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Research Article

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HIV-1 Incidence in the Era of Rapid Tests for Recent Infection in Livingstone District, Zambia

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Abstract

Objective

HIV incidence is not well documented where health services are delivered as a result failure of better understanding transmission of HIV. The aim was to determine the incidence of HIV-1 and factors associated with recent infection in Livingstone district using the HIV-1 recent infection testing algorithm to identify true HIV recent patients infected within 12 months.

Results

This was a laboratory based study in which samples of newly diagnosed HIV positive adults sent to LUTH PCR laboratory for Recency testing and HIV VL testing were used. In our study participants, the younger age group were more likely to have been infected in the past 12 months, median age: recently infected 28 (23, 37.5) vs long term 33 (27, 40) p-value = 0.002. Out of the 768 clients subjected to RITA, 18.75% were true HIV recent, with the majority of them being female at 59.51%. 50.74% of the clients classified as recent were virally unsuppressed, p- value =0.000. Mahatima Gandhi clinic had a high number of recent infections relative to other facilities at 17.36%. Majority of the clients were captured under index modality with a percentage of HIV recent patients at 47.22%. Adjusted analysis indicated a significant association between age, HIV VL and recent infection (OR 0.97; 95%CI 0.95-0.99; p- value=0.002) and (OR 0.32; 95%CI 0.22-0.48; p- value =0.000).

A high HIV incidence of recent infection with a 50.74% HIV VL unsuppressed clients was observed suggestive of high HIV transmission rate in the community. The majority of clients were captured under index testing indicating that most clients are less likely to seek medical care for HIV testing. Being virally unsuppressed and age were associated with recent infection. Facilities servicing low income areas are hot spot zones where preventive and treatment interventions be prioritized.

Keywords: HIV, Recency, Livingstone District

Abbreviations

LUTH: Livingstone university teaching hospital
VCT: Voluntary HIV counselling and testing
PITC: Provider-initiated HIV testing and counseling
PMTC: Prevention of Mother to Child Transmission
VMMC: Voluntary medical male circumcision
ASO: Army school of Ordnance
ZAF: Zambia Army Force clinic
HIV: Human Immunodeficiency Virus
CLSI: Clinical laboratory standards institute
VL: Viral Load

1. Introduction

HIV "recency assays," are often used to estimate HIV incidence in a specific country, region, or subpopulation, as part of recent infection testing algorithms (RITAs) [1]. HIV incidence is not well documented where health services are delivered as a result failure of better understanding current transmission of HIV in a community [2]. As part of achieving the 95–95-95 targets by 2030, Zambia has HIV-focused population based surveys that have been measuring in country progress with primary objectives of estimating HIV prevalence, HIV-1 incidence, and viral load (VL) suppression as indicators of treatment and prevention program impact [3,4].

Recency assays help differentiate between recent and long-term HIV-1 infection in one testing device and this is achieved by discriminating recent from longstanding infection in an individual using 1 or more biomarkers in newly diagnosed HIV clients [1,3]. The HIV-1 recent infection testing algorithm (RITA), couples Rapid test for Recent infection (RTRI) with HIV viral load (VL) testing to identify true HIV recent patients infected within 12 months [5].

Identification of recent cases of HIV infection is crucial for public health as this allows for the detection of individuals during a phase where they are more likely to transmit the virus. This insight enables health professionals to channel intervention efforts effectively while making the best use of the limited resources available and monitoring of new infection trends in real-time, which is cardinal in providing timely assessments of the effectiveness of preventive measures [4-6]. It is designed to detect recent infection in the population and in turn this information can be used in epidemic monitoring, identification of individuals at high risk and also assist experts in gaining an understanding of epidemic dynamics in a community [7-10].

Understanding the incidence of new infections in a population enables to better understand current transmission of HIV, evaluate whether specific prevention interventions that are in existence as having the desired impact. This will facilitate focusing of limited resources for prevention or treatment services on groups of people or geographic locations with the greatest potential benefit [11-15].

A recent infection testing algorithm includes a test for recent HIV infection and a viral load test is the recommended strategy to estimate national HIV incidence, reducing false-recent misclassification to <1% [7,16]. In as much as the prevalence and incidence of HIV at regional and national levels is readily available, the burden of the disease where health services are organized and delivered, is not well documented. There is need, therefore, for studies to estimate HIV prevalence and HIV-1 incidence at appropriate levels to improve HIV-related planning and resource allocation. Therefore, the objectives of this study were to determine the prevalence of HIV-1 recency infection and establish factors associated with recent infection in Livingstone district.

2. Main Text

2.1 Methods

3. Study Design and Setting

This was a laboratory based cross-sectional study at the Livingstone University Teaching Hospital laboratory (LUTH) from January, 2023 to September, 2023. LUTH laboratory is located in Livingstone town, southern part of Zambia. It is a main referral center for specialized testing for HIV VL diagnosis servicing 13 districts in the province and local clinics in Livingstone district.

3.1 Test Methods

3.2 Recency Testing

Samples of newly diagnosed HIV positive adults sent to LUTH PCR laboratory were used for this study and all procedures for documentation and record keeping were upheld. The RTRI was conducted at the LUTH PCR laboratory, with each of the RTRI recent results subjected to an HIV VL at the PCR laboratory to determine true recent patients. Data obtained were mapped to facilities and HIV testing modalities. HIV recency testing for confirmed HIV-seropositive participants with plasma samples was conducted using Asanté™ HIV-1 Rapid Recency® Assay, a rapid, 20-minute in vitro immunoassay that distinguishes recent from long-term HIV-1 infections.

4. Baseline HIV Viral Load Testing

Plasma VL testing was conducted using The COBAS4800 HIV-1 is based on fully automated sample preparation followed by PCR amplification and detection. The cobas® 4800 System consists of the cobas x 480 sample preparation instrument and the cobas z 480 real-time PCR analyzer. Real-time detection and discrimination of PCR products is accomplished by measuring the fluorescence of the released reporter dyes for the viral targets and RNA QS, respectively and the Aptima HIV-1 Quant Dx assay which involves three main steps, which all take place in a single tube on the Panther system: these include target capture, target amplification by transcription-mediated amplification (TMA), and detection of the amplification products (amplicon) by the fluorescent labeled probes (torches).

5. Statistical Analysis

Data was analyzed using STATA 15. The stored information from excel was exported to Strata 15 for analysis. Descriptive statistics was used to understand the distribution of the data. Quartile-quartile (QQ) PLOT was used to test for the normality of the continuous variable of interest. The significance of two categorical variables was ascertained by the use of Chi-square test. Logistic regression, both univariate and multivariate was used to determine the factors associated with recent infection. Both 95% confidence interval and a 5% level of significance were used ascertain the statistical difference.

6. Reporting Guidelines

We used the technical guidance on the use of recency assay our reporting and interpretation of the findings [4].

7. Results

7.1 Descriptive Characteristics

With reference to Table 1 below, the study comprised of 768 participants of which 311 (40.49%) were male and 457 (59.51%)

female with a median age of 32. A total of 37 (4.82 %) were pregnant while 420 (54.69%) were not pregnant. Participants that were breastfeeding were 4 (0.52%). Majority of the clients were captured under Index testing 333 (43.36%), followed by PITC at 205 (26.69%), VCT 65(8.46%), PMTCT 67(8.72%), VMMC 1(0.13%) and other 97 (12.63%). A total of 144 (18.75%) were classified as having recent infection while 624 (81.25%) were classified as having a long term infection. Majority of the participants came from Maramba clinic 116 (15.10%), followed by Chreso ministries 109 (14.19%), Mahatima ghandi clinic 106 (13.80%). ASO, Chileleko, Dambwa mini hospital, Dambwa north, Dambwa site, Libuyu, Linda, Luth, Namatama, Police urban, Prisons, Sakubita, Sepo, St. josephs hospice and ZAF clinics had 16 (2.08), 6(0.78%), 29 (3.78%), 21 (2.73%), 1 (0.13%), 41 (5.34%), 31 (4.04%), 88 (11.46%), 24 (3.13%), 29 (3.78%), 46 (5.99%), 15 (1.95%), 15 (1.59%), 44 (5.73%) and 31 (40.4%) participants respectively.

Variable	Median, (IQR)	Frequency	Percentage (%)
		N=768	
Continuous			
Age	32(26,40)		
Categorical			
Sex			
Male		311	40.49
Female		457	59.51
Pregnant			
Yes		37	4.82
No		420	54.69
N/A		311	40.49
Breastfeeding			
yes		4	0.52
no		453	58.98
N/A		311	40.49
Modality			
Index		333	43.36
Vct		65	8.46
Pitc		205	26.69
Pmtct		67	8.72
Vmmc		1	0.13
other		97	12.63
Recency infection			
Recent		144	18.75
Long term		624	81.25
Facility			
Army school of ordance		16	2.08
Chileleko hp		6	0.75
Chreso		109	14.19
Dambwa mini		29	3.78
Dambwa north		21	2.73
Dambwa site		1	0.13
Libuyu		41	5.34
Linda		31	4.04
Luth		88	11.46
Mahatima ghandi		106	13.80
Maramba		116	15.10
Namatama		24	3.13
Police		29	3.78
Prisons		46	5.99
Sakubita hp		15	1.95

Sepo		15	1.95
Hospice		44	5.73
Zaf clinic		31	4.04
HIV VL			
Suppressed		215	28.94
Unsuppressed		528	71.04

Table 1: Descriptive characteristics

8. Relationship Between Recency Infection with Sociodemographic and Clinical Characteristics

Table 2 below shows the association between sociodemographic, clinical characteristics and recency infection. Participants with a recent infection were significantly younger than those classified under long term infection (median age 28 vs. 33, p-value=0.0002). Participants with unsuppressed viral load were seen to have significantly long term infection as opposed to those with a recent infection (459 vs. 69, p-value=0.000). Variables such as sex, modality, pregnancy, breastfeeding, facility were of no statistical significance as the p-value was above 0.05.

Recent infection				
Variable	**N= 768**	**NO, 624**	**YES, 144**	**p-value**
Age				**0.0002**
		33(27,40)	28 (23, 37.5)	
Sex				
Male		258(41.35)	53(36.81)	0.317
Female		366(58.65)	91(63.19)	
HIVVL				
Suppressed <1000		148(28.94)	67(49.26)	0.000
Unsuppressed > 1000		459(75.62)	69(50.74)	
Pregnant				
Yes		27(4.33)	10(6.94)	0.31
No		339(54.33)	81(56.25)	
Breastfeeding				
Yes		2(1.39)	2(1.39)	0.18
No		364(58.33)	89(61.81)	
Modality				
Index		265(42.47)	68(47.22)	
Vct		56(8.97)	9(6.25)	
Pitc		175(28.04)	30(20.83)	
Pmtc		51(8.17)	16(11.11)	
vmmc		1(0.16)	0(0)	
Other		76(12.18)	21(14.58)	
Facility				
ASO		12(1.92)	4(2.78)	0.210
Chileleko		3(0.48)	3(2.08)	
Chreso		95(15.22)	14(9.72)	
Dambwa mini		21(3.37)	8(5.56)	
Dambwa north		18(2.88)	3(2.08)	
Dambwa site		1(0.16)	0(0)	
Libuyu		28(4.49)	13(9.03)	
Linda		254.01)	6(4.17)	
Livingstone		73(11.40)	15(10.42)	
Mahatima Gandi		81(12.98)	25(17.36)	
Maramba		94(15.06)	22(15.28)	

Namatama		18(2.88)	6(4.17)	
Police		24(3.85)	5(3.47)	
Prisons		39(6.25)	7(4.86)	
Siakubita		14(2.24)	1(0.69)	
Sepo		15(2.40)	0(0)	
Hospice		37(5.93)	7(4.86)	
Zaf		26(4.17)	5(3.47)	

Table 2: Relationship between recency infection with sociodemographic and clinical characteristics

9. Univariate Analysis of Factors Associated with Recency Infection

Table 3 below shows the univariate analysis of factors associated with recency infection. In this analysis, a unit increase in age was significantly associated with 0.97 protection of having a recent infection (OR 0.97; 95% CI 0.95-0.98; p-value <0.005). Participants with unsuppressed baseline HIV VL were less likely to be recently infected as compared to those with suppressed HIV VL (OR 0.33; 95%CI 0.23-0.49; p-value=0.000). The other variables showed no association.

Variable	OR	95%CI	p-value
Age	0.97	0.95-0.98	0.000
Sex			
Male	ref		
Female	1.21	0.83-1.76	0.317
Baseline HIVVL			
Suppressed <1000	Ref		
Unsuppressed > 1000	0.33	0.23-0.49	0.000

Table 3: Univariate analysis of factors associated with recency infection

10. Multivariate Analysis of Factors Associated with Recent HIV Infection

Table 4 shows multivariate analysis, in this analysis an increased in age was seen to significantly protect individuals from being recently infected in the past 12 months by 0.97 (OR 0.97; 95%CI 0.95-0.99 ; p- value=0.002) and HIV VL was significantly associated with recent infection (OR 0.32; 95%CI 0.22-0.48; p- value <0.005). Other variables had no significant association.

Variable	OR	95%CI	p-value
Age	0.97	0.95-0.99	0.002
Sex	**1.15**	**0.77-1.73**	**0.502**
Baseline HIV VL	0.32	0.22-0.48	0.000

Table 4: Multivariate analysis of factors associated with recency infection

11. Discussion

This study offers an estimate of HIV incidence among the residents of Livingstone district, Zambia. The findings depict the results of HIV-1 recent infection in clients who sought out healthcare services in facilities within Livingstone district, a period from January 2023 to September 2023.

From the newly diagnosed HIV positive clients in the study period, out of sample size of 768 the prevalence of HIV-1 recent infection was found to be at 18.75% and long term infection in our study participants was at 81.25%. It was observed the younger age group were more likely to have been infected in the past 12 months with median age: recently infected 28 (23, 37.5) vs long term 33 (27, 40) p-value = 0.002. Out of the 768 clients subjected to RITI, 18.75% were true HIV recent, with the majority of them being female at 59.51%. 50.74% of the clients classified as recent were virally unsuppressed, p- value <0.005. Mahatma Gandhi clinic had a high number of recent infections relative to other facilities at 17.36%. Majority of the clients were captured under index modality with a percentage of HIV recent patients at 47.22%. Adjusted analysis indicated a significant association between age, HIV VL and recent infection (OR 0.97; 95%CI 0.95-0.99; p- value=0.002) and (OR 0.32; 95%CI 0.22-0.48; p- value <0.005).

The younger population were more likely to be have recently infected and this can be attributed to increased risk of HIV infection during unprotected sex, risky sexual behaviors and/or may be due to lowered coital occurrence among the older population. We found more women newly testing HIV-positive were more likely to test recent than their male counterparts. The observed difference by sex is probably due to women presenting earlier in their course of infection than men. Based on our findings, these results provide support for recency test results among index cases informing partner testing strategies.

Several studies have explored recent infection testing in sub-Saharan Africa with particular interest in estimating the HIV incidence. However, a couple of studies provide details on recency testing and present recency percentages contrary to those we report. Our findings indicated a high prevalence of HIV-1 incidence in Livingstone of 18.75% as compared to a study done in Kenya and Zimbabwe in which a total of 1269 people completed the RITA across the three studies, of whom 7% were found to have a recent infection [17]. In Zimbabwe, 10.5% (33/313) of female sex workers testing HIV-positive through the outreach Programme were classified recent [6]. Another study reported a lower prevalence of HIV-1 recent infection: defined recent infection as testing LAg-Avidity-recent with unsuppressed VL and, if unsuppressed, having no ART exposure. RITA-derived incidence among persons aged 15-49 years in Kenya was 0.8% and 1.7% in south Africa [18]. Contrary to our findings a cross-sectional national survey, conducted in Swaziland found an HIV incidence of 2.5% categorized LAg-based incidence in men (1.8%; 1.2-2.5) and women (3.2%; 2.4-3.9) and in Siaya County 2.3% of women testing HIV positive were classified as recent and 8.7% men in Nairobi [17].

A high proportion of long term infection was observed in our study, this is suggestive and indicative of delayed HIV diagnosis, which is in turn reflected by late presentation to care, and this in turn will lead to worse prognosis for the individual and allows for unrecognized community transmission [19]. Finding new strategies to increase access to testing, especially for populations that are not adequately reached by traditional test modalities, is therefore a priority for HIV programs.

Our study observed that majority of the clients were captured under Index as a test modality and this was contrary to a study that was done in Lusaka district in which Voluntary Counselling and Testing (VCT) modality had the highest percentage of HIV recent patients at 36.4% [20]. Suggesting it being a better capacity to reach individuals with lower likelihood to present at health facilities for HIV testing, however, there were no discernible differences in incidence by facility and modality.

Univariate and multivariate analysis showed a significant association between age, HIV VL and having a recent infection. Majority of the clients testing positive for recent infection had unsuppressed viral load, this coincides with literature on recency infection.

12. Conclusion

A high HIV incidence of recent infections with a 50.74% HIV VL unsuppressed clients was observed suggestive of high HIV transmission rate in the community. The majority of clients were captured under index testing indicating that most clients are less likely to seek medical care for HIV testing in the district. Being virally unsuppressed and age were associated with recent infection. Facilities servicing low income areas may be hot spot zones where preventive and treatment interventions should be prioritized in the district.

13. Limitations

This being a laboratory based study, establishing association using other demographics was limited

14. Availability of Data and Materials

All data generated or analyzed during this study are included in this published Article. For other data, these may be requested through the corresponding Author.

15. Acknowledgements

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16. Contributions

PS conceived the study. Ps conducted the data collection. PS and MZ contributed to data analysis and led the writing of the manuscript. BMH, K.C, MZ, PC and PJC reviewed. All authors read and approved the final manuscript.

17. Ethical Declarations

18. Ethical Approval

This was a laboratory based study involving routine laboratory specimens and all methods were carried out in accordance with relevant guidelines. The need for informed consent was waived by National Health Research Authority (NHRA) "Laboratory Quality Improvement Research in Ministry of Health Laboratories" Ref No: NHRA000004/16/11/2021. The need for ethical approval was waived by National Health Research Authority (NHRA) Ref No: NHRA000004/16/11/2021. Permission to conduct the study was granted by Livingstone University Teaching Hospital management.

19. Consent to Publish

National Health Research Authority authorized the article to be published Ref No: NHRA009/12/10/2023

20. Competing Interest

The authors declares that they have no competing interests.

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