

An assessment of ART-related factors as predictors of non-communicable diseases among adult patients on antiretroviral therapy in tertiary hospitals in Lagos State, Nigeria

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Abstract

Background

Globally, antiretroviral therapy (ART) has saved millions of lives, enabling people living with HIV (PLHIV) lead longer and more productive lives, though they become more susceptible to non-communicable diseases (NCDs) later in life. However, despite therapeutic effectiveness, ART regimens have long been associated with metabolic complications. This study aims to assess ART-related factors as predictors of NCDs among adult patients on antiretroviral therapy attending tertiary health facilities in Lagos.

Methods

A descriptive cross-sectional study was conducted among 416 adult PLHIV attending two tertiary hospitals, using a multistage sampling method. Data was obtained using a pre-tested structured questionnaire adapted from the World Health Organization (WHO) STEPS Instrument, in addition to anthropometric and biomedical measurements. Descriptive, bivariate and multivariate analyses were carried out using IBM SPSS version 27.

Results

The mean age group of respondents was 49.13 ± 10.18 years. Majority, 70.2% (n = 292) were female, and 54.1% (n = 225) married. The prevalence of obesity, hypertension, and diabetes was 37.3% (n = 155), 52.6% (n = 219), and 7.2% (n = 30) respectively; and over 70% of the respondents had at least one NCD. ART regimen was a predictor of obesity: patients on second-line ART regimen had 58.1% lower odds of obesity, compared with those on first-line regimen (aOR = 0.419, 95% CI: 0.219–0.801, P = 0.008). Hypertension was more prevalent among the patients on first-line ART regimen (54.6%, $\chi^2=3.287$, P = 0.070), though not statistically significant.

Conclusion

This study suggests that ART regimen is a predictor of obesity, as it was more prevalent among the patients on first-line regimen. Though hypertension was also more prevalent among these patients, the association was not significant. The identification of ART regimen type as a modifiable predictor of obesity among PLHIV has direct programmatic implications for the adoption of an integrated care model that addresses the dual epidemic of HIV and NCDs, especially in resource-poor countries.

Introduction

Globally antiretroviral therapy (ART) has saved millions of lives, with a decline of 58% in deaths from AIDS-related causes from 2001 to 2020.^{1,2} This has enabled people living with HIV (PLHIV) to lead longer

and more productive lives, though they become more susceptible to NCDs later in life due to an interplay of aging, ART-related factors, and lifestyle.^{3,4,5,6} Despite the progress made in treatment and prevention, HIV infection remains a significant public health problem, with 40.8 million people living with HIV globally as at the end of 2024, and 1.9 million people living with the virus in Nigeria, as of 2025.^{2,7} The availability of improved ART treatment options has turned HIV into a manageable chronic condition, with marked improvement in survival and quality of life.^{8,9} Key indicators of favorable long-term outcomes for patients on ART include optimal HIV viral suppression and immune system restoration.¹⁰

However, despite therapeutic effectiveness, ART regimens have long been associated with metabolic complications like dyslipidaemia, insulin resistance, weight gain and bone demineralization. Generally, metabolic syndrome (MS) refers to a group of metabolic abnormalities, which includes three or more these criteria: abdominal obesity, high blood pressure, increased fasting glucose, increased triglycerides, and decreased high-density lipoproteins (HDLs). MS is associated with insulin resistance, proinflammatory and prothrombotic states; which increase cardiovascular disease (CVD) risk.¹¹ The resulting NCDs reduce quality of life; and increase mortality among PLHIV, eroding the gains of ART.¹² Muhammad et al. found in Northwest Nigeria that the prevalence of MS in patients receiving ART was 19.3% compared to 5.3% in ART-naive patients; with insulin resistance in 79.3% of the ART-exposed patients compared to the 25.0% ART-naive group.¹³ Similarly, in a study among Tanzanian adults, glucose metabolism disorders were more prevalent among ART-exposed patients (32.7%) compared to ART-naive (8.0%) and control groups (7.2%); diabetes and impaired glucose tolerance were also more common in patients receiving ART.¹⁴

Clinical and laboratory evidence have shown that ART can induce adverse metabolic complications, characterized by lipodystrophy, dyslipidemia, insulin resistance, central adiposity, increased risk of cardiovascular disease and atherosclerosis.^{15,16} The dyslipidemia is characterized by hypercholesterolemia, hypertriglyceridemia, and decreased serum HDL, with or without increased serum LDL.¹⁷ The older ART regimen are associated with higher metabolic toxicity, but are still used in resource-limited countries due to cost effectiveness.¹⁸ Nucleoside reverse transcriptase inhibitors NRTIs (abacavir, lamivudine, zidovudine, emtricitabine, tenofovir), non-nucleoside reverse transcriptase inhibitors NNRTIs (nevirapine, efavirenz), and protease inhibitors PIs (lopinavir, ritonavir, atazanavir) are commonly recommended in the first-line regimens.¹⁹ The lipid abnormalities associated with use of PIs are severe and more common than other classes of ARTs, sometimes resulting in discontinuation.^{20,21} However, NNRTIs and NRTIs are reported to cause modest changes.^{17,21,22} A cycle of events invariably ensues: the NCDs that result from ART metabolic toxicity complicates HIV disease management by affecting adherence to ART, and increasing the risk of drug-drug interactions.^{3,4,5,23} In turn, poor ART adherence leads to suboptimal and slow immune recovery, characterised by low CD4 cell counts, and non-suppression of HIV viral load, increasing the NCD risk factors.²⁴⁻²⁷

With the paradoxical intricacies surrounding ART in PLWHA, an assessment of ART-related factors as predictors of NCDs among adult patients on antiretroviral therapy attending tertiary health facilities in Lagos state will enable the prompt deployment of preventive measures, early detection and early onset of treatment of NCDs in this population. This is consistent with the integration of health services being canvassed to tackle the double disease burden of HIV-NCD, which will improve the overall well-being of the patients, by reducing morbidity and mortality rates, and decreasing HIV transmission within the community. Identification of these predictors will also help stakeholders make informed decisions in developing targeted interventions to address the dual disease burden. Despite the growing burden of NCDs, particularly in LMICs, studies on the predictors for NCDs among PLHIV remain limited. This gap is hindering the development of effective and efficient evidence-based strategies, targeted interventions, and policies for integrating HIV and NCD care and services, which is crucial for managing the dual disease burden, and improving health outcomes for this vulnerable population.^{28,29} Lagos State, despite its relatively low HIV prevalence of 1.4% remains a priority area for the study due to its dense population, high internal migration, and complex socioeconomic structure, which collectively pose ongoing challenges for HIV prevention and care.³⁰

Methods

Study design and setting

This cross-sectional study was carried out between June and July 2025 in the Antiretroviral clinics of the departments of Haematology and Blood Transfusion of the Lagos University Teaching Hospital (LUTH), Idi Araba, and, the Lagos State University Teaching Hospital (LASUTH), Ikeja. These clinics were commissioned in 2004, to cater to children, adolescents, adults, pregnant women, both citizens and foreign nationals infected with HIV, under the auspices of the US President's Emergency Plan for AIDS Relief (PEPFAR) program, with the Centre for Integrated Health Programs (CIHP) as the implementing partner in Nigeria.^{31,32,33}

Study Population: These consisted of HIV-positive patients attending ART clinics in LUTH and LASUTH, aged 18 years and above, and having documented HIV-positive results: either newly diagnosed ART-naïve or ART experienced. Those less than 18 years of age, with severe illness requiring urgent care, accessing care for pre- or post-exposure prophylaxis, and pregnant women (to avoid confounding metabolic changes) were excluded from the study.

Sample size determination

The minimum sample size (n) was determined using Cochran's formula $n = z^2 pq / d^2$. Z at 95% confidence level is 1.96; d is the margin of error at 5% (0.05), and p was the prevalence of obesity among PLHIV from a previous study in Nigeria (38.4%).³⁴ Accordingly, n = 363; with 10% contingency, the minimum sample size was 400. Four hundred and sixteen (416) eligible patients were recruited from the clinics within the two-month study period.

Sampling technique

A multistage sampling technique was used. Stage 1 was the purposive selection of the two tertiary hospitals in Lagos state, because they serve as the major ART treatment centers. The total number of eligible patients currently receiving ART at both facilities was the sampling frame. This served as the pool from which study participants were selected. Facility 1 (LUTH) 5,895 + Facility 2 (LASUTH) 5,526 = 11,421 patients. Stage 2 involved proportional allocation of the minimum sample size (400) across the two facilities. Facility 1 (LUTH) 206 + Facility 2 (LASUTH) 194 = 400 patients. Systematic random sampling was used in stage 3 to select the participants from each facility. The sampling interval (k) was determined by dividing the total population in the facility by the sample size desired from each facility. Facility 1 (LUTH) $k = 5,895 / 206 = 29$. Facility 2 (LASUTH) $k = 5,526 / 194 = 29$. A random number between 1 and the calculated interval of 29 was chosen by simple random sampling (balloting), to serve as the starting point, which was 10. Every tenth patient was recruited until the sample size was reached, excluding those that declined consent.

Data collection: This was carried out on week days at the ART clinics. A recruitment schedule using simple random sampling (balloting) facilitated allocation of days for recruitment to the 2 facilities. A structured interviewer-administered questionnaire adapted from the WHO STEPS Instrument, a question-by-question guide approach to noncommunicable disease risk factor surveillance was used.³⁵ The electronic medical record database, Nigeria Medical Record System (NMRS) was also reviewed to confirm baseline patient information and comorbidities. The questionnaire had sections for socio-demographic information, NCD disease status, anthropometric and biomedical measurements. The study was introduced to the participants and their consent sought, while waiting to be seen by the physicians. A secluded area within the facility was used for face-to-face interview, followed by taking of measurements. Data was collected using Kobo Toolbox app on smartphones: an open-source platform for collecting, managing, and visualizing data.³⁶ Five ART nurses and two ART case managers were trained for two days on the study objectives, informed consent, the data collection process, and confidentiality. The questionnaire was pre-tested among twenty-nine patients attending the ART clinic at the General hospital Mushin, a secondary health facility.

Study variables

Independent variables: ART-related variables (viral load suppression, ART regimen, and ART duration) and sociodemographic variables (age-group, sex, level of education and income).

Dependent variables: The presence or absence of obesity, hypertension, and diabetes.

Data Analysis

Data entered using the Kobo toolbox software was exported to IBM SPSS version 27 by IBM Corporation, Armonk, New York, United States. Descriptive analysis, such as frequencies, charts, and percentages were used to analyze socio-demographic data, prevalence of NCDs and ART-related factors. Bivariate

analysis using Chi square test was used to test for significant relationships between variables. Thereafter, variables that had a P-value of < 0.2 were entered into the multivariate logistic regression model to determine the predictors of NCDs.³⁷ The results were presented using adjusted odds ratio and 95% confidence interval. A P-value of < 0.05 determined the level of statistical significance.

Results

The mean age group of respondents was 49.13 ± 10.18 years. Majority, 70.2% (n = 292) were female, 54.1% (n = 225) married, and 81.5% (n = 339) Christian. Most, 48% (n = 200) attained secondary education, 64% (n = 266) were self-employed, and majority, 44.2% (n = 184) earned less than N50,000 monthly (low-income). The prevalence of obesity, hypertension, and diabetes was 37.3% (n = 155), 52.6% (n = 219), and 7.2% (n = 30) respectively; and over 70% of the respondents had at least one NCD.

Viral load results were available for 407 of the 416 respondents. Of these 363 (89.2%) and 44 (10.8%) were virally suppressed (viral load < 1000 copies/mL), and not suppressed (≥ 1000 copies/mL) respectively; 350 (84.1%) and 66 (15.9%) were on a first- and second-line ART regimen respectively; while 68 (16.3%), 104 (25%), and 244 (58.7%) were on ART regimen for < 5 years, 5–10 years, and > 10 years respectively.

Table 1
Association between socio-demographic, ART-related factors and Obesity (n = 416)

Variable	Category	Yes (%)	No (%)	Total n (%)	χ^2	P value
Age group	18–27	2 (12.5)	14 (87.5)	16 (100)	4.880	0.3
	28–37	8 (33.3)	16 (66.7)	24 (100)		
	38–47	55 (39.6)	84 (60.4)	139 (100)		
	48–57	61 (38.9)	96 (61.1)	157 (100)		
	58–67	29 (36.3)	51 (63.7)	80 (100)		
Sex	Female	110 (37.7)	182 (62.3)	292 (100)	0.070	0.79
	Male	45 (36.3)	79 (63.7)	124 (100)		
Income	Low	58 (31.5)	126 (68.5)	184 (100)	11.100	0.004 ^a
	Middle	35 (33.0)	71 (67.0)	106 (100)		
	High	62 (49.2)	64 (50.8)	126 (100)		
Education	None	16 (50.0)	16 (50.0)	32 (100)	4.21	0.379
	Vocational	5 (50.0)	5 (50.0)	10 (100)		
	Primary	16 (30.2)	37 (69.8)	53 (100)		
	Secondary	75 (37.5)	125 (62.5)	200 (100)		
	Tertiary	43 (35.5)	78 (64.5)	121 (100)		
Viral load status	Suppressed	136 (37.5)	227 (62.5)	363 (100) ^b	0.192	0.662
	Not suppressed	15 (34.1)	29 (65.9)	44 (100) ^b		
ART Regimen	First-line	141 (40.3)	209 (59.7)	350 (100)	8.642	0.003 ^a
	Second-line	14 (21.2)	52 (78.8)	66 (100)		
ART Duration	> 5 years	26 (38.2)	42 (61.8)	68 (100)	3.288	0.193
	5–10 years	46 (44.2)	58 (55.8)	104 (100)		
	> 10 years	83 (34.0)	161 (66.0)	244 (100)		

^a Significant ^b Viral load results (n = 407)

Obesity was significantly more prevalent among patients on first-line ART regimen (40.3%, $\chi^2 = 8.642$, $p = 0.003$), and the high-income earners (49.2%, $\chi^2 = 11.100$, $p = 0.004$). More virally suppressed patients,

and those on ART therapy for 5–10 years were obese, though association was not significant (37.5%, $\chi^2 = 0.192$, $p = 0.662$) and (44.2%, $\chi^2 = 3.288$, $p = 0.193$) respectively. (Table 1).

Table 2
Association between socio-demographic, ART-related factors and Hypertension (n = 416)

Variable	Category	Yes (%)	No (%)	Total n (%)	χ^2	P value
Age group	18–27	4 (25.0)	12 (75.0)	16 (100)	18.438	0.001 ^a
	28–37	9 (37.5)	15 (62.5)	24 (100)		
	38–47	62 (44.6)	77 (55.4)	139(100)		
	48–57	91 (58.0)	66 (42.0)	157(100)		
	58–67	53 (66.3)	27 (33.7)	80 (100)		
Sex	Female	152 (52.1)	140 (47.9)	292(100)	0.14	0.712
	Male	67 (54.0)	57 (46.0)	124(100)		
Income	Low	100 (54.3)	84 (45.7)	126(100)	0.57	0.752
	Middle	56 (52.8)	50 (47.2)	106(100)		
	High	63 (50.0)	63 (50.0)	184(100)		
Education	None	20 (62.5)	12 (37.5)	32 (100)	5.36	0.253
	Vocational	7 (70.0)	3 (30.0)	10 (100)		
	Primary	30 (56.6)	23 (43.4)	53 (100)		
	Secondary	107 (53.5)	93 (46.5)	200(100)		
	Tertiary	55 (45.5)	66 (54.5)	121(100)		
Viral load status	Suppressed	195 (53.7)	168 (46.3)	363 (100) ^b	1.748	0.186
	Not suppressed	19 (43.2)	25 (56.8)	44 (100) ^b		
ART Regimen	First-line	191 (54.6)	159 (45.4)	350 (100)	3.287	0.070
	Second-line	28 (42.4)	38 (57.6)	66 (100)		
ART Duration	> 5 years	32 (47.1)	36 (52.9)	68 (100)	2.922	0.232
	5–10 years	50 (48.1)	54 (51.9)	104 (100)		
	> 10 years	137 (56.1)	107 (43.9)	244 (100)		

^a Significant ^b Viral load results (n = 407)

The prevalence of hypertension showed a significant upward trend with age, highest among the 58–67-year age group (66.3%, $\chi^2=18.438$, $P = 0.001$). More virally suppressed patients (53.7%, $\chi^2=1.748$, $P = 0.186$), on first-line regimen (54.6%, $\chi^2=3.287$, $P = 0.070$), and on ART therapy for more than 10 years (56.1%, $\chi^2=2.922$, $P = 0.232$) had hypertension, though association was not significant. (Table 2).

Table 3
Association between socio-demographic, ART-related factors and Diabetes Mellitus (n = 416)

Variable	Category	Yes (%)	No (%)	Total n (%)	χ^2	P value
Age group	18–27	0 (0.0)	16 (100.0)	16 (100)	0.135	0.102 ^a
	28–37	2 (8.3)	22 (91.7)	24 (100)		
	38–47	5 (3.6)	134 (96.4)	139 (100)		
	48–57	13 (8.3)	144 (91.7)	157 (100)		
	58–67	10 (12.5)	70 (87.5)	80 (100)		
Sex	Female	22 (7.5)	270 (92.5)	292 (100)	0.019	0.837
	Male	8 (6.5)	116 (93.5)	124 (100)		
Income	Low	13 (7.1)	171 (92.9)	184 (100)	0.031	0.835
	Middle	9 (8.5)	97 (91.5)	106 (100)		
	High	8 (6.3)	118 (93.7)	126 (100)		
Education	None	2 (6.3)	30 (93.7)	32 (100)	0.039	0.864 ^a
	Vocational	1 (10.0)	9 (90.0)	10 (100)		
	Primary	5 (9.4)	48 (90.6)	53 (100)		
	Secondary	14 (7.0)	186 (93.0)	200 (100)		
	Tertiary	8 (6.6)	113 (93.4)	121 (100)		
Viral load status	Suppressed	29 (8.0)	334 (92.0)	363 (100) ^b		0.230 ^a
	Not suppressed	1 (2.3)	43 (97.7)	44 (100) ^b		
ART Regimen	First-line	25 (7.1)	325 (92.9)	350 (100)		0.800 ^a
	Second-line	5 (7.6)	61 (92.4)	66 (100)		
ART Duration	> 5 years	5 (7.4)	63 (92.6)	68 (100)	2.434	0.312 ^a
	5–10 years	4 (3.8)	100 (96.2)	104 (100)		
	> 10 years	21 (8.6)	223 (91.4)	244 (100)		

^a Fisher's Exact value ^b Viral load results (n = 407)

There was no statistically significant association between the explored factors and diabetes. (Table 3).

Table 4
Predictors of NCDs among Respondents

Variable		B	aOR	95% CI for aOR		P value
				Lower	Upper	
Obesity						
Income	Low income		1			0.007 ^a
	Middle income	0.038	1.038	0.619	1.741	0.886
	High income	0.708	2.030	1.261	3.269	0.004 ^a
ART Regimen	First-line		1			
	Second-line	-0.870	0.419	0.219	0.801	0.008 ^a
ART Duration	> 5 years		1			0.638
	5–10 years		1.239	0.656	2.337	0.509
	> 10 years		0.984	0.555	1.745	0.957
Hypertension						
Age groups	18–27 years		1			0.005 ^a
	28–37 years	0.354	1.424	0.341	5.940	0.628
	38–47 years	0.637	1.890	0.563	6.350	0.303
	48–57 years	1.175	3.238	0.970	10.814	0.056
	58–67 years	1.498	4.471	1.275	15.683	0.019 ^a
Viral load status	Suppressed		1			
	Not suppressed	-0.296	0.744	0.387	1.430	0.374
ART Regimen	First-line		1			
	Second-line	-0.402	0.669	0.387	1.158	0.151
Diabetes						
Age groups	18–27 years		1			0.231
	28–37 years	18.805	146862316.311	0.000		0.999
	38–47 years	17.914	60279308.934	0.000		0.999
	48–57 years	18.798	145842439.114	0.000		0.999
	58–67 years	19.257	230783639.917	0.000		0.998

Logistic regression revealed that ART regimen and monthly income were predictors of obesity. Patients on second-line ART regimen had 58.1% lower odds of obesity, compared with those on first-line regimen (aOR = 0.419, 95% CI: 0.219–0.801, P = 0.008); respondents in the high-income category had 2 times higher odds of being obese, compared with those in the low-income category (aOR = 2.030, 95% CI: 1.261–3.269, P = 0.004). Similarly, respondents in the oldest age-group of 58-67-year-olds had 4 times higher odds of having hypertension, compared with the youngest age-group of 18–27-year-olds (aOR = 4.471, 95% CI: 1.275–15.683, P = 0.019). None of the explored factors were found to be predictors of having diabetes mellitus. (Table 4).

Discussion

The objective of this study was to assess ART-related factors as predictors of non-communicable diseases among adult patients on antiretroviral therapy in tertiary hospitals in Lagos State, Nigeria. The prevalence among the respondents that are PLHIV for obesity, hypertension, and diabetes mellitus was 37.3%, 52.6%, and 7.2% respectively. ART regimen was a predictor of obesity, as it was more prevalent among the patients on first-line regimen. Though hypertension was also more prevalent among these patients, the association was not significant. Income and age were also predictors of obesity and hypertension respectively: most prevalent among the high-income earners, and the 58–67-year age group, respectively.

Our finding that obesity was more prevalent among patients on first-line ART regimen is consistent with other studies from Nigeria and Uganda, that reported increase in the BMI of PLHIV after initiating ART; and elevated rates of metabolic syndrome and its components among HIV-positive patients on ART.^{34,38,39,40,41} A substantial weight gain in ART-naïve individuals starting first-line ART, and elevated rates of metabolic syndrome and its components among treatment-experienced PLHIV was reported in other studies.^{34,38,42} We also found that hypertension was more prevalent among the patients on first-line ART regimen. Though this was not a statistically significant association, it is consistent with findings from a Northwestern Nigeria study, in which 90% of the ART- exposed group received first-line therapy. The prevalence of MS (hypertension being the most common feature) in the ART-exposed group was 19.3%, compared with 5.3% in the ART-naïve group. Similarly, Dimala et al. found in a study involving 100 first-line ART exposed patients, and 100 ART-naïve patients, that hypertension was significantly more prevalent in the ART-exposed patients than the ART-naïve group; 38% and 19%, respectively (p = 0.003). These findings were also not statistically significant.^{13,43}

None of the explored factors were found to be predictors of diabetes mellitus. This could possibly be as a result of lack of effect size due to the small proportion of respondents (7.2%) that had diabetes in this study. This is dissimilar to findings in many studies that reported significantly higher prevalence of diabetes or hyperglycemia among ART-exposed patients. In a cross-sectional study of 200 PLHIV at Limbe Regional Hospital, Cameroon, those on first-line ART for > 12 months had a higher median diabetes risk score (2.30% vs 1.62%) and greater prevalence of high diabetes risk (31% vs 17%) compared with ART naïve counterparts.⁴⁴ A similar study found that MS was significantly more prevalent

among the patients receiving first-line ART; with a quarter of the patients with MS having hyperglycemia.⁴⁵

Interestingly, duration of ART use and viral load suppression status were not significantly associated with obesity, or the other NCDs. This is in agreement with a South-Western Nigeria study that reported no association between ART status and NCDs, and other studies that reported duration of ART exposure was not significantly associated with insulin resistance or glucose metabolism disorders.^{13,18,46} However, this contrasts with some longitudinal studies, which reported an increased cardiometabolic risk with longer ART exposure, and also runs contrary to the hypotheses that chronic immune activation might influence metabolic risk.^{6,47,48,49}

Though the use of older ART regimen with higher metabolic toxicity persists in resource-limited countries because cost effectiveness, there are newer classes of ART that have excellent suppression of viremia, without apparent toxic effects on lipid metabolism.¹⁵ However, switching to these is not recommended in all cases, in order not to jeopardise viral suppression.^{50,51} A 2017 study found that insulin resistance was less prevalent among patients using new antiretroviral regimens: 14% compared with 28% among patients on PIs.⁵² However, in situations where newer drugs and/or regimens did not achieve the desired suppression, either because of viral resistance, lack of an immune response, or non-adherence to treatment, the older drug combinations, especially PI-containing regimens are used, with efforts made to choose the one with the least metabolic effects.^{53,54}

Limitations

A longitudinal study design would have been preferable to infer causality. Over 20% of the CD4 count and baseline WHO staging data were missing, so these markers could not be reliably included in the study. This may have underestimated the assessment of the influence of HIV disease severity or immune suppression on NCD development.

Conclusion

This study suggests that ART regimen is a predictor of obesity, as it was more prevalent among the patients on first-line regimen. Though hypertension was also more prevalent among these patients, the association was not significant. The identification of ART regimen type as a modifiable predictor of obesity among PLHIV has direct programmatic implications for the adoption of an integrated care model that addresses the dual epidemic of HIV and NCDs, especially in resource-poor countries.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. Ethics approval was obtained from the Health Research and Ethics Committee of the Lagos University Teaching Hospital (Approval No.

ADM/DSCST/ HREC/APP/7324) and the Lagos State University Teaching Hospital (Approval No. LREC/06/10/2895). Permission to conduct the study was obtained from the heads of departments of Haematology and Blood Transfusion in the two facilities, Written informed consent was obtained from every participant, and confidentiality was maintained throughout the study.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

Conceptualization of the study and design by EOO, OMO, OFA; data acquisition, data analysis, and manuscript preparation by EOO, OMO; manuscript editing and manuscript review by EOO, OMO, OFA.

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We want to express our gratitude to the participants that took part in the study.

Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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