.10)		
4th	14.9 (13.0–16.9)	2.12 (1.73–2.59)		1.64 (1.18–2.27)	87.4 (83.0–91.0)	1.53 (0.94–2.49)		
5th	10.9 (9.8–12.1)	1.48 (1.23–1.78)		1.11 (0.80–1.55)	85.8 (82.2–89.0)	1.34 (0.89–2.01)		
Lifetime sexual partners			<0.01				0.27	
None	3.1 (2.1–4.4)	0.45 (0.31–0.65)		2.95 (2.09–4.15)	85.8 (67.6–96.0)	0.88 (0.30–2.56)		
1	6.6 (5.9–7.3)	Ref.		Ref.	87.3 (83.3–90.6)	Ref.		
2–4	13.5 (12.5–14.5)	2.21 (1.95–2.50)		2.22 (1.93–2.55)	83.9 (81.1–86.4)	0.76 (0.54–1.07)		
5–9	14.2 (12.5–16.0)	2.34 (1.97–2.79)		3.14 (2.49–3.96)	88.4 (84.0–91.9)	1.11 (0.70–1.76)		
≥10	19.6 (16.7–22.7)	3.45 (2.81–4.24)		4.73 (3.63–6.17)	88.9 (83.8–92.8)	1.16 (0.69–1.97)		
Age at first sex†			0.04				0.41	
≤14	9.8 (8.2–11.5)	Ref.			85.9 (78.1–91.7)	Ref.		

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	HIV prevalence				VLS prevalence			
	% (95% CI) (*N* = 18 804)	OR (95% CI)	*P*-value*	aOR (95% CI)	% (95% CI) (N = 2205)	OR (95% CI)	*P*-value*	aOR (95% CI)
15–17	11.8 (10.8–12.9)	1.24 (1.03–1.49)			85.4 (82.2–88.2)	0.97 (0.53–1.75)		
18–20	12.6 (11.6–13.8)	1.34 (1.11–1.62)			86.0 (82.8–88.9)	1.01 (0.55–1.87)		
≥21	12.1 (10.5–13.8)	1.27 (1.00–1.61)			89.9 (86.0–93.0)	1.46 (0.72–2.96)		
Pregnant†,‡			0.02				0.8	
No	14.3 (13.4–15.2)	Ref.			85.5 (82.7–88.0)	Ref.		
Yes	9.6 (7.1–12.7)	0.68 (0.49–0.95)			86.5 (77.8–92.7)	1.09 (0.56–2.11)		
Male circumcision status†			<0.01				0.12	
Uncircumcised	9.8 (8.6–11.0)	Ref.			86.3 (82.6–89.5)	Ref.		
Medical	4.6 (3.2–6.3)	0.44 (0.32–0.62)			86.5 (78.0–92.6)	1.02 (0.55–1.90)		
Nonmedical	7.8 (5.9–10.1)	0.78 (0.57–1.08)			76.0 (67.9–83.0)	0.51 (0.31–0.81)		
Ever tested for HIV¶			<0.01				<0.01	
No	1.5 (1.1–2.0)	Ref.		Ref.	46.5 (32.0–61.4)	Ref.		
Yes	13.3 (12.5–14.2)	10.22 (7.56–13.83)		4.33 (3.15–5.95)	87.3 (85.5–88.9)	7.87 (4.42–14.01)		
Alcohol use frequency			<0.01				0.42	
Never	9.9 (9.2–10.5)	Ref.		Ref.	86.3 (84.1–88.3)	Ref.		
≤Monthly	13.4 (12.0–14.9)	1.41 (1.23–1.62)		1.15 (0.99–1.34)	83.9 (79.3–87.9)	0.83 (0.59–1.16)		
2–4 times a month	17.0 (13.7–20.6)	1.86 (1.48–2.35)		1.52 (1.23–1.88)	89.2 (83.2–93.7)	1.31 (0.76–2.28)		
2–3 times a week	14.2 (11.4–17.3)	1.51 (1.20–1.89)		1.17 (0.90–1.51)	83.8 (75.7–90.0)	0.82 (0.49–1.37)		
≥4 times a week	13.0 (9.4–17.3)	1.37 (0.97–1.92)		1.04 (0.71–1.52)	89.5 (81.0–95.1)	1.36 (0.65–2.83)		
Visited a health facility in the last 12 months			<0.01				<0.01	
No	5.4 (4.8–6.1)	Ref.		Ref.	72.4 (68.0–76.5)	Ref.		Ref.
Yes	15.5 (14.4–16.6)	3.22 (2.79–3.72)		2.08 (1.84–2.36)	90.0 (88.0–91.7)	3.43 (2.53–4.64)		3.20 (2.34–4.39)
Report ≥1 NCD**			<0.01				0.41	
No	10.3 (9.5–11.1)	Ref.		Ref.	85.8 (83.7–87.7)	Ref.		
Yes	15.9 (13.7–18.3)	1.65 (1.36–2.01)		0.93 (0.77–1.12)	87.7 (83.0–91.6)	1.19 (0.79–1.79)		

*Chi-square test.

†Omitted from the multivariable model because the questions were only asked to a subset of persons.

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‡Pregnancy analysis restricted to women aged 15–49 years. Male circumcision analysis restricted to men.

¶Ever tested excluded from VLS multivariable model because persons who never tested would not be expected to be virally suppressed aside from a small proportion of elite controllers.

**Noncommunicable disease defined as 'yes' to self-reported diabetes, hypertension, heart disease, kidney disease, cancer, lung diseases, mental health condition, epilepsy, or other noncommunicable disease.

aOR, adjusted odds ratio; CI, confidence interval; EA, enumeration area; OR, odds ratio; PLHIV, persons living with HIV; VLS, viral load suppression.

Table 3.

HIV prevalence and viral load suppression (VLS) prevalence by selected demographic characteristics among persons aged 15–59 years in Zambia, 2016 and 2021 *.

	HIV prevalence				VLS prevalence			
	2016, % (95% CI) (*N* = 19 115)	**2021, % (95% CI) (*N* = 17 213)**	**Difference (%)**	***P*-value†**	**2016, % (95% CI) (*N* = 2,467)**	**2021, % (95% CI) (*N* = 2,047)**	**Difference (%)**	***P*-value†**
Overall	12.0 (11.4–12.6)	11.1 (10.4–11.8)	−0.93	0.07	59.2 (56.7–61.6)	85.7 (83.8–87.6)	26.56	<0.01
Sex								
Men	9.3 (8.6–10.0)	7.8 (6.9–8.8)	−1.45	0.02	57.2 (53.2–61.1)	84.9 (81.3–88.0)	27.69	<0.01
Women	14.6 (13.8–15.5)	14.2 (13.4–15.1)	−0.41	0.54	60.4 (57.7–63.0)	86.2 (83.7–88.4)	25.81	<0.01
Age group‡								
15–24	3.8 (3.3–4.3)	2.8 (2.3–3.4)	−0.94	0.01	34.3 (28.3–40.7)	70.9 (61.9–78.7)	36.56	<0.01
25–44	16.6 (15.5–17.7)	13.8 (12.7–14.9)	−2.81	<0.01	58.9 (56.0–61.8)	85.1 (82.6–87.4)	26.19	<0.01
45–59	21.7 (19.9–23.6)	25.1 (22.8–27.5)	3.41	0.07	73.1 (69.3–76.7)	91.4 (88.9–93.5)	18.26	<0.01
Province								
Central	12.8 (10.6–15.3)	11.6 (10.1–13.2)	−1.21	0.49	59.1 (52.0–66.0)	83.6 (79.6–87.1)	24.68	<0.01
Copperbelt	13.8 (12.4–15.3)	11.9 (10.9–13.1)	−1.86	0.28	56.7 (51.7–61.6)	84.9 (77.7–90.6)	24.48	<0.01
Eastern	8.1 (6.1–10.4)	9.2 (7.4–11.4)	1.17	0.42	67.1 (58.5–74.9)	89.4 (83.1–94.0)	28.24	<0.01
Luapula	9.3 (6.9–12.1)	8.5 (7.2–9.8)	−0.83	0.55	53.1 (37.8–68.0)	79.2 (70.5–86.2)	22.36	<0.01
Lusaka	15.7 (14.2–17.3)	14.2 (11.8–16.9)	−1.50	0.31	62.7 (58.0–67.1)	87.3 (81.4–91.9)	26.08	<0.01
Muchinga	5.7 (4.1–7.7)	6.6 (5.5–7.8)	0.92	0.39	63.7 (54.8–72.0)	76.6 (68.9–83.2)	12.89	0.02
Northern	9.2 (7.4–11.3)	6.2 (4.9–7.7)	−3.04	<0.01	50.6 (32.5–68.6)	80.1 (68.9–88.6)	29.50	<0.01
Northwestern	6.9 (5.7–8.2)	7.0 (5.5–8.9)	0.17	0.88	53.4 (46.8–60.0)	76.9 (68.4–84.0)	23.44	<0.01
Southern	13.3 (11.6–15.1)	13.0 (9.2–17.7)	−0.27	0.90	63.7 (56.2–70.8)	92.8 (86.6–96.7)	29.10	<0.01
Western	15.9 (12.2–20.2)	14.1 (11.6–16.8)	−1.85	0.42	47.3 (35.3–59.5)	87.1 (82.4–91.0)	39.82	<0.01
Urban/rural EA								
Urban	15.3 (14.3–16.3)	13.5 (12.7–14.4)	−1.79	<0.01	61.8 (58.8–64.7)	84.3 (81.7–86.6)	22.50	<0.01
Rural	9.2 (8.5–10.1)	9.2 (8.1–10.4)	−0.02	0.98	55.5 (51.2–59.7)	87.3 (84.3–90.0)	31.88	<0.01

*The age group that overlapped in both ZAMPHIA surveys was 15–59 years.

†Chi-square test.

‡In ZAMPHIA 2021, the HIV prevalence for men aged ≥60 years was 10.3 (95% CI: 7.8–13.4) and women aged ≥60 years was 10.5 (95% CI: 8.4–12.9).

CI, confidence interval; EA, enumeration area; VLS, viral load suppression.

Table 4.

HIV incidence among persons aged 15–59 years in Zambia, 2016 and 2021*.

	2016 (*N* = 2467)		2021 (*N* = 2047)		‡	
	Recent infections, n	**Incidence, % (95% CI)†**	**Recent infections, n**	**Incidence, % (95% CI)†**	**Risk ratio (95% CI)**	***P*-value**
HIV incidence						
Overall	41	0.61 (0.40–0.81)	18	0.33 (0.15–0.52)	0.55 (0.29–1.05)	0.07
Men	9	0.29 (0.08–0.50)	4	0.07 (0.00–0.17)	0.23 (0.04–1.25)	0.09
Women	32	0.93 (0.60–1.26)	14	0.61 (0.24–0.98)	0.65 (0.32–1.32)	0.24

*The age group that overlapped in both ZAMPHIA surveys was 15–59 years.

†HIV incidence and 95% CIs were calculated using a laboratory-based testing algorithm that employed a combination of assays: an HIV-1 LAg avidity assay, viral load, and ARV detection (which was for the most commonly prescribed first and second line regimens in both surveys [i.e., atazanavir, efavirenz, and lopinavir in 2016 and atazanavir, dolutegravir, efavirenz, lopinavir, and nevirapine in 2021]). In-depth details are provided in Appendix B of the ZAMPHIA 2021 Technical Report, which may be found online at: https://nada.zamstats.gov.zm/index.php/catalog/1/related-materials.

‡Calculated by *Z*-test.

Analysis of incidence by age group was not possible given low number of recent infections in surveys.

ARV, antiretroviral drugs; CI, confidence interval; LAg, limited antigen.