

Determinants of Undetectable Viral Load among Recipients of HIV Care in Cross River State, Nigeria: A Mixed-Methods Study

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Abstract

Achieving and sustaining viral load suppression among people living with HIV is essential for improving treatment outcomes and reducing transmission. However, determinants of undetectable viral load remain insufficiently documented in Cross River State, Nigeria, particularly using mixed methods approaches. This study examined socio-demographic and patient-related determinants of undetectable viral load among recipients of HIV care in selected health facilities. A mixed-methods design combined a facility-based cross-sectional survey with qualitative interviews. Quantitative data were collected from 203 HIV-positive clients aged ≥ 15 years who had been on antiretroviral therapy (ART) for at least six months, while qualitative data were obtained from in-depth interviews with 12 healthcare providers. Descriptive statistics, Chi-square tests, and multivariate logistic regression were used for quantitative analysis, and qualitative data were analyzed thematically. Findings showed that 51.7% of participants achieved undetectable viral load (< 50 copies/mL), 27.6% had suppressed viral load (51–999 copies/mL), and 79.3% attained overall viral suppression. ART adherence emerged as the strongest predictor of viral suppression, alongside regular clinic attendance, counselling participation, and use of medication reminders. Conversely, missed doses, treatment interruptions, recreational drug use, and difficulty accessing healthcare significantly reduced the likelihood of viral suppression. Qualitative findings highlighted stigma, economic hardship, transportation barriers, and occasional drug stock-outs as key contextual factors influencing adherence. The study underscores the need for patient-centered interventions that strengthen adherence counselling, improve access to ART, and address structural and socio-economic barriers to optimize viral suppression outcomes in resource-limited settings.

Keywords: Antiretroviral Therapy, Art Adherence, Determinants of Viral Suppression, HIV, Mixed-Methods Research, Undetectable Viral Load, Viral Load Suppression.

Introduction

Background and Problem Statement

Human Immunodeficiency Virus (HIV) remains one of the most significant global public health challenges despite substantial progress in prevention, diagnosis, and treatment over the past four decades. Since the beginning of the epidemic, an estimated 91.4 million

individuals have been infected globally, while approximately 44.1 million people have died from HIV-related illnesses. By the end of 2024, about 40.8 million people were living with HIV worldwide [26]. Although notable progress has been achieved through expanded treatment and prevention strategies, the burden of HIV remains disproportionately concentrated in sub-Saharan Africa, where nearly two-thirds of the

global population of people living with HIV reside [25, 23].

A central global strategy for addressing the HIV epidemic is the UNAIDS 95-95-95 targets, which aim to ensure that by 2030, 95% of people living with HIV know their status, 95% of those diagnosed receive sustained antiretroviral therapy (ART), and 95% of those on treatment achieve viral suppression [22]. Viral suppression is critical because it improves individual health outcomes and prevents onward transmission. Despite these efforts, achieving sustained viral suppression remains a major challenge, particularly in resource-limited settings.

Nigeria bears a substantial share of the global HIV burden, with an estimated 1.9 million people living with HIV and a national prevalence of approximately 1.4% among adults aged 15–49 years [11]. Within Nigeria, regional disparities exist, with Cross River State reporting a prevalence of about 1.8%, higher than the national average [12, 21]. Although ART coverage has expanded significantly, not all individuals receiving treatment achieve or sustain viral suppression.

Existing Solutions and Their Limitations

Antiretroviral therapy (ART) remains the most effective clinical intervention for achieving viral suppression. By suppressing viral replication, ART improves immune function and reduces HIV-related morbidity and mortality. Global expansion of ART has led to a significant decline in AIDS-related deaths, from approximately 2.1 million in 2004 to about 630,000 in 2024 [24]. However, ART effectiveness is highly dependent on consistent adherence and sustained engagement in care. Existing interventions such as: adherence counselling, routine viral load monitoring, and differentiated service delivery, have improved treatment outcomes. Nevertheless, these approaches often fail to fully address the socio-demographic and patient-related barriers that influence adherence behaviour. Factors such as

stigma, economic hardship, limited access to healthcare services, and inadequate knowledge about ART continue to hinder optimal treatment outcomes [16, 4].

Research Gap and Novelty

Despite extensive research on HIV treatment outcomes, significant gaps remain in understanding the determinants of viral suppression in specific contexts such as Cross River State. Much of the existing literature in Nigeria has focused on clinical or health-system factors, with limited attention to socio-demographic and patient-related determinants of adherence and viral suppression. Furthermore, few studies have employed mixed methods approaches to provide both quantitative and contextual insights into these factors.

This study addresses this gap by focusing specifically on how socio-demographic characteristics (e.g., age, sex, education, employment) and patient-related factors (e.g., adherence behaviour, knowledge, stigma, and clinic attendance) influence the achievement of undetectable viral load. The novelty of this work lies in its integration of quantitative and qualitative evidence to provide a comprehensive, context-specific understanding of behavioural and social determinants of viral suppression in Cross River State.

Achievements of the Study

This study provides empirical evidence on the proportion of ART clients achieving viral suppression and identifies key determinants associated with undetectable viral load. It highlights adherence as the strongest predictor of viral suppression and demonstrates how socio-demographic factors interact with patient behaviours to influence treatment outcomes. Additionally, qualitative insights offer deeper understanding of contextual barriers such as: stigma, economic constraints, and access to care.

Objective of the Study

The primary objective of this study is to examine the determinants of undetectable viral load among recipients of HIV care in Cross River State, Nigeria. Specifically, the study aims to:

1. Examine the relationship between socio-demographic factors of ART clients and undetectable viral load.
2. Determine the relationship between patient-related factors of ART clients and undetectable viral load.

Schematic Representation (Conceptual Framework)

The study is guided by a conceptual framework in which socio-demographic factors (age, sex, education, employment, residence) influence patient-related behaviours (ART adherence, clinic attendance, counselling participation, substance use), which in turn determine the likelihood of achieving undetectable viral load. This framework reflects the interaction between structural and behavioural determinants of HIV treatment outcomes.

In summary, this study responds to the need for context-specific, evidence-based understanding of viral suppression by focusing on key socio-demographic and patient-related determinants, thereby contributing to efforts aimed at achieving the UNAIDS 95-95-95 targets and improving HIV treatment outcomes in resource-limited settings.

Materials and Methods

Description of the Study Site

The study was conducted in selected health facilities providing HIV treatment and care services in Cross River State, located in the South-South geopolitical zone of Nigeria. Specifically, the study was carried out at the University of Calabar Teaching Hospital (UCTH) and the General Hospital, Calabar, both of which serve as major centers for HIV

treatment and care within the state. Cross River State shares boundaries with Benue, Ebonyi, and Akwa Ibom States and an international border with Cameroon. The state has an estimated population of approximately 3.5 million people and comprises both urban and rural communities.

HIV treatment services in the selected facilities include the provision of antiretroviral therapy (ART), adherence counselling, and routine viral load monitoring. These facilities serve a diverse population of people living with HIV and provide a suitable setting for examining determinants of undetectable viral load.

Description of the Experiments Done (Study Design and Data Collection Procedures)

This study adopted a mixed-methods research design integrating quantitative and qualitative approaches to examine determinants of undetectable viral load among ART clients. The quantitative component consisted of a facility-based cross-sectional survey of HIV-positive clients receiving antiretroviral therapy (ART). Eligible participants were individuals aged 15 years and above who had been on ART for at least six months and had documented viral load results. The sample size was determined using a one-proportion sample size estimation approach for viral load suppression, assuming a 50.0% expected proportion of viral suppression, a 95% confidence level, and a margin of error of 10.0%. This yielded an initial unadjusted sample size of 97 HIV-positive respondents. The sample size was subsequently adjusted to account for a design effect of 2.0 and a non-response rate of 5.0%, resulting in a final adjusted sample size of 203 participants. This adjusted sample size also corresponded to the total accessible population of eligible ART clients within the selected facilities during the study period. The final sample was proportionately distributed across the selected health facilities based on patient load:

University of Calabar Teaching Hospital (UCTH): 112 participants (55.2%), and General Hospital, Calabar: 91 participants (44.8%).

Structured interviewer-administered questionnaires were accordingly allocated and administered within each facility based on this proportional distribution. Eligible ART clients were identified from clinic registers, and stratified random sampling was used to select participants within each facility. The qualitative component involved in-depth interviews with a purposively selected subset of ART clients to explore experiences related to treatment adherence and engagement in HIV care. A total of 12 participants were recruited, with distribution across facilities as follows: University of Calabar Teaching Hospital (UCTH): 7 participants and General Hospital, Calabar: 5 participants.

Participants were selected to reflect diverse socio-demographic and adherence experiences. Interviews were conducted using a semi-structured guide and continued until thematic saturation was achieved.

Quantitative data were collected using a structured interviewer-administered questionnaire alongside review of patient medical records. The questionnaire captured information on socio-demographic characteristics (age, sex, marital status, education level, employment status, income level, and place of residence) and patient-related factors (ART adherence, substance use, clinic attendance, knowledge of ART, counselling participation, and perceived stigma). Viral load outcomes were obtained from clinical records.

Qualitative data were collected through face-to-face interviews conducted in private settings within the health facilities. Each interview lasted approximately 30–45 minutes and was audio-recorded with participants' consent.

Description of Laboratory Methods

Viral load measurements were obtained from routine clinical records maintained at the

selected health facilities: University of Calabar Teaching Hospital and General Hospital, Calabar. Viral load testing followed national guidelines, with measurements conducted at least six months after ART initiation and periodically thereafter. For this study, undetectable viral load was defined as a plasma viral load of less than 50 HIV RNA copies per millilitre, while viral suppression was defined as less than 1,000 copies per millilitre in accordance with national HIV treatment guidelines. These laboratory results were used as the primary outcome variable for assessing treatment success among ART clients.

Description of Statistical Methods Used

Quantitative data were analyzed using IBM SPSS Statistics version 28. Descriptive statistics were used to summarize study variables, with frequencies and percentages reported for categorical variables and means with standard deviations for continuous variables.

Bivariate analysis was conducted using Chi-square (χ^2) tests to examine associations between socio-demographic and patient-related factors and undetectable viral load. Variables that demonstrated statistical significance at $p < 0.05$ were included in a multivariate logistic regression model to identify independent predictors of undetectable viral load. Adjusted odds ratios (AORs) with 95% confidence intervals were reported.

Qualitative data were transcribed verbatim and analyzed using thematic analysis. The analytical process involved familiarization with transcripts, coding of relevant text segments, categorization of codes, and development of themes reflecting patient-related determinants of viral suppression.

Findings from the qualitative component were used to complement and provide contextual interpretation of the quantitative results, thereby enhancing the overall understanding of determinants of undetectable viral load.

Ethical Considerations

Ethical approval for this study was obtained from the Health Research Ethics Committee, Government of Cross River State, Ministry of Health, PMB 1049, Calabar (Approval No.:CRS/MH/HREC/023/Vol.V1/262). The ethical approval was granted for a duration of one year, within which the study was conducted in accordance with approved protocols.

Written informed consent was obtained from all participants prior to data collection. Participation was entirely voluntary, and respondents were informed of their right to withdraw from the study at any stage without any consequences to their access to healthcare services.

Confidentiality and anonymity were strictly maintained throughout the study. No personal identifiers were collected, and all data were coded to ensure participant privacy. Both

electronic and hard-copy data were securely stored in password-protected databases and locked cabinets accessible only to the research team. In line with standard research ethics guidelines, data will be retained for a minimum period of five (5) years after publication, after which they will be securely destroyed. All procedures were conducted in accordance with ethical principles for research involving human participants, including respect for persons, beneficence, and justice.

Results

Participant Characteristics

A total of 203 HIV-positive individuals receiving antiretroviral therapy (ART) were included in the quantitative component of the study. For data relating to socio-demographic and treatment-related characteristics of the participants see Table 1,

Table 1. Socio-Demographic Factors of ART Clients and Undetectable Viral Load (n = 203)

Variables	Frequency	Percentage
Age Distribution		
15–24	51	25.10%
25–34	61	21.70%
35–44	44	21.70%
45–54	31	15.30%
55 and above	16	7.90%
Total	203	100
Sex Distribution		
Male	91	44.80%
Female	112	55.20%
Total	203	100
Pregnancy Status		
Pregnant	17	15.20%
Not pregnant	95	84.80%
Total	112	100
Marital Status		
Single	71	35.00%
Married	102	50.20%
Divorced	11	5.40%
Widowed	10	4.90%
Separated	9	4.40%
Total	203	100

Highest Education Level		
No formal	9	4.40%
Primary	41	20.20%
Secondary	91	44.80%
Tertiary	62	30.50%
Total	203	100
Employment Status		
Full-time	51	25.10%
Part-time	20	9.90%
Self-employed	63	31.00%
Unemployed	41	20.20%
Student	20	9.90%
Retired	8	3.90%
Total	203	100
Monthly Income Level		
No Income	22	10.80%
< ₦10,000	52	25.60%
₦10,000–₦30,000	70	34.50%
₦30,000–₦50,000	41	20.20%
> ₦50,000/Above	18	8.90%
Total	203	100
Place of Residence		
Urban	121	59.60%
Rural	82	40.40%
Total	203	100
Duration on ART		
< 6 months	32	15.80%
6–12 months	41	20.20%
1–2 years	61	30.00%
2–5 years	50	24.60%
> 5 years	19	9.40%
Total	203	100

The study population was relatively young, with 55.1% of respondents aged 15–34 years. Females constituted a slightly higher proportion of participants (55.2%). Among female respondents, 15.2% were pregnant at the time of data collection. Half of the respondents were married (50.2%), and the majority had secondary (44.8%) or tertiary education (30.5%), indicating relatively high educational attainment. Regarding employment, self-employment (31.0%) was the most common

occupation. Most participants resided in urban areas (59.6%), and the largest proportion of respondents (30.0%) had been on ART for 1-2 years, reflecting relatively recent treatment initiation among many clients.

Proportion Achieving Viral Suppression

Viral load outcomes were obtained from clinical records and laboratory monitoring reports; (see Table 2).

Table 2. Distribution of Viral Load Outcomes Among ART Clients (n = 203)

Viral Load Category	Frequency	Percentage (%)
Undetectable (<50 copies/mL)	105	51.7
Suppressed (51–999 copies/mL)	56	27.6
Unsuppressed (≥ 1000 copies/mL)	32	15.8
Unknown	10	4.9
Toal	203	100

Overall, 161 participants (79.3%) achieved viral suppression (<1000 copies/mL), while 105 participants (51.7%) achieved undetectable viral load (<50 copies/mL). However, 15.8% of clients remained virologically unsuppressed, indicating suboptimal treatment outcomes among a subset of ART clients. These findings suggest that while viral suppression rates among ART clients in the study setting are substantial, there remains a significant

proportion of patients who require intensified adherence support and clinical follow-up to achieve optimal virologic outcomes.

Bivariate Analysis: Patient-Related Factor

Chi-square (χ^2) tests examined associations between patient-related factors and undetectable viral load; see Table 3.

Table 3. Bivariate Associations (Patient-Related Factors)

Factor	χ^2	df	p-value	Significance
Recreational drug use	6.12	1	0.013	Yes
Ever counselled on substance use	7.41	1	0.006	Yes
Appointment attendance consistency	12.52	4	0.014	Yes
Missed appointment in last 6 months	10.79	1	0.001	Yes
Ease of accessing health facility	9.02	3	0.029	Yes
Belief that ART must be taken daily	8.54	2	0.014	Yes
Confidence (self-efficacy)	11.72	2	0.003	Yes
Adherence to ART schedule	22.61	3	0.000	Yes
Missed doses in past month	15.04	3	0.002	Yes
Use of reminders	6.57	1	0.010	Yes
Ever stopped ART >2 days	9.84	1	0.002	Yes
Difficulty accessing ART	5.92	1	0.015	Yes
Running out of medication	4.66	1	0.031	Yes
Ever considered stopping ART	7.98	1	0.005	Yes
Attendance at counselling	8.76	2	0.013	Yes
Missed counselling sessions	7.23	1	0.007	Yes

Key findings: the above analysis revealed several patient-related factors that were significantly associated with the achievement of undetectable viral load among clients receiving antiretroviral therapy (ART). Adherence-related behaviours demonstrated the strongest relationships with viral

suppression outcomes. Participants who consistently adhered to their prescribed ART regimen were significantly more likely to achieve undetectable viral load compared with those who reported irregular medication use ($\chi^2 = 22.61$, $p < 0.001$). Similarly, treatment interruption was significantly associated with

viral load status. Clients who reported ever stopping ART for more than two days were less likely to achieve viral suppression ($\chi^2 = 9.84$, $p = 0.002$), while those who reported running out of medication were also more likely to have detectable viral load ($\chi^2 = 4.66$, $p = 0.031$). The use of medication reminder strategies further demonstrated a statistically significant association with viral suppression ($\chi^2 = 6.57$, $p = 0.010$).

Engagement with HIV care services also emerged as an important factor. Regular attendance at clinic appointments was significantly associated with undetectable viral load ($\chi^2 = 12.52$, $p = 0.014$). In contrast, respondents who reported missing clinic appointments within the previous six months were significantly less likely to achieve viral suppression ($\chi^2 = 10.79$, $p = 0.001$). Difficulty accessing health facilities was also associated with poorer viral load outcomes ($\chi^2 = 9.02$, $p = 0.029$), suggesting that structural barriers may influence continuity of care.

Medication-taking behaviour further reinforced these findings. Participants who reported missing ART doses within the previous month were significantly less likely to achieve undetectable viral load compared with those who maintained consistent medication intake ($\chi^2 = 15.04$, $p = 0.002$). Substance use behaviours were also associated with viral

suppression outcomes. Recreational drug use showed a statistically significant relationship with viral load status ($\chi^2 = 6.12$, $p = 0.013$), with drug users being less likely to achieve viral suppression compared with non-users. However, tobacco use and alcohol consumption did not demonstrate statistically significant associations with viral load status.

Participation in counselling services was another factor significantly associated with viral suppression. Clients who reported attending counselling sessions were more likely to achieve undetectable viral load ($\chi^2 = 8.76$, $p = 0.013$), while those who missed counselling sessions were more likely to have detectable viral load ($\chi^2 = 7.23$, $p = 0.007$). In addition, receipt of counselling related to substance use was significantly associated with viral suppression outcomes ($\chi^2 = 7.41$, $p = 0.006$).

Overall, the findings indicate that patient-related factors particularly ART adherence, clinic appointment adherence, missed doses of medication, recreational drug use, and participation in counselling, were significantly associated with the likelihood of achieving undetectable viral load among ART clients.

Multivariate Logistic Regression

Independent predictors of undetectable viral load were identified using multivariate logistic regression; see Table 4.

Table 4. Predictors of Undetectable Viral Load

Variable	AOR	95% CI	p-value
Good ART adherence	4.82	2.10–11.04	<0.001
Regular clinic attendance	2.91	1.34–6.31	0.007
Counselling attendance	2.44	1.18–5.03	0.016
Recreational drug use	0.42	0.19–0.91	0.028
Missed doses	0.36	0.17–0.76	0.008

Interpretation: The multivariate analysis above indicates that good ART adherence was the strongest independent predictor of achieving undetectable viral load among ART clients (AOR = 4.82, $p < 0.001$), suggesting that individuals who consistently adhered to

treatment were nearly five times more likely to attain viral suppression. Regular clinic attendance (AOR = 2.91, $p = 0.007$) and participation in counselling sessions (AOR = 2.44, $p = 0.016$) were also positively associated with viral suppression, highlighting the

importance of continuous engagement in HIV care services. Conversely, recreational drug use (AOR = 0.42, $p = 0.028$) and missed ART doses within the past month (AOR = 0.36, $p = 0.008$) significantly reduced the likelihood of achieving undetectable viral load, indicating that behavioural factors that disrupt adherence can adversely affect treatment outcomes.

Qualitative Findings

To complement the quantitative findings, qualitative interviews were conducted with 12 key informants involved in HIV care and ART service delivery in the selected health facilities. Participants included nurses, physicians, counsellors, pharmacists, and other healthcare personnel directly engaged in HIV treatment programmes. The interviews explored provider perspectives on patient-related factors influencing adherence to antiretroviral therapy and the achievement of undetectable viral load among ART clients. Thematic analysis of the interview transcripts generated several themes that reflect behavioural and contextual factors affecting treatment outcomes.

Stigma and Disclosure Barriers

Healthcare providers consistently identified HIV-related stigma and fear of disclosure as persistent barriers affecting adherence to ART. According to participants, some clients remain reluctant to disclose their HIV status to family members or partners due to fear of discrimination or social rejection. This reluctance often influences treatment behaviours, including hesitation to take medication in the presence of others or reluctance to attend clinic appointments regularly. Providers noted that such concerns may lead to delayed medication intake, missed doses, or irregular clinic attendance. These observations reinforce the quantitative findings showing that adherence-related behaviours play a central role in determining viral suppression outcomes.

Economic Hardship and Treatment Challenges

Economic vulnerability emerged as another factor influencing clients' ability to maintain consistent engagement with HIV treatment services. Participants reported that transportation costs, unemployment, and unstable income frequently affect the ability of clients to attend clinic appointments or obtain medication refills on schedule. In addition, food insecurity was described as a challenge for some clients who prefer not to take ART on an empty stomach due to perceived side effects. Providers noted that these economic pressures may contribute to missed appointments or irregular medication intake, thereby affecting treatment continuity. These accounts complement the quantitative results that identified clinic attendance and consistent medication use as significant predictors of viral suppression.

Counselling and Adherence Support

Counselling services were widely described as a critical intervention for strengthening adherence and improving treatment outcomes among ART clients. Healthcare providers emphasized that adherence counselling is routinely provided to reinforce knowledge of HIV treatment, address misconceptions about ART, and identify barriers that may interfere with consistent medication use. Enhanced adherence counselling was particularly highlighted for clients with detectable viral load, where counselling sessions are used to assess adherence challenges and provide targeted support. Participants also noted that counselling helps improve patient motivation and self-management behaviours, which are essential for achieving sustained viral suppression.

Patient Self-Management and Reminder Strategies

Another theme that emerged from the interviews relates to self-management practices

adopted by ART clients to support medication adherence. According to healthcare providers, many clients adopt practical reminder strategies such as mobile phone alarms, assistance from family members, or personal routines to ensure that medication is taken consistently. These strategies were viewed as helpful mechanisms for minimizing missed doses and reinforcing daily treatment adherence. Providers indicated that such behavioural practices contribute positively to sustained engagement in treatment and improved viral load outcomes.

Overall, the qualitative findings highlight how stigma, economic challenges, counselling support, and patient self-management behaviours shape adherence to ART and engagement in HIV care services. These insights complement the quantitative results by providing contextual explanations for the observed associations between patient-related factors, particularly adherence behaviour, clinic attendance, counselling participation, and missed doses and the likelihood of achieving undetectable viral load among ART clients.

Discussion

Principal Findings

This study examined the influence of socio-demographic characteristics and patient-related behavioural factors on the achievement of undetectable viral load among clients receiving antiretroviral therapy (ART) in selected health facilities in Cross River State, Nigeria. The findings demonstrate that both socio-demographic and behavioural factors significantly shape viral suppression outcomes among people living with HIV.

The socio-demographic profile of respondents indicates that most ART clients were young adults, with females slightly more represented than males. A substantial proportion of respondents were married, had at least secondary education, and were engaged in informal or self-employment activities. Despite relatively high educational attainment, many participants reported low-income levels,

reflecting persistent economic vulnerability among ART clients. The quantitative analysis revealed that socio-demographic characteristics such as age, sex, marital status, education, and employment status were significantly associated with undetectable viral load. These characteristics influence treatment outcomes by shaping individuals' health-seeking behaviours, access to healthcare services, and capacity to sustain long-term adherence to ART.

These findings are consistent with prior empirical studies. For instance, [8] reported that age significantly influences viral suppression outcomes among ART clients. This study supports the current findings by demonstrating that older individuals were more likely to achieve viral suppression, indicating that maturity and stability may enhance adherence and long-term treatment engagement. Similarly, [10] found that viral suppression improves progressively with age across multiple African settings. The observed age gradient in viral suppression aligns with this study's findings, suggesting that younger individuals may face behavioural and structural barriers that reduce adherence and compromise treatment outcomes.

Marital status was also significant in this study, consistent with findings by [7]. Their findings indicate that individuals in stable relationships had higher viral suppression, supporting this study's result that social support systems enhance adherence behaviours and improve treatment continuity among ART clients. Furthermore, [6] highlighted the role of education, employment, and financial stability. This aligns with the present findings, suggesting that higher education and employment improve health literacy, access to care, and financial capacity, thereby promoting adherence and increasing the likelihood of viral suppression.

However, contrasting evidence from [27] reported no association between socio-economic factors and viral suppression. This

contradiction highlights contextual differences, suggesting that socio-demographic influences on viral suppression may vary across settings depending on healthcare accessibility, social support systems, and programmatic interventions.

Patient-related behavioural factors were also strongly associated with viral suppression. Clients who consistently attended clinic appointments, adhered to their medication schedules, and participated in counselling sessions were more likely to achieve undetectable viral load. Conversely, missed medication doses, treatment interruptions, and recreational drug use were associated with a reduced likelihood of viral suppression. These behavioural determinants highlight the central role of treatment engagement and adherence practices in achieving optimal HIV treatment outcomes.

Overall, the study provides evidence that viral suppression among ART clients is shaped by the combined influence of socio-demographic characteristics and patient-related adherence behaviours, thereby addressing the research gap concerning context-specific determinants of treatment outcomes in Cross River State.

The qualitative findings further illuminate the contextual factors underlying these patterns. Healthcare providers and ART clients described how stigma, economic hardship, and treatment-related knowledge influence adherence behaviour. Fear of HIV disclosure was frequently cited as a barrier to consistent medication use and clinic attendance, while financial constraints particularly transportation costs and food insecurity, affected clients' ability to attend clinic appointments or maintain regular medication schedules. These insights provide important contextual explanations for the quantitative findings and demonstrate how socio-demographic conditions interact with behavioural factors to influence viral suppression. Overall, the study provides evidence that viral suppression among ART

clients is shaped by the combined influence of socio-demographic characteristics and patient-related adherence behaviours, thereby addressing the research gap concerning context-specific determinants of treatment outcomes in Cross River State.

Adherence as the Strongest Predictor

Adherence to ART emerged as the most significant independent predictor of viral suppression in this study. The multivariate analysis demonstrated that clients who maintained good ART adherence were substantially more likely to achieve undetectable viral load compared with those who reported missed doses or inconsistent medication use. Similarly, regular clinic attendance and participation in counselling sessions significantly increased the likelihood of viral suppression.

These findings are strongly supported by existing literature. For example, [5] identified adherence as a key determinant of viral suppression.

This supports the present findings, demonstrating that poor adherence significantly increases the likelihood of viral non-suppression, emphasizing adherence as the most critical factor influencing ART treatment success. Similarly, [19] linked behavioural practices to viral suppression outcomes. This aligns with the study findings by showing that risky behaviours reduce viral suppression, reinforcing the importance of behavioural modification in improving adherence and achieving optimal treatment outcomes.

Substance use was also significant, consistent with [28]. Their findings demonstrate that alcohol use significantly increases the likelihood of detectable viral load, supporting this study's observation that substance use disrupts adherence and negatively affects viral suppression. Counselling and psychosocial support findings align with [20]. This study supports the current findings by highlighting that patients who

engage in positive health behaviours and receive counselling are more likely to achieve viral suppression through improved adherence and treatment understanding.

Additionally, [18] examined behavioural correlates of viral suppression. Although no association with smoking was found, the study emphasizes the broader role of behavioural factors in treatment outcomes, supporting this study's conclusion that patient behaviours significantly influence viral suppression.

These findings underscore the importance of sustained engagement in HIV care. Consistent adherence ensures adequate drug levels in the body, preventing viral replication and promoting immune recovery. The results further indicate that behavioural support mechanisms such as counselling and adherence monitoring play a critical role in reinforcing treatment adherence and improving health outcomes among ART clients.

The qualitative findings further strengthen the observed relationship between adherence behaviours and viral suppression by illustrating the critical role of counselling in HIV care. Counselling services were shown to enhance patients' understanding of antiretroviral therapy (ART), correct misconceptions about treatment, and build self-efficacy necessary for long-term disease management. Participants emphasized that counselling facilitated the adoption of practical adherence strategies, including the use of medication reminders and the establishment of structured daily routines. These behavioural supports are particularly important in enabling clients to navigate contextual barriers such as stigma, fear of disclosure, and economic hardship, thereby promoting sustained medication adherence and improved treatment outcomes.

This position is strongly supported by existing empirical literature. [1, 2] demonstrate that improved knowledge of HIV treatment and patient-centred care approaches significantly enhance adherence behaviours. Similarly, [17], highlight the importance of adherence

counselling in addressing barriers to viral suppression, while [3] establish a strong link between medication adherence and virological outcomes. Furthermore, [15] provide evidence that behavioural factors, particularly substance use, significantly undermine sustained viral suppression among people living with HIV.

Conversely, behaviours that compromise adherence most notably recreational drug use and missed medication doses, were associated with a significantly reduced likelihood of achieving viral suppression in this study. These findings underscore the dual importance of strengthening adherence-promoting interventions while simultaneously addressing behavioural risk factors that disrupt treatment continuity. Collectively, the evidence highlights the need for integrated, patient-centred HIV care models that combine adherence counselling, behavioural support, and targeted risk-reduction strategies to optimize virological outcomes among ART clients.

Comparison with Other Studies

The findings of this study are consistent with existing literature on determinants of viral suppression among people living with HIV. Previous studies conducted in sub-Saharan Africa and other regions have similarly reported significant associations between socio-demographic characteristics and HIV treatment outcomes.

For instance, [9] reported that age and sex were important predictors of viral suppression among ART clients. Similarly, [13] found that demographic characteristics such as age, sex, and educational attainment influenced viral suppression outcomes across several African countries. Evidence from high-income settings also supports these findings, with [14] demonstrating that demographic factors such as age, sex, and employment status significantly influence viral suppression among people living with HIV.

The strong relationship between ART adherence and viral suppression observed in this study is also consistent with findings from other low- and middle-income settings. [5] reported that poor adherence to ART was strongly associated with viral non-suppression among patients receiving treatment in Uganda. Similar studies conducted in Kenya and other African countries have likewise emphasized adherence as the most important determinant of viral suppression.

Furthermore, behavioural risk factors such as substance use have been shown to negatively influence HIV treatment outcomes. [19] demonstrated that behavioural risk factors influence HIV transmission and treatment outcomes, while [18] reported that alcohol and substance use were associated with higher likelihood of viral non-suppression. Collectively, these studies support the findings of the present research, confirming that both socio-demographic conditions and behavioural adherence practices are critical determinants of viral suppression among ART clients.

Study Limitations

Several limitations should be considered when interpreting the findings of this study. First, the cross-sectional design limits the ability to establish causal relationships between socio-demographic characteristics, patient-related behaviours, and viral suppression outcomes. The associations observed therefore indicate relationships rather than direct causality.

Second, some behavioural variables such as missed doses of medication or substance use, were based on self-reported information, which may be subject to recall bias or social desirability bias. Participants may have underreported behaviours perceived as undesirable, which could influence the accuracy of the findings.

Third, the study was conducted in selected health facilities within Cross River State, which may limit the generalizability of the results to

other regions with different healthcare systems or socio-demographic contexts. Nevertheless, the mixed-methods design strengthened the study by integrating quantitative analysis with qualitative insights, thereby providing a more comprehensive understanding of the factors influencing viral suppression among ART clients.

Despite these limitations, the study provides valuable context-specific evidence on the socio-demographic and patient-related determinants of viral suppression in Cross River State.

Equations

Logistic regression model used in the study:
$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \dots + \beta_nX_n$$

Where:

- p = probability of achieving undetectable viral load
- X_n = independent variables
- β_n = regression coefficients

Conclusion

This study demonstrates that the achievement of undetectable viral load among ART clients in Cross River State is influenced by both socio-demographic characteristics and patient-related behavioural factors. Socio-demographic variables including age, sex, marital status, education level, and employment status, shape treatment engagement and adherence behaviours among people living with HIV.

However, behavioural factors related to treatment adherence emerged as the most critical determinants of viral suppression. Consistent adherence to ART, regular clinic attendance, and participation in counselling services significantly increased the likelihood of achieving undetectable viral load, while missed medication doses and recreational drug use reduced the likelihood of viral suppression.

The integration of quantitative and qualitative findings demonstrates that viral suppression is influenced not only by clinical

treatment but also by broader social and behavioural contexts. Stigma, economic hardship, and limited access to healthcare services can undermine adherence behaviours, whereas counselling, adherence education, and patient self-management strategies strengthen treatment engagement.

By focusing on socio-demographic and patient-related determinants, this study addresses an important research gap concerning context-specific factors influencing viral suppression among ART clients in Cross River State. The findings highlight the need for patient-centered interventions that strengthen adherence support, enhance counselling services, and address socio-economic barriers to treatment engagement.

Such approaches are essential for improving viral suppression outcomes and advancing HIV treatment goals in resource-limited settings.

Conflict of Interest

The contributors to the study declare no conflict of interest.

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Data Availability

The datasets underlying the findings of this study can be obtained from the corresponding

author upon reasonable request. Premised on ethical considerations and the need for total compliance with research ethics, the dataset is not publicly available. All data were obtained from structured questionnaires, clinical records, and qualitative interviews conducted within the selected health facilities in Cross River State, Nigeria.

Author Contributions

Ofere, I. M. conceptualized the study, developed the research design, secured funding and coordinated the overall field activities. Agada, P. supervised the overall research process and provided critical review of the manuscript. He ensured language consistency, methodological validity, and verification of results, and confirmed the integrity and reliability of the data presented in the study and Mbeh, O.A. designed the quantitative questionnaire using the KoboCollect mobile data collection platform, coordinated the field data collection process, and conducted data verification and statistical analysis. The author also proofread the data analysis section to ensure accuracy and clarity of the results. All authors contributed to the revisions and approved the final manuscript.

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