The epidemiology of delayed HIV diagnosis in Ibadan, Nigeria

Michael O Oluwalana¹, Olutosin A Awolude²,³, Zhiwei Gao¹ and Peter K Daley¹

Abstract

Background: Human immunodeficiency virus infection (HIV) is one of the major health burdens in Nigeria. Delayed HIV diagnosis remains a significant driver of HIV transmission. The risk factors of delayed HIV diagnosis have not been widely studied in Nigeria. This observational study examined demographic risk factors for delayed HIV diagnosis and the trends in the annual total cases of delayed HIV diagnosis in Ibadan, Nigeria.

Methods: We examined the data on HIV patients enrolled in care at the University College Hospital’s Antiretroviral Therapy (ART) clinic in Ibadan, Nigeria. Delayed HIV diagnosis was defined as a Cluster of Differentiation 4 (CD4) count of less than 350 cells/mm³ at the time of diagnosis. The association between delayed HIV diagnosis and risk factors was analyzed using logistic regression. The trends in the annual total cases of delayed HIV diagnosis over time were examined.

Results: This study included 3458 HIV patients. There were 1993/3458 prevalent cases of delayed HIV diagnosis (57.6%). The risk factors for delayed HIV diagnosis were older age, retirement, marriage separation, never married, and widowed female. The factors that were significantly associated with a low risk of delayed HIV diagnosis were student and tertiary education. There was a progressive decline in the annual cases of delayed HIV diagnosis.

Conclusions: Although the cases of delayed HIV diagnosis are still high, they are declining. Human immunodeficiency virus testing should be targeted at populations at risk of delayed diagnosis. Considerable public awareness and education programs about HIV testing may significantly reduce delayed HIV diagnosis in Nigeria.

Keywords

Nigeria, human immunodeficiency virus, delayed diagnosis, prevention of transmission, risk factors, trends in annual cases

Introduction

Since the pandemic began, an estimated 76.1 million people have been infected with Human Immunodeficiency Virus (HIV), with 35 million deaths from AIDS-related diseases.¹ Globally, 36.7 million people were living with HIV at the end of 2018, and it is estimated that Sub-Saharan Africa accounted for 70% of this burden.² ³ Nigeria has the second-largest HIV epidemic globally.⁴ In 2018, there were 130,000 new cases of HIV and 53,000 HIV-related deaths in Nigeria.⁵ Heterosexual transmission accounts for over 90% of HIV transmissions in Nigeria.² The 2019 prevalence of HIV in Nigeria among adults aged 15–49 years is 1.4% compared to 2.8% in 2017, and the estimated number of people living with HIV (PLHIV) has decreased from 3.1 million in 2017 to 1.9 million in 2019.⁶ ⁷ It is estimated that 47% of PLHIV in Nigeria are diagnosed, 96% are on antiretroviral therapy (ART), and 81% have achieved viral suppression on ART.⁸ As a result, Nigeria has not achieved the United Nations Program on HIV/AIDS (UNAIDS) 90-90-90 treatment target that was proposed in 2014.⁹

Delay in HIV diagnosis represents a missed opportunity to prevent transmission through viral suppression.¹⁰ The European consensus definition of delayed diagnosis is a CD4 count of less than 350 cells/mm³ or clinical AIDS or the presence of opportunistic infection at the time of diagnosis.¹¹ Several developed countries have reported
a prevalence of delayed HIV diagnosis ranging between 14.9% and 55.9%. Although the prevalence of delayed HIV diagnosis is not reported nationally in Nigeria, some observational studies exist. Agaba et al. (2014) observed an 85.6% prevalence of delayed diagnosis among 14,000 PLHIV in Jos, Nigeria. A cross-sectional study in Nigeria observed a mean time between HIV infection and diagnosis was 6.7 years and 8.1 years for men and women, respectively. In Nigeria and the United Kingdom, delayed HIV diagnosis is associated with increased mortality and decreased survival time.

Demographic factors have been described as predictors of delayed HIV diagnosis. In most countries, older age, heterosexuality, men who have sex with men (MSM), and injecting drug users (IVDU) were all associated with a delayed HIV diagnosis. Male gender, older age, being a civil servant, widowed or divorced, unemployment, poverty, and fear of discrimination have been previously described as risk factors associated with delayed HIV diagnosis in Nigeria. Identifying these risk factors is a critical first step in developing strategies toward targeting HIV testing. The objectives of this study were to describe risk factors associated with delayed HIV diagnosis in Nigeria and to examine the trends in the annual total cases of delayed HIV diagnoses over time.

Methods

Study Design, Setting and Population, Data Source

Antiretroviral therapy (ART)-naïve HIV patients with documented CD4 count at diagnosis who attended the ART clinic at the University College Hospital, Ibadan, Nigeria for the first time and enrolled in care between October 2013 and December 2018 were included. Patients’ information was collected at the first clinic visit using a standardized pre-assessment form and entered into the APIN Public Health Initiatives database. While the data included ART-naïve HIV patients with their first known CD4 count, the HIV tests or CD4 tests may not be the first tests for some patients as some may have previous tests during their routine doctors’ visits without linkage to care.

We made secondary use of data made available by the APIN Public Health Initiatives database. APIN Public Health Initiative is a non-governmental organization (NGO) in Nigeria and a direct implementing partner of the United States Centers for Disease Control and Prevention (CDC) with a focus on HIV control and prevention and other current and emerging public health issues. APIN Public Health Initiative collaborates closely with the federal government of Nigeria, major STI clinics in several states of Nigeria, and relevant stakeholders to strengthen policy and service delivery systems for HIV treatment and prevention.

Inclusion criteria were ART-naïve HIV patients with documented CD4 count at diagnosis and aged 15 years or older. Of the 3559 patients available, 101 (2.8%) were excluded (58 no CD4 count, 30 missing data, 13 age less than 15). Ethics approval was given by the APIN Institutional Review Board (IRB) in Nigeria and the Health Research Ethics Board (HREB) of Newfoundland and Labrador, Canada. Both ethics review boards determined that the de-identified secondary data we used in this study did not require consent.

Analysis

We defined delayed HIV diagnosis in accordance with European consensus as a CD4 count of less than 350 cells/mm³ at the time of diagnosis. All variables were categorical, with the exception of the CD4 count at diagnosis, which was a continuous variable. Differences in percentage for categorical variables and means for continuous variable were examined by t-test and Chi-squares tests. Logistic regression analysis was performed to identify risk factors associated with delayed HIV diagnosis in Nigeria. The predictor (independent) variables, which were socio-demographic factors of the patients, were gender, age at diagnosis, employment status, marital status, educational status, occupation, leader in a religious organization, and reference categories were selected. The outcome variable is delayed HIV diagnosis. All analyses were conducted using the SAS System for Windows (copyright 2019 SAS Institute Inc).

Logistic regression

Independent variables that were significant at \( p \leq .20 \) level in the univariate analysis were included in the multivariate model. Effect modification was also included. The strength of association between the risk factors and outcome was reported as odds ratios, 95% confidence interval and \( p \)-value. In addition to the logistic regression analysis, the Cochran-Armitage linear trend test was used to determine the relationship between the outcome and the ordinal independent variables (age group and level of education).

Annual total cases of delayed HIV diagnosis

Annual observations of the total delayed HIV diagnosis were compared annually between 2014 to 2018.

Results

Descriptive statistics

Table 1 describes the included PLHIV. The percentage of delayed HIV diagnosis was 1993/3458 (57.6%).
Univariate analysis

The univariate analysis is summarised in Table 2. The odds of delayed HIV diagnosis in PLHIV aged 40 years or more was higher than those aged 15–39 years (OR 1.73; 95% CI 1.51–1.99), higher in males than females (OR 1.50; 95% CI 1.30–1.73), higher among separated PLHIV (OR 2.29; 95% CI 1.74–3.02), divorced PLHIV (OR 1.85; 95% CI 1.09–3.15), and widowed PLHIV (OR 1.36; 95% CI 1.09–1.70) compared to married PLHIV, higher among patients who were leaders in a religious organization (OR 2.47; 95% CI 1.17–5.22) than those who were not, higher among retirees (OR 4.20; 95% CI 2.50–6.18), and higher among commercial drivers (OR 2.28; 95% CI 1.61–3.23), compared to other occupations. The odds of delayed HIV diagnosis were lower among single PLHIV compared to married PLHIV (OR 0.84; 95% CI 0.72–0.99), lower among PLHIV with a tertiary education compared to no formal education (OR 0.64; 95% CI 0.52–0.79) and lower among students (OR 0.50; 95% CI 0.38–0.66) compared to other occupations.

Multivariate analysis

The multivariate analysis is summarised in Table 3. The odds of a delayed HIV diagnosis were significantly higher in PLHIV aged 40 years or older than in those aged 15–39 years (OR 1.29; 95% CI 1.10–1.51). The linear trend test revealed a linear relationship between delayed HIV diagnosis and age categories (15–40, 21–40, 41–60, and 61 years or more) (trend test: \( p < .0001 \)), indicating that the probability of delayed HIV diagnosis increases with increasing age. The odds of a delayed HIV diagnosis were significantly lower among PLHIV with tertiary education compared to those with no formal education (OR 0.71; 95% CI 0.56–0.88). There was a linear relationship between delayed HIV diagnosis and educational level (trend test: \( p < .0001 \)), indicating that the probability of delayed HIV diagnosis decreases as educational level increases from none to tertiary education. In comparison with other occupations, the odds of delayed HIV diagnosis were higher among retirees (OR 3.24; 95% CI 1.56–6.74) and lower among
students (OR 0.61; 95% CI 0.45–0.82). We observed a statistically significant interaction between gender and married status (p = .0249). The odds of delayed HIV diagnosis were higher among male PLHIV who were separated compared to married male PLHIV (OR 2.16; 95% CI 1.21–3.88). The odds of delayed HIV diagnosis were higher among single female PLHIV (OR 1.36; 95% CI 1.09–1.71), separated female patients (OR 2.17; 95% CI 1.57–2.99), and widowed female PLHIV (OR 1.37; 95% CI 1.06–1.77) compared to married female patients.

**Trends in the annual total cases of delayed HIV diagnosis**

Table 4 summarised the trends in the annual total cases of delayed HIV diagnosis. Between 2014 and 2018, the number of cases of delayed HIV diagnosis steadily decreased. Over a 4-years period, delayed HIV diagnosis cases decreased by 5%.

**Discussion**

Early diagnosis of HIV with immediate initiation of ART and retention in care will not only result in viral suppression and reduced mortality but also reduce the risk of HIV transmission. Describing factors associated with delayed HIV diagnosis may inform targeted HIV screening. Older PLHIV were more likely to have delayed HIV diagnosis compared to younger PLHIV, and this is consistent with previous studies in Nigeria and other parts of the world. Older PLHIV may be perceived as a low risk group. Association of delayed HIV diagnosis and male gender, and delayed HIV diagnosis and marital status have been well documented in many studies. Separated male and female PLHIV were found to be associated with delayed HIV diagnosis, with more delayed diagnosis among females. Married women are less likely to have a delayed HIV diagnosis, which may be linked to routine mandatory screening for HIV offered to pregnant women in Nigeria during their first antenatal visit. The differential
effect of marital status on delayed HIV diagnosis based on gender may be explained by unmarried women’s lower health care utilization compared to married women. 26 People living with HIV who had a tertiary education are less likely to have a delayed HIV diagnosis compared to PLHIV with no formal education; this finding is consistent with a previous study. 27 People with higher education are often financially independent and are empowered to make well-informed decisions related to their health and well-being. 28,29 We found a high risk of delayed HIV diagnosis among retirees, which has not been previously reported, and a low risk among students. Retirees and older people are among the most vulnerable populations in Nigeria due to the lack of a national plan for social welfare for senior citizens resulting in a low standard of living and diminished health status. 30,31 Poor pension programs and insufficient health insurance coverage with resultant difficulty to access health care services in Nigeria 30 may explain the high risk of delayed HIV diagnosis observed among retiree and older age group. Several targeted screening programs have been conducted among students in various Nigerian higher educational institutions. 32,33 This countrywide awareness among students in Nigeria may contribute to the low risk of delayed HIV diagnosis observed among students.

We found a progressive decline in the annual total cases of delayed HIV diagnosis over the period examined. Nigeria has no information on national trends in delayed HIV diagnosis in the last decades and studies on trends in the delayed HIV diagnosis in the literature are scarce. The overall percentage of delayed HIV diagnosis observed in

### Table 3. Multivariate analysis of delayed HIV diagnosis.

| Variables          | Odds ratio | 95% CI | p-value | Type 3 p-value |
|--------------------|------------|--------|---------|----------------|
|                    | Lower      |        |         |                |
|                    | Upper      |        |         |                |
| Age                |            |        |         |                |
| ≥40 years          | 1.29       | 1.10   | 1.51    | .0016          |
| 15–39 years        | 1          |        |         |                |
| Educational status |            |        |         |                |
| Primary            | 1.18       | 0.93   | 1.50    | .1706          |
| Secondary          | 1.01       | 0.82   | 1.24    | .9614          |
| Tertiary           | 0.71       | 0.56   | 0.88    | .0021          |
| None               | 1          |        |         |                |
| Occupation         |            |        |         |                |
| Trader             | 1.09       | 0.92   | 1.29    | .3018          |
| Student            | 0.61       | 0.45   | 0.82    | .0012          |
| Commercial driver  | 1.35       | 0.93   | 1.97    | .1151          |
| Civil servant      | 1.10       | 0.73   | 1.67    | .6466          |
| Retiree            | 3.4        | 1.56   | 6.74    | .0017          |
| Other              | 1          |        |         |                |
| Interaction between gender and marital status | | | | |
| Male               |            |        |         |                |
| Single             | 0.77       | 0.57   | 1.04    | .0857          |
| Separated          | 2.16       | 1.21   | 3.88    | .0096          |
| Divorced           | 2.02       | 0.67   | 6.11    | .2122          |
| Widowed            | 0.93       | 0.54   | 1.61    | .7952          |
| Married            | 1          |        |         |                |
| Female             |            |        |         |                |
| Single             | 1.36       | 1.09   | 1.71    | .0073          |
| Separated          | 2.17       | 1.57   | 2.99    | <.0001         |
| Divorced           | 1.73       | 0.93   | 3.24    | .0856          |
| Widowed            | 1.37       | 1.06   | 1.77    | .0179          |
| Married            | 1          |        |         |                |

### Table 4. Trends in the annual total cases of delayed HIV diagnosis.

| Year of diagnosis | Cases of HIV | Delayed HIV diagnosis |
|-------------------|--------------|-----------------------|
|                   | n (3247)     | % (100)               |
|                   | n (886)      | % (58.1)              |
| 2014              | 903          | 27.8                  |
|                   | 495          | 15.2                  |
| 2015              | 660          | 20.3                  |
|                   | 383          | 11.8                  |
| 2016              | 667          | 20.5                  |
|                   | 397          | 12.2                  |
| 2017              | 542          | 16.7                  |
|                   | 313          | 9.6                   |
| 2018              | 476          | 14.7                  |
|                   | 297          | 9.1                   |
this study was consistent with previous studies in Nigeria. Furthermore, studies conducted in other parts of the world, such as Europe and the United States of America, revealed similar trends in delayed HIV diagnosis. Voluntary counselling and testing (VCT) and provider-initiated testing and counselling (PITC) strategies have served as models for HIV testing in Nigeria over the last decade. Several other countries also use these models. Human Immunodeficiency Virus testing is free in Nigeria’s public health facilities, VCT and PITC (opt-out and opt-in) are available in both public and private clinics and hospitals, as well as via HIV mobile testing. The improvement in access to HIV testing over the last decade, as well as the testing models adopted in Nigeria, may contribute to the increased rate of testing. This may explain the decline in the annual total cases of delayed HIV diagnosis observed. Despite the easy accessibility of HIV testing, testing often does not occur until years after infection in many cases. While the available HIV testing strategies in Nigeria may contribute to the reduced delayed diagnosis observed over the years of the period we studied, neither of these strategies achieves a high testing rate.

A general belief has been reported in Nigeria that HIV testing and counselling centers are only for HIV positive individuals, indicating a lack of understanding of the purpose of testing. Many Nigerians fear stigmatization if they are HIV positive. As a result, patients may refuse HIV testing if offered by physicians. Effective public awareness campaigns may be critical in resolving these misperceptions. Additional support may be required to educate some specific categories of people, such as people at high risk, about the importance of knowing HIV status and early diagnosis. In an effort to address stigmatization, home oral fluid HIV self-testing has been introduced in Nigeria and other African countries, with a reported high acceptability. In a study by Iliyasu et al. 2020, a higher uptake of HIV self-testing was observed compared to other testing strategies among university students in Nigeria. Self-testing may avoid stigmatization, but positive results need to be linked to care.

The assurance of confidentiality of results may overcome hesitancy to be tested for HIV. Testing for HIV in regular clinics or health facilities with blood draw sent to the laboratory coded without a name may encourage more people to be tested. However, this testing strategy may have a negative effect on referral and linkage to care. All of these testing strategies should be made available not only in primary healthcare centres and other healthcare facilities but also in pharmacies, religious centres, and other community-based organizations. Human immunodeficiency virus testing is an essential component of HIV care. A widespread awareness campaign may play a major role in achieving greater results from the available testing strategies in Nigeria. Promoting HIV testing among all demographic and at-risk groups, including the risk factors observed in this study, such as older ages, retirees, and less-educated populations, will complement these testing strategies. Consequently, effective HIV testing strategies may significantly reduce delayed HIV diagnosis and HIV transmission in Nigeria and other African countries.

Our findings are based on a population tested at a university college hospital in a large city in a single state, and a regional referral center, are generalizable to an urban referral population in this location but may not be generalizable to the country as a whole. We examined PLHIV with their first known CD4 count at diagnosis. However, some of the patients may have previous tests without linkage to care. A further limitation is a retrospective design, so risk factors that were not collected could not be analyzed, such as access to testing and perception of the need for testing. The sample size was adequate to detect a statistically significant association between delayed HIV diagnosis and the risk factors.

**Conclusion**

Delayed HIV diagnosis is common in the study setting but declining. Delayed diagnoses continue to be a major problem among some demographic groups of the population we studied. While HIV testing has increased in Nigeria over the last decade, the majority of patients are diagnosed at the late stage of infection. Significant expansion of the existing testing strategies, with emphasis on the population at risk is needed in Nigeria to reduce delayed HIV diagnosis. To achieve effective HIV control through care and treatment, a larger portion of PLHIV need to be diagnosed and enrolled in care sooner after they acquire HIV. In addition to more public awareness about the importance of HIV testing, more studies investigating factors responsible for delayed HIV diagnoses should be encouraged in Nigeria. These may lead to a better knowledge of delayed HIV diagnosis and control policy.

**Authors’ contributions**

MO, PD, ZG, and OA conceptualized and designed the study. The study proposal was developed by MO, PD, ZG and OA, ethical application by MO. MO conducted a statistical analysis with input from ZG and PD. MO and PD wrote the first draft and subsequent revisions with input from PD, ZG and OA. MO, PD, ZG, and OA contributed and supported all revisions. All authors have read and approved the final manuscript.

**Declaration of conflicting interests**

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

**Funding**

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was funded by Memorial University of Newfoundland, St...
John’s Newfoundland and Labrador, Canada. We thank the entire staff of APIN Public Health Initiatives in Nigeria, who did everything possible to ensure that the data was ready in a timely manner, even during the height of COVID-19 in Nigeria.

ORCID iD
Michael O Oluwalana https://orcid.org/0000-0002-1720-7783

References
1. Girum T, Wasie A and Worku A. Trend of HIV/AIDS for the last 26 years and predicting achievement of the 90-90-90 HIV prevention targets by 2020 in Ethiopia: a time series analysis. *BMC Infect Dis* 2018; 18(1): 1–10. DOI: 10.1186/s12879-018-3214-6
2. Federal Ministry of Health Nigeria. *National guidelines for HIV prevention treatment and care*, 2016. apps.who.int, https://www.prepwatch.org/wp-content/uploads/2017/08/nigeria_national_guidelines_2016.pdf
3. Avert. *Global HIV and AIDS statistics*. avert.org, 2020, https://www.avert.org/global-hiv-and-aids-statistics
4. Children and AIDS. *National HIV and AIDS strategic framework 2017-2021*, 2017, https://www.childrenandaidsoapin.org.ng/sites/default/files/2017-11/NATIONAL-HIV-AND-AIDS-STRATEGIC-FRAMEWORK.pdf
5. Avert. *HIV and AIDS in Nigeria*, AVERT, 2018, https://www.avert.org/professionals/hiv-around-world/sub-saharan-africa/nigeria
6. Federal Ministry of Health Nigeria and UNAIDS. *New survey results indicate that Nigeria has an HIV prevalence of 1.4%. 2030 Ending the AIDS epidemic, 2019*, https://reliefweb.int/sites/reliefweb.int/files/resources/20190314_PR_Nigeria_en.pdf
7. NACA. *National agency for control of AIDS, federal ministry of health, Nigeria. NAL HIV/AIDS framework 2017-2021*, 2019, pp. 1–53, http://www.naca.gov.ng/wp-content/uploads/2018/05/National-HIV-and-AIDS-Strategic-plan-FINAL1
8. Nigerian Federal Ministry of Health, et al. *Nigeria HIV/AIDS indicator and impact survey - 2018 technical report*, 2019, pp. 1–267, http://cibe.org/media/SOM/Microsites/CIBEB/documents/NAIIS-Report-2018.pdf
9. UNAIDS. *UNAIDS data 2021*. unaidso.org, 2021, https://www.unaids.org/sites/default/files/media_asset/JC3032_AIDS_Data_book_2021_En.pdf
10. Yendewa GA, Poveda E, Lakoh S, et al. High prevalence of late-stage disease in newly diagnosed human immunodeficiency virus patients in Sierra Leone. *Open Forum Infect Dis* 2018; 5(9): 1–4. DOI: 10.1093/ofid/ofy208
11. Antinori A, Coenen T, Costagiola D, et al. Late presentation of HIV infection: a consensus definition. *HIV Med* 2011; 12(1): 61–64. DOI: 10.1111/j.1468-1293.2010.00857.x
12. Agaba PA, Meloni ST, Sule HM, et al. Patients who present late to HIV care and associated risk factors in Nigeria. *HIV Med* 2014; 15(7): 396–405. DOI: 10.1111/hiv.12125
13. Motayo BO, Aturaka SO, Ohusola BA, et al. CD4 decay rate as an indicator of the time interval between initial infection and first diagnosis among drug-naïve human immunodeficiency virus seropositive individuals in Lagos, Nigeria. *Med Princ Pract* 2016; 25(6): 572–576. DOI: 10.1159/000449465
14. Forbi JC, Forbi TD and Agwale SM. Estimating the time period between infection and diagnosis based on CD4+ counts at first diagnosis among HIV-1 antiretroviral naïve patients in Nigeria. *J Infect Dev Ctries* 2010; 4(10): 662–667. DOI: 10.3855/jidc.1015
15. Croxford S, Kitching A, Desai S, et al. Mortality and causes of death in people diagnosed with HIV in the era of highly active antiretroviral therapy compared with the general population: an analysis of a national observational cohort. *Lancet Public Heal* 2017; 2(1): e35–e46. DOI: 10.1016/S2468-2667(16)30020-2
16. Boyd SE, Allison J, Penney CC, et al. Timeliness of diagnosis of HIV in Newfoundland and Labrador, Canada: a mixed-methods study. *Off J Assoc Med Microbiol Infect Dis Can* 2019; 4(1): 15–23. DOI: 10.3138/jammi.2018-0029
17. Campbell M, Frederiksen CM, Friis-Moller N, et al. Late presentation for HIV care across Europe: update from the Collaboration of Observational HIV Epidemiological Research Europe (COHERE) study, 2010 to 2013. *Euro Surveill* 2015; 20(47). DOI: 10.2807/1560-7917.ES.2015.20.47.30070
18. APIN. *APIN Public Health Initiative*. apin.org.ng, 2021, https://www.apin.org.ng/expertise.html
19. May MT. Better to know: the importance of early HIV diagnosis. *Lancet Public Heal* 2017; 2(1): e6–e7. DOI: 10.1016/S2468-2667(16)30038-X.
20. Group TISS. Early treatment in asymptomatic HIV infection. *Physiol Behav* 2017; 176(1): 139–148. DOI: 10.1056/NEJMoa1506816.Initiation
21. Drain PK, Losina E, Parker G, et al. Risk factors for late-stage HIV disease presentation at initial HIV diagnosis in Durban, South Africa. *PLoS One* 2013; 8(1): e55305. DOI: 10.3171/journal.pone.0055305
22. Althoff KN, Gebo KA, Gange SI, et al. CD4 count at presentation for HIV care in the United States and Canada: are those over 50 years more likely to have a delayed presentation? *AIDS Res Ther* 2010; 7: 45. DOI: 10.1186/1742-6405-7-45
23. Gullón A, Verdejo J, de Miguel R, et al. Factors associated with late diagnosis of HIV infection and missed opportunities for earlier testing. *AIDS Care - Psychol Socio-Med Asp AIDS/HIV* 2016; 28(10): 1296–1300. DOI: 10.1080/09540121.2016.1177800
24. Mugavero MJ, Castellano C, Edelman D, et al. Late diagnosis of HIV infection: the role of age and sex. *Am J Med* 2007; 120(4): 370–373. DOI: 10.1016/j.amjmed.2006.05.050
25. Bonjour MA, Montagne M, Zambrano M, et al. Determinants of late disease-stage presentation at diagnosis of HIV infection in Venezuela: a case-case comparison. *AIDS Res Ther* 2008; 5: 1–12. DOI: 10.1186/1742-6405-5-6
26. Diamini-Simelane TTT and Moyer E. “Lost to follow up”: rethinking delayed and interrupted HIV treatment among married Swazi women. *Health Policy Plan* 2017; 32(2): 248–256. DOI: 10.1093/heapol/czw117
27. Sogbanmu OO, Goon DT, Obi LC, et al. Socio-demographic and clinical determinants of late presentation among patients newly diagnosed with HIV in the Eastern Cape, South Africa. *Medicine (Baltimore)* 2019; 98(8): e14664. DOI: 10.1097/MD.0000000000014664
28. Adewuyi EO, Auta A, Khanal V, et al. Prevalence and factors associated with underutilization of antenatal care services in Nigeria: a comparative study of rural and urban residences based on the 2013 Nigeria demographic and health survey. *PLoS One* 2018; 13(5): 1–21. DOI: 10.1371/journal.pone.0197324

29. Zangerle R, Touloumi G, Warszawski J, et al. Delayed HIV diagnosis and initiation of antiretroviral therapy: inequalities by educational level, COHERE in EuroCoord. *Aids* 2014; 28(15): 2297–2306. DOI: 10.1097/QAD.0000000000000410

30. Daramola OE, Awunor NS and Akande TM. The challenges of retirees and older persons in Nigeria; a need for close attention and urgent action. *Int J Trop Dis Heal* 2019; 34(4): 1–8. DOI: 10.9734/ijtdh/2018/v34i430099

31. Aregbeshola B. Health care in Nigeria: challenges and recommendations. *socialprotection.org*, 2019, https://socialprotection.org/discover/blog/health-care-nigeria-challenges-and-recommendations

32. Solomon O, Mahafroz K, Mashor M, et al. Prevalence of HBV and HIV among students and staff at the University of Jos, Nigeria: results from a medical outreach screening program. *Int J Sci Res Publ* 2014; 4(11): 1–5. www.ijsrp.org

33. Emeka-Nwabunia I, Ibeh BO and Ogbulie TE. High HIV sero-prevalence among students of institutions of higher education in Southeast Nigeria. *Asian Pac J Trop Dis* 2014; 4(2): 159–165. DOI: 10.1016/S2222-1808(14)60334-0

34. Daniyam C, Iroezindu M, Shehu N, et al. Characteristics of HIV/AIDS patients presenting late at a teaching hospital in Nigeria. *J Med Trop* 2011; 13(2). DOI: 10.4314/ijmjt.v13i2.70699

35. Akinbami A, Dosunmu A, Adediran A, et al. CD4 count pattern and demographic distribution of treatment-naïve HIV patients in Lagos, Nigeria. *AIDS Res Treat* 2012; 2012: 1–6. DOI: 10.1155/2012/352753

36. UK Health Security Agency. *HIV testing, new HIV diagnoses, outcomes and quality of care for people accessing HIV services.* assets.publishing.service.gov.uk, 2021, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1037215/hiv-2021-report.pdf

37. Saganic L, Carr J, Solorio R, et al. Comparing measures of late HIV diagnosis in Washington state. *AIDS Res Treat* 2012; 2012: 1–8. DOI: 10.1155/2012/182672

38. R2P. *Provider-initiated HIV testing & counseling rigorous evidence – usable results.* Research to Prevention, 2012, https://www.jhsph.edu/research/centers-and-institutes/research-to-prevention/publications/pitc.pdf?msclkid=66ee357f1b6911eca0ad3570baa599bc

39. Clouse K, Hannahan CF, Bassett J, et al. Impact of systematic HIV testing on case finding and retention in care at a primary care clinic in South Africa. *Trop Med Int Heal* 2014; 19(12): 1411–1419. DOI: 10.1111/tmi.12387

40. Nwaozuru U, Iwelunmor J, Ong JJ, et al. Preferences for HIV testing services among young people in Nigeria. *BMC Health Serv Res* 2019; 19(1): 1–9. DOI: 10.1186/s12913-019-4847-x

41. Ahmed S, Delaney K, Villalba-diebold P, et al. HIV counseling and testing and access-to-care needs of populations most-at-risk for HIV in Nigeria. *AIDS Care* 2016; 25(1): 85–94. DOI: 10.1080/09540121.2012.686597.HIV

42. Mukhtar-Yola M, Adeleke S, Gwarzo D, et al. Preliminary investigation of adherence to antiretroviral therapy among children in Aminu Kano Teaching Hospital, Nigeria. *Afr J AIDS Res* 2006; 5(2): 141–144. DOI: 10.2989/16085900609490374

43. Tun W, Vu L, Dirisu O, et al. Uptake of HIV self-testing and linkage to treatment among men who have sex with men (MSM) in Nigeria: a pilot programme using key opinion leaders to reach MSM. *J Int AIDS Soc* 2018; 21(2016): e25124. DOI: 10.1002/jia2.25124

44. Heard AC and Brown AN. Public readiness for HIV self-testing in Kenya. *AIDS Care - Psychol Socio-Med Asp AIDS/HIV* 2016; 28(12): 1528–1532. DOI: 10.1080/09540121.2016.1191602

45. Brown B, Folayan MO, Imosili A, et al. HIV self-testing in Nigeria: public opinions and perspectives. *Glob Public Health* 2015; 10(3): 354–365. DOI: 10.1080/17441692.2014.947303

46. Iliyasu Z, Kassim RB, Iliyasu BZ, et al. Acceptability and correlates of HIV self-testing among university students in northern Nigeria. *Int J STD AIDS* 2020; 31(9): 820–831. DOI: 10.1177/0956462420920136