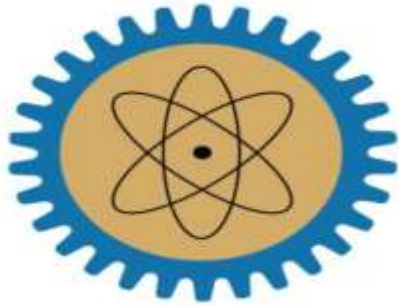




**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF COMMUNITY & PUBLIC HEALTH

RESEARCH DISSERTATION

**MAPPING HOTSPOTS, TRENDS, AND DRIVERS OF RECENT
HIV INFECTIONS AMONG TASO CLIENTS IN UGANDA
(2021-2024)**

By

SYDNEY NSUBUGA

REG. No. BU/GS22/IDE/15

**This Research Dissertation is submitted to the Directorate of
Graduate Studies, Research and Innovation, in Partial Fulfilment of
the requirements for the award of the degree of Master
of Science in Infectious Disease Field Epidemiology
of Busitema University**

NOVEMBER 2025

DECLARATION

Candidate's Declaration

I, Sydney Nsubuga, declare that this study, titled “Mapping Hotspots, Trends, and Drivers of Recent HIV Infections among TASO Clients in Uganda (2021-2024).”, is my original work. All aspects of the study, including its design, methodology, data analysis, and conclusions, are genuine and have been conducted following ethical standards and research integrity. I confirm that no part of this study has been plagiarized, and all sources, including literature and data, have been appropriately acknowledged.

Supervisor's Declaration

I, Professor Peter Olupot-Olupot and Dr Simple Ouma, hereby declare that we have thoroughly reviewed and assessed the dissertation titled “Mapping Hotspots, Trends, and Drivers of Recent HIV Infections among TASO Clients in Uganda (2021-2024).” submitted by Sydney Nsubuga in partial fulfillment of the requirements for the Master of Infectious Diseases Epidemiology and Biostatistics of Busitema University.

After thoroughly examining the contents of the dissertation, I can affirm the following:

1. **Originality and Significance:** The research showcases originality in its approach and addresses a significant research gap. The topic is relevant and has the potential to contribute valuable insights into the existing body of knowledge.
2. **Feasibility and Methodology:** The methodology suits the research objectives outlined. The research design demonstrates a solid understanding of the subject matter and uses appropriate data collection and analysis techniques.
3. **Academic Rigor:** The dissertation meets academic standards and shows a clear, logical structure. The research questions are well-defined, and the objectives are articulated clearly. The literature review offers a comprehensive overview of relevant theories and prior studies, establishing a strong foundation for the proposed research.
4. **Ethical Considerations:** The dissertation acknowledges and addresses ethical issues related to the research, including confidentiality and potential risks. The researcher demonstrates awareness of ethical guidelines and outlines suitable measures to ensure the welfare of participants and the integrity of the research process.

5. Supervision and Support: As the supervisor, we confirm that we have provided guidance and support throughout the research process. Based on the above assessment, we endorse and recommend the research for further consideration and examination.

Signed:



Dr. Simple Ouma – MBChB, MPH, Ph.DC

Head of Research – The AIDS Support Organization

August 06, 2025



Professor Peter Olupot-Olupot

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Supervisor

APPROVAL

I, Sydney Nsubuga, as the principal investigator of this epidemiological study, confirm that the research protocol was reviewed and approved by the Institutional Review Board (IRB) at Mbale Regional Referral Hospital. The study adheres to all ethical guidelines and regulations governing human research, and informed consent has been obtained from all participants. All modifications to the study protocol were duly reviewed and approved by the IRB. This research was conducted with the utmost commitment to data confidentiality, privacy, and the ethical principles outlined in the Declaration of Helsinki.

Sydney Nsubuga – Dip Med, BSc. HSM, MPH



Principal Investigator

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August 06, 2025

This dissertation has been submitted for examination with the approval of my supervisors.



Dr. Simple Ouma – MBChB, MPH, PhD

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Professor Peter Olupot-Olupot

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DEDICATION

This study is dedicated to all individuals affected by HIV/AIDS in Uganda and around the world. Your resilience, strength, and courage inspire our commitment to advancing scientific knowledge for the betterment of public health. This dedication extends to healthcare providers, community advocates, and researchers who work tirelessly towards the goal of eliminating HIV. May the findings of this study contribute to the ongoing efforts to create a world free from the burden of HIV/AIDS.

ACKNOWLEDGEMENT

I extend my deepest gratitude to all individuals and institutions who have contributed to the successful completion of this epidemiological study, **“Mapping Hotspots, Trends, and Drivers of Recent HIV Infection among TASO Clients in Uganda (2021-2024).”** My heartfelt appreciation goes to:

The individuals who generously participated in this study shared their medical information and experiences, thereby enabling us to gain valuable insights into the dynamics of HIV infections.

Uganda's dedicated healthcare professionals (particularly at TASO) provided access to electronic medical records, facilitating the data collection process. Your commitment to advancing public health is truly commendable.

Community advocates and organizations whose collaboration and support were instrumental in fostering community engagement, ensuring the study's relevance, and amplifying the voices of those affected by HIV.

The dedicated team of researchers and collaborators whose expertise, diligence, and tireless efforts contributed to the design, implementation, and analysis of this study. Your commitment to scientific rigor and excellence is highly appreciated.

The Institutional Review Board (IRB) members meticulously reviewed and provided ethical oversight for the study. Your insights and commitment to research ethics are invaluable.

Our international collaborators shared their knowledge and expertise, contributing to the global context of HIV research and the development of elimination strategies.

Finally, I would like to express my gratitude to friends and family for their unwavering support, encouragement, and understanding throughout this study.

This collaborative effort reflects the cooperation of diverse stakeholders committed to advancing our understanding of HIV epidemiology in Uganda. Each contribution, no matter how small, played a pivotal role in the success of this research endeavor. I am sincerely grateful for your collective support and dedication to the broader goal of eliminating HIV.

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ABBREVIATIONS AND ACRONYMS

AGYW	:	Adolescent Girls and Young Women
AIDS	:	Acquired Immunodeficiency Syndrome
AMR	:	Antimicrobial Resistance
ART	:	Antiretroviral Therapy
CDC	:	Centers for Disease Control and Prevention
CD4	:	Cluster of Differentiation 4
CI	:	Confidence Interval
CPHL	:	Central Public Health Laboratory
		District Health Information System 2 (common health
DHIS2	:	management information system)
DNA	:	Deoxyribonucleic Acid
DREAMS:		Determined, Resilient, Empowered, AIDS-free, Mentored, Safe
EDCTP	:	European and Developing Countries Clinical Trials Partnership
EIA	:	Enzyme Immunoassay
EMR	:	Electronic Medical Record
GIS	:	Geographic Information System
HIV	:	Human Immunodeficiency Virus
HTS	:	HIV testing services
IDEA	:	Infectious Diseases Epidemiology
IRB	:	Institutional Review Board
LA _g	:	Limiting Antigen
LISA	:	Local Indicator of Spatial Autocorrelation
LTFU	:	Lost to Follow-Up
MSc	:	Master of Science
MSM	:	Men who have Sex with Men

NGO	:	Non-Governmental Organization
NIAID	:	National Institute of Allergy and Infectious Diseases
PEPFAR	:	President's Emergency Plan for AIDS Relief.
PCR	:	Polymerase Chain Reaction
PHIA	:	Population HIV Impact Assessment
PMTCT	:	Prevention of Mother-to-Child Transmission
PWID	:	People Who Inject Drugs
RHI	:	Recent HIV Infection
RITA	:	Recent HIV infection testing algorithm
RNA	:	Ribonucleic Acid
RTRI	:	Rapid Test for Recent Infection
SEM	:	Social Ecological Model
SDGs	:	Sustainable Development Goals
SIV	:	Simian immunodeficiency virus
SIVcpz	:	Simian immunodeficiency virus of the chimpanzee origin
STI	:	Sexually Transmitted Infection
UBOS	:	Uganda Bureau of Statistics
UPHIA	:	Uganda Population HIV Impact Assessment
UN	:	United Nations
UNAIDS	:	Joint United Nations Program on HIV/AIDS
VL	:	Viral load
VLS	:	Viral Load Suppression
WHO	:	World Health Organization

DEFINITION OF KEY TERMS

These operational definitions provide clear criteria for categorizing and analyzing data in the context of this epidemiological study, ensuring consistency and reliability in the interpretation of results.

Antiretroviral Therapy (ART) Initiation

The initiation of antiretroviral therapy following an HIV diagnosis.

Associated Factors

Factors associated with an increased likelihood of HIV transmission, such as behavioral, social, and clinical determinants.

Community Perspectives

Qualitative insights include the perspectives, experiences, and attitudes of community members regarding HIV, healthcare services, and stigma.

Drivers of Recent HIV Infection

These are correlates of recent HIV infection. The factors that are attributed to or associated with recent HIV infections. They are divided into the following categories: sociodemographic factors (income, education, married status, age, and sex), behavioral factors (multiple sexual partners, condom use, and substance use) and structural factors (e.g., socioeconomic disparities, mobility, stigma, and healthcare access).

Geographic Information System (GIS) Mapping

The use of GIS tools to visually represent and analyze the spatial distribution of data. **HIV**

Healthcare Disparities

Variations in healthcare access, utilization, and outcomes among individuals with recent and long-term HIV infections.

Recent HIV Hotspots

Places or demographic groups where the prevalence of recent HIV infections is noticeably greater than in nearby locations.

Long-term HIV Infection

Individuals with HIV infection for more than twelve months between January 2021 and December 2021, January 2022 and December 2022, through January to December 2023, and January 2024 to December 2024.

Mapping HIV

The practice of using statistical methods and geospatial tools to depict the geographic distribution of current HIV infections graphically. GIS (Geographic Information Systems) can be used to illustrate infection clusters and their temporal distribution.

Recent HIV Infection

Recent refers to a period of up to one year following the acquisition of infection. It serves as a proxy for estimating HIV incidence and as an index for measuring the degree of ongoing transmission within a population. In this study, recent infections include individuals who tested positive for recent HIV within twelve months from January 2021 to December 2021, January 2022 to December 2022, January 2023 to December 2023, and January 2024 to December 2024.

Spatial Clustering:

The identification of geographic areas with a higher concentration of recent and long-term HIV infections.

Trends in HIV

The trends and variations in recent HIV infections over time, as determined by seasonality, epidemiological studies of incidence rates, or new developments in affected populations. Regression models or time-series analysis were employed to characterize these trends.

Time to ART Initiation:

The duration (in days) between the date of HIV diagnosis and the recorded date of antiretroviral therapy initiation. Calculation: **Viral Suppression:** The achievement and maintenance of an undetectable viral load.

ABSTRACT

Background

Despite significant progress on HIV control in Uganda, the population-level viral suppression rate remains low at 74.9% and Uganda now records about 50,000 new HIV infections annually, which underscores the need to detect geographic hotspots and programmatically relevant drivers among clients entering care. . Recent HIV infections, defined as those acquired within twelve months, are important indicators of ongoing transmission and the extent of prevention efforts. However, data at the subnational level regarding recent infections, their geographic clustering, temporal trends, and risk factors are limited. This study aimed to map the spatial distribution, identify temporal trends, and explore the drivers of recent HIV infections among clients of The AIDS Support Organization (TASO) in Uganda from 2021 to 2024.

Methods:

A retrospective, multiple-methods study design was employed, utilizing routinely collected HIV recency testing data from 11 TASO centers across Uganda. Individuals newly diagnosed with HIV were classified according to the national recent infection testing algorithm (RITA) detailed in Figure 1-3. Spatial analysis involved empirical Bayesian smoothing, Global and Local Moran's I, and Getis-Ord G_i^* techniques to identify hotspots. Temporal trends were evaluated using Mann-Kendall tests and time-series clustering. Multivariable logistic regression identified individual-level predictors of recent HIV infection. Data were extracted from electronic medical records and analyzed with ArcGIS Pro, R, and Stata.

Results:

A total of 8,276 HIV-positive clients were analyzed for hotspot and temporal trend detection, and 5,422 clients for identifying drivers of recent HIV infection. Spatial analysis revealed persistent and emerging hotspots, including a new outbreak in Kyenjojo (2024) and sporadic clusters along the southwestern and eastern cattle corridors. No district showed sustained or increasing hotspots, while districts in the Lake Victoria basin experienced episodic surges.

Temporal patterns were mostly oscillatory. Sixty-four districts maintained near-zero incidence over 48 months, indicating epidemic control through stable treatment and low-risk behavior. Forty-five districts showed a gradual increase from late 2022, peaking in mid-2023 before declining, reflecting mobility-driven surges linked to the post-COVID-19 reopening. Another

37 districts experienced short-lived urban and peri-urban spikes in mid-2022 and early 2023, which were quickly contained through responsive health interventions.

In multivariable analysis, male clients had significantly lower odds of recent HIV infection compared to females (OR = 0.74; 95% CI: 0.57–0.96; $p = 0.021$). Other variables, age, education, HIV testing approach, delivery model, pre-test counseling, and ARV adherence, were not significantly associated with HIV recency ($p > 0.05$).

Conclusion:

The study found an overall HIV recency prevalence of 10.5% among TASO clients, with significant variation across centers and over time. Centers in the southwestern and eastern regions, especially along the Cattle Corridor and the Lake Victoria basin, experienced episodic surges. At the same time, most other districts consistently maintained low or zero recency rates. A new hotspot appeared in Kyenjojo in 2024, indicating localized outbreaks amid general epidemic control. Temporal analysis revealed oscillating trends, with brief peaks in mid-2022 and early 2023, corresponding to post-COVID mobility and economic reopening. These findings emphasize the fragmented and changing nature of recent HIV infections across Uganda. Targeted surveillance, rapid response, and geographically focused prevention strategies are critical to maintaining epidemic control and progressing toward the 2030 HIV elimination goals.

Keywords:

Recent HIV infection, Spatial analysis, Uganda, HIV recency testing, GIS mapping, TASO, Epidemiology, Hotspots, Temporal trends.

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