



ORIGINAL ARTICLE

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Predictors of Incomplete Adherence and Immuno-virologic Failure among HIV Infected Patients in Osun State, Nigeria

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Received 17th May 2022; Revised 19th May 2022; Accepted 22nd June 2022

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ABSTRACT

BACKGROUND: To identify and address modifiable baseline clinical and non-clinical predictors related to negative outcomes, and identify high risk patients who need priority attention in order to prevent future failure of treatment in HIV patients.

METHODS: The study was a longitudinal clinical based cohort study of One hundred and forty (140) HIV infected adults who were initially ART naive and commenced ART in June- July 2013 were followed up to June 2014. Three out of the participants were lost to follow up, one participant died and 1 participant was transferred to another treatment centre, while a total of one hundred and thirty-five (135) patients were finally included in the immuno-virologic analysis. Adherence was assessed using both self-report questionnaire and measurement of Mean Cell Volume (MCV) which was obtained using automated haematology analyzer. CD4 counts were analyzed using flow cytometry method and HIV-RNA levels were measured by using the RT-Polymerase Chain Reaction technique.

RESULTS: Incomplete adherence was recorded in 28 (20.7%) of the study participants, immunologic failure (decline in CD4 count to or below baseline or CD4 count change < 50 cells/ul at 12 months) was observed in 39 (28.8%) of the participants. Virologic failure rate (viral load > 400 copies/ml) was 27.4% and immuno-virologic failure rate was 31.9%. Using logistic regression model, immunologic failure was associated with male gender (OR=1.29; p=0.008), non-disclosure of status (OR=1.24; p=0.01), baseline anaemia (OR=1.15; p=0.009) and incomplete adherence by self-report (OR=3.28; p=0.001). Virologic failure was associated with no formal education (OR=2.29; p=0.01), non-disclosure of status (OR=1.04; p = < 0.01), non-adherence (OR=2.74; p=0.015), being unemployed (OR=0.57; p=0.04).

CONCLUSIONS: The study observed that immunologic recovery and virologic suppression rate within the first year of treatment was significant, although the rate of incomplete adherence obtained still needs improvement. Effort to promote social coping particularly to patients who were unemployed, re-strategizing on improving patient education and counseling especially to patients with no formal education, focusing on campaigns against stigmatization will help in addressing predictors of negative immuno-virologic outcomes. Baseline HIV-RNA level should also be considered in addition to CD4 testing in order to identify virological failure and thus preventing the emergence of drug resistance in HIV/AIDS management.

Keywords: Incomplete adherence; immuno-virologic failure; HIV patients; Osun state.

1. INTRODUCTION

Allium cepa contains sulfur-amino acid, vitamins and minerals, and varieties of secondary metabolites such as phytosterols, flavonoids, and saponins. [1,2,3] *Allium cepa* is highly valued for its therapeutic, antioxidant, antimicrobial, and antidiabetic properties. [4,5] The bulb possessed antiseptic, anthelmintic, antispasmodic, anti-inflammatory, diuretic, carminative, expectorant, hypoglycaemic, febrifuge, lithotriptic, hypotensive, stomachic, and tonic properties [5]. *Allium cepa* (Onions) contain generous amounts of flavonoid quercetin that protect against cataracts, cardiovascular disease, and cancer [6,7]. Ivermectin is potently active against many of internal and external pathogens [8,9]. Ivermectin is effective against a wide range of parasites; gastrointestinal roundworms, lungworms, mites, lice, and horn flies [11-13]. Ivermectin proved to be a 'Wonder drug' in human health, improving nutrition, general health, and wellbeing [14,15]. The growth of various human cancers, such as ovarian cancer (OC), has been completely suppressed by Ivermectin due to its anti-parasitic nature [16-20].

Infertility is a global health issue growing as environmental pollution increases [21-23]. Cadmium (Cd) is a heavy metal known to be an endocrine disruptor [24] and a threat to human fertility health [25]. Diet and smoking are believed to be the primary sources of Cd in the general population [26]. Women are thought to be at greater risk of increased Cd accumulation [27,28] as Cd can accumulate in the ovary. An epidemiological survey reported that Cd in smokers is higher than in nonsmokers [29-31]. Cadmium directly affects the ovary and uterus, resulting in pathological changes, such as ovarian effusion, bleeding, and atrophies [32]. Cadmium increases apoptosis and causes cell damage by inducing oxidative stress [33-37].

Cadmium toxicity has been demonstrated in several organs [38-42]. Cd induces tissue injury by creating oxidative stress, [43,44] epigenetic changes in DNA expression, [45-48] and inhibition or upregulation of transport pathways [49,50]. Notably in the proximal S1 segment of the kidney tubule [51,52] inhibition of heme synthesis [53] and impairment of mitochondrial function potentially inducing apoptosis [54]. Depleting glutathione has been observed, as has structural distortion of proteins due to Cd binding to sulfhydryl groups [55-57]. This study investigated the protective effects of Ivermectin and *Allium cepa* on the damaged ovary and uterus of Wistar rats exposed to Cd.

2. METHODOLOGY

2.1 Study Design

The study was a cross-sectional study that involved a cohort of HIV infected patients who were initially ART-naïve. Baseline data of the recruited patients including detailed laboratory and socio-demographic data were extracted from the medical records, the study also involved interviews and laboratory work-up that was carried out over a period of 12 months after commencement of antiretroviral therapy. Laboratory work included CD4 cell count, Full blood count (FBC) and HIV RNA quantification. The ethical review committee of Ladoke Akintola University of Technology, Osogbo, reviewed and approved this study and assigned the Institutional Ethical Clearance Number: LTH/EC/2015/10/234. Written informed consent was obtained from all the study participants after counselling and introduction of the study.

2.2 Study Population

The study was carried out among HIV infected patients visiting the IHVN clinic of the Ladoke Akintola University Of Technology (LAUTECH) Teaching Hospital Osogbo. One Hundred and forty (140) HIV infected patients who met the inclusion criteria were recruited into the study and were followed up for 12 months

2.3 Inclusion Criteria

The study participants comprised of HIV infected adults (>18 years), who were initially ART naïve, all started ART in June-July 2013 at the commencement of the study and were being followed up to June 2014. Decision to initiate ART was made according to WHO criteria: Clinical staging 3 or 4 irrespective of CD4 count level and immunological criteria of CD4 $\leq$ 500 cells/ μ l irrespective of the WHO clinical staging.

2.4 Exclusion Criteria

Pregnant or lactating women, HIV infected children, patients with history of diabetes or any other metabolic disorders, patients who have been placed on ART earlier before the commencement of the study, newly diagnosed patients who did not meet the criteria for ART eligibility.

2.5 Sample Collection

Ten millilitres (10ml) of venous blood was collected aseptically by venipuncture from the cubital-fossa into two 5ml EDTA anticoagulant bottles for each patient. Whole blood was used for enumerating CD4 counts and full blood count (FBC) while mean cell volume (MCV) was gotten from FBC. Plasma samples were separated from

freshly collected blood into cryovials by centrifugation at 3000rpm for 15mins. The plasma samples extracted were cryopreserved at - 20 °C and were used for HIV RNA quantification.

2.6 Self Report Questionnaire

Self-report questionnaires have been used widely especially in developing countries because of their simplicity and being less expensive (Glass T.R et al.,2006). This study used an adaptation of a validated adherence questionnaire for measuring adherence [16]. Questions addressing potential predictors of incomplete adherence were developed through literature search for established predictors of incomplete adherence, virologic failure, and the development of antiviral drug resistant infection from both the developed and developing world (16). Participants with no formal education were interviewed and the questionnaires were filled for them.

2.7 Estimation of CD4 count and Mean Cell Volume (MCV)

CD4 lymphocyte cell counts of each of the selected participants were enumerated using Partec CD4 CyFlow Counter. Mean corpuscular volume (MCV) was determined from full blood count (FBC) using automated multi-parameter blood cell counter (SYSMEX KX-21). Evidence of macrocytosis, defined as mean cell volume (MCV) exceeding 100fl has been associated with zidovudine (AZT) containing regimens and Due to fact that the accuracy of self report questionnaire can be compromised by issues of recall bias and social desirability, Evidence of macrocytosis has been reported as an alternative and less expensive way of assessing adherence (Olivier et al.,2010).

2.8 Viral load quantification

HIV-RNA in the plasma of each participant was measured using the COBAS Ampliprep/COBAS Taqman HIV-test, version 2.0. The COBAS uses the PCR technology to achieve maximum sensitivity and dynamic range for the quantitative detection of HIV-1 RNA in the EDTA anticoagulated plasma.

2.9 Data Analysis

Statistical Package for Social Sciences (SPSS 20.0) software was used to analyze the descriptive statistics of variable. Logistic regression was used to determine the association between potential clinical and non-clinical predictors of immunologic and virologic outcomes. All results were assessed at the 5% level of statistical significance.

3. RESULTS

Overall, 135 subjects were considered in the final analysis. Three (2.1%) participants were lost to follow up, one (0.7%) participant died, while another one (0.7%) relocated.

Out of the 135 participants that were evaluated, 102 (75.6%) of the patients were female while only 33 (24.4%) were males and the mean age of the respondents at ART initiation was 39 years. Majority of the patients; 103 (76.3%) were married, 130 (96.3%) were Yorubas, 63 (46.7%) were self-employed while 66 (48.9%) had post secondary/tertiary educational qualification. About 76 (56.3%) of the participants have disclosed their HIV status to either their relatives or partner (Table 1).

Table 1. Socio demographic characteristics of study participants

Characteristics	Frequency	Percentage (%)
Gender		
Female	102	75.6
Male	33	24.4
Age at ART initiation (years)		
Mean $\pm$ SD	39.01 $\pm$ 10.00	
<30	28	20.7
31-40	59	43.7
41-50	27	20
>50	21	15.6
Marital status		
Single	26	19.3
Married	103	76.3
Divorced/widowed	06	4.4
Ethnicity		
Yoruba	130	96.3
Hausa	01	0.7
Igbo	04	3.0
Religion		
Islam	75	55.6
Christianity	60	44.4
Traditional	Nil	Nil
Educational qualification		
No formal education	35	25.9
Primary	19	14.1
Secondary	15	11.1
Post-secondary/Tertiary	66	48.9
Occupation		
Civil servant	53	39.3
Self-employed	63	46.7
Unemployed	14	10.4
Student	05	3.7
HIV disclosure		
Yes	76	56.3
No	59	43.7

Table 2. Baseline and clinical markers of study participants

Characteristics	Number of participants	Percentage (% of total)
Baseline CD4 cell Count (cells/μl)		
Mean $\pm$ SD	209.77 $\pm$ 161.53	
<50	17	12.6
50 - <200	55	40.7
200 - <350	45	33.3
350 - <500	06	4.4
$\geq$ 500	12	8.9
CD4 cell count at 12 months(cells/μl)		
Mean	306.92 $\pm$ 182.05	
(standard deviation)		
<50	03	2.2
50 - <200	38	28.1
200 - <350	49	36.3
350 - <500	25	18.5
$\geq$ 500	20	14.8
Immunologic recovery (CD4 cell change $\geq$50)		
Yes	96	71.1
No	39	28.8
Viral load (copies/ml) at 12 months		
Mean (standard deviation)	37453.8 $\pm$ 23224 6.42	
<20	75	55.6
20-400	23	17.0
401-1000	19	14.1
>1000	18	13.3
Virologic suppression (<400copies/ml)		
Yes	98	72.6
No	37	27.4
Baseline hemoglobin (g/dl)		
Mean $\pm$ SD	12.24 $\pm$ 2.74	
>10	117	86.6
9.5-10.0 (Grade 1 anemia)	13	9.6
8.0-9.4 (Grade 2 anemia)	03	2.2
6.5-7.9 (Grade 3 anemia)	01	0.7
<6.5 (Grade 4 anemia)	01	0.7
Baseline anemia (Hb<10g/dl)		
Yes	18	13.3
No	117	86.7
MCV (fl)		
<100	66	48.9
$\geq$ 100	69	51.1
ART regimen at baseline		
AZT/3TC/NVP or EFV	93	68.9
TDF/3TC/NVP or EFV	42	31.1
Immunovirologic success (CD4+/VL+)		
Yes	92	68.1
No	43	31.9

*Categorical variables expressed as n (%) and continuous variables almost expressed as mean (standard deviation) Hb: Hemoglobin, MCV: Mean cell volume, VL: Viral load, ART: Antiretroviral treatment, AZT: Zidovudine, 3TC: Lamivudine, EFV: Efavirenz and TDF: Tenofovir.

The average baseline CD4 cell count was 209 cells/ μ l (SD: $\pm$ 161.53) while the mean CD4 cell count at 12 months of follow up was 306 cells/ μ l indicating that most of the participants had immunologic recovery with the recovery rate of 71% (Figure1). Out of the 135 participants, 96(71%) of the participants had their CD4 cell count increased by $\geq$ 50 cells/ μ l at 12 months giving the immunologic failure rate of 28.8%. While 68% of the study had immunovirologic success that is, virologic success was accompanied by immunologic success (VL+/CD4+). (Table 2)

In an attempt to identify the non-adherent patients, two different measures of adherence were tested. Patients were considered non-adherent if any single parameter suggested that they were non-adherent. The different measures of adherence showed that most of the participants were adherent. Based on self-report, 107 (79.3%) of the subjects was reported not to have missed any doses of ART from the initiation of treatment while the remaining 28 (20.7%) of the study population was defined as having incomplete adherence. When evidence of macrocytosis was added to self-report questionnaire, 24 (25.8%) of the participants did not show the evidence of macrocytosis (MCV<100fl) indicating incomplete adherence, though the macrocytosis could only be used as an indicator of adherence in patients receiving regimen containing Zidovudine (AZT) as shown in Table 3.

Table 3. Description of tools used to access adherence

Characteristics	Number of participants (%)
ART dose missed in the last four days *	
Yes	5 (3.7)
No	130 (96.3)
ART dose missed in the previous weekend*	
Yes	8 (5.9)
No	127 (94.4)
Dose delayed for more than 2hours in the last four days*	
Yes	20 (14.8)
No	115 (79.3)
Self report questionnaire (combining the above three items) *	
At least one ART dose missed	28 (20.7)
$\geq$ 95% adherent	107 (79.3)
Macrocytosis (MCV>100fl)**	
Yes	69 (74.2)
No	24 (25.8)

*Available for all the patients, ** Available for only patients receiving AZT based regimen, ART: Antiretroviral treatment, AZT: Zidovudine, MCV: Mean cell volume

Table 4 shows the predictors of virologic failure at 12 months in patients on ART using logistic regression model. An increased odd ratio (OR) of virologic failure was significantly associated with non-disclosure of status (OR=1.04; P = <0.01), poor adherence by self-report (OR= 2.74; P= 0.015) and no formal education (OR= 2.29; P= 0.01) compared to tertiary educational qualification. A decreased odd ratio of virologic failure was significantly associated with baseline CD4 cell count of 50 that is, less than 200 cells/ul (OR= 0.03; P= 0.015), un-

employed (OR= 0.57; P= 0.04) compared to those that were employed.

Table 5 shows the predicting factors that could be responsible for immunologic failure. An increased odds was significantly associated with male gender (OR= 1.29; P=0.008), non-disclosure of status (OR= 1.24; P= 0.01), baseline anaemia (OR= 1.15; P= 0.009) and poor adherence by self-report (OR= 3.28; P <0.001). A decreased

Table 4. Logistic regression analysis of predictors of virologic failure (viral load >400 copies/ml) among the study participants

Characteristics	Overall Participants (n=135)	Virologic failure (n=37)	OR (95% CI)	p-value
Gender				
Female	102	13 (35.1%)	1	
Male	33	24 (64.9%)	0.47 (0.21-1.09)	0.079
Age at ART initiation (years)				
< 30	19	5 (13.5%)	1	
>30	116	32 (86.5%)	0.66 (0.14-3.11)	0.59
Currently married				
Yes	103	11 (29.7%)	1	
No	32	26 (70.3%)	1.51 (0.41-5.55)	0.54
Disclosure of status				
Yes	76	04 (10.8%)	1	
No	59	33 (89.2%)	1.04 (0.90-2.14)	<0.01
Drug adherence by self report				
≥ 95% adherent	107	20 (54.1%)	1	
At least one ART dose missed	28	17 (45.9%)	2.74 (2.03-5.45)	0.015
ART regimen at baseline				
AZT/3TC/NVP or EFV	93	23 (62.2%)	1.52 (0.68-3.37)	0.30
TDF/3TC/NVP or EFV	42	14 (37.8%)	1	
CD4 cell count at baseline(cells/μl)				
<50	17	11 (29.7%)	0.23 (0.02-2.84)	0.25
50 - < 200	55	14 (37.8%)	0.03(0.002-0.50)	0.015
200 - <350	45	10 (27%)	1	
350 - <500	06	1 (2.7%)	0.34 (0.03-4.41)	0.41
≥500	12	1 (2.7%)	0.14 (0.04-4.41)	0.14
Baseline Anemia (Hb <10g/dl)				
Yes	18	8 (21.6%)	0.95 (0.09-9.43)	0.96
No	117	29 (78.4%)	1	
Baseline Anemia (Hb <10g/dl)				
Yes	18	8 (21.6%)	0.95 (0.09-9.43)	0.96
No	117	29 (78.4%)	1	
Employment status				
Employed	116	26 (70.3%)	1	
Unemployed	14	9 (24.3%)	0.57 (1.04-2.96)	0.04
Student	05	2 (5.4%)	0.16 (0.06-4.77)	0.29
Educational qualification				
Tertiary	66	8 (21.6%)	1	
Secondary	15	2 (5.4%)	0.89 (0.07-0.77)	0.018
Primary	19	7 (18.9%)	0.10 (0.04-0.28)	<0.01
No formal education	35	20 (54.1%)	2.29 (0.73-3.20)	0.01

OR: odds ratio, CI: confidence interval, ART: antiretroviral treatment, AZT: zidovudine, TDF: Tenofovir, 3TC: Lamivudine, EFV: Efavirenz and NVP: Nevirapine.

odd ratio of immunologic failure was not significantly associated with any predictor.

4. DISCUSSION

In this study, the rate of incomplete adherence to ART was 20.7% and 79.3% of the studied participants had optimal adherence level of $\geq 95\%$ which indicates a high

Table 5. Logistic regression analysis of predictors for immunologic failure among the study participants

Characteristics	Overall participants (n=135)	Immunologic Failure (n=39)	OR (95% CI)	P-value
Gender				
Female	102	25 (64.1%)	1	
Male	33	14 (35.9%)	1.29 (1.22-7.31)	0.008
Age at ART initiation (years)				
< 30	19	7 (17.9%)	1	
>30	116	32 (82.1%)	0.39 (0.12-1.36)	0.14
Currently married				
Yes	103	12 (30.8%)	1	
No	32	27 (69.2%)	0.65 (0.21-2.04)	0.46
Disclosure of status				
Yes	76	9 (23.1%)	1	
No	59	30 (76.9%)	1.24 (1.78-7.03)	0.01
Drug adherence by self-report				
$\geq 95\%$ adherent	107	21 (53.8%)	1	
At least one ART dose missed	28	18 (46.2%)	3.28 (2.01-5.54)	<0.001
ART regimen at baseline				
AZT/3TC/NVP or EFV	93	23 (59%)	0.59 (0.34-4.73)	0.34
TDF/3TC/NVP or EFV	42	16 (41%)	1	
CD4 cell count at Baseline (cells/ μ l)				
<50	17	5 (12.8%)	2.75(0.68-11.06)	0.15
50 - < 200	55	13 (33.3%)	2.99(0.55-16.44)	0.21
200 - <350	45	13 (33.3%)	1	
350 - <500	06	3 (7.7%)	1.75 (0.43-7.04)	0.43
≥ 500	12	5 (12.8%)	0.49 (0.07-3.67)	0.49
Baseline Anemia (Hb <10g/dl)				
Yes	18	15 (38.5%)	1.15(2.03-5.81)	0.009
No	117	24 (61.5%)	1	
Employment status				
Employed	116	31 (79.4%)	1	
Unemployed	14	7 (17.9%)	1.401(0.07-2.09)	0.28
Student	05	1(2.6%)	0.683(0.19-1.07)	0.34
Educational qualification				
Tertiary	66	12 (30.8%)	1	
Secondary	15	4 (10.3%)	1.72 (0.37-8.01)	0.47
Primary	19	6 (15.4%)	3.38(0.78-14.65)	0.10
No formal education	35	17 (43.5%)	3.43(0.89-10.95)	0.08

OR: odds ratio, CI: confidence interval, ART: antiretroviral treatment, AZT: zidovudine, TDF: Tenofovir, 3TC: Lamivudine, EFV: Efavirenz and NVP: Nevirapine

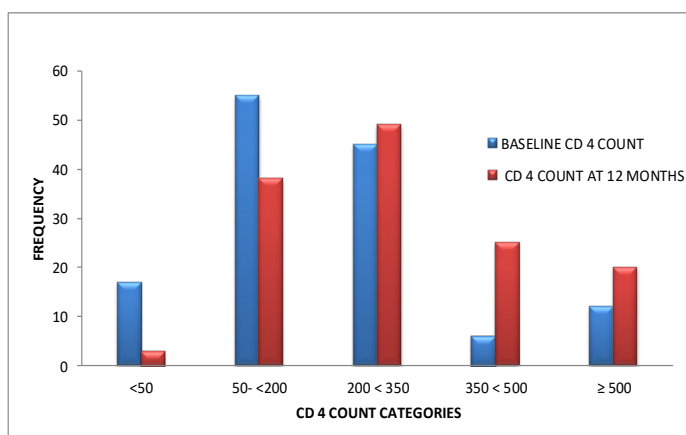


Figure 1: Distribution of CD4 counts at baseline and at 12 months post ART among the study participants.

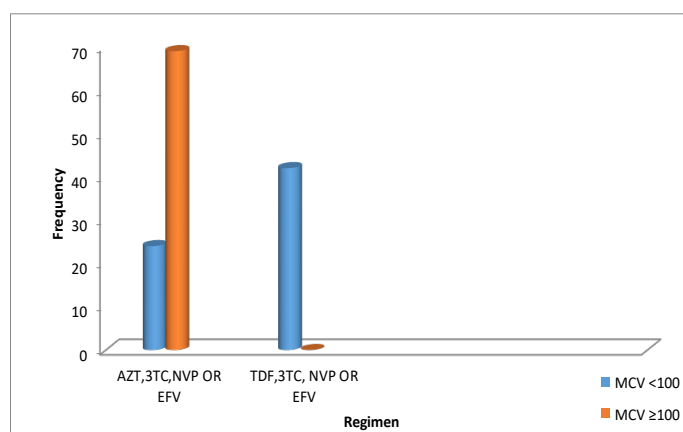


Figure 2: Evidence of macrocytosis among study participants on different treatment regimen

level of adherence. This report is in tandem with 78.3% and 73.3% reported from studies conducted in Nnewi and Ilorin respectively in Nigeria [1][13]. The low level of incomplete adherence in this study may be due to the fact that the ART supplied was free of charge for all patients, the patients received therapeutic education before the commencement of ART and the availability of good drug procurement and distribution strategies.

However, some studies in Nigeria have reported very high rate of incomplete adherence. There have been reports of 85.1%, 75%, 50.8% and 42% from different locations in Nigeria [14][15]. The difference in the rates of incomplete adherence in various studies reported in Nigeria may be attributed to the lack of gold standard for the measurement of adherence and also the difference in funding from one location to the other as ART given to patients were totally funded in some studies while it was subsidized in other studies[16].

The virologic suppression rate of 73% observed in this study is similar to the rate reported in the analysis of

large HIV treatment program in Nigeria where 77% suppression rate was reported[17]. This is also in resonance with large review of studies on antiretroviral treatment programs in sub-sahara Africa where 76% virologic suppression rate was reported[18]. However, diminished suppression rate was observed in some studies conducted in Nigeria; 62% suppression rate[19] and 70% suppression rate[20]. The high virologic suppression rate corroborates the low level of incomplete adherence to ART reported among the study participants in this study.

In this study, a high immunologic recovery rate of 71.1% was observed. This is similar to 77.4% [17] and 72.1% [21] reported previously. The favourable immunovirologic outcomes obtained in this study confirm the availability of free antiretroviral drug supply to all the study participants also, more than half of the entire cohort was placed on nevirapine-containing regimen. High virologic suppression rate has been previously attributed with nevirapine-based regimens[22].

Virological failure in this present study was found to be significantly associated with non-disclosure of status to partners or relatives given an increased odd ratio. Other studies have reported similar findings; most notable is [23], who reported that non-disclosure was associated with virologic failure at 48 weeks of ART exposure. However, studies have indicated that disclosure of HIV status help to reduce stress and isolation with a consequent increase in adherence and social support [24]. Non-disclosure of status has been reported from a meta-analysis in Africa as a predictor of poor adherence to ART and this perhaps was due to the fact that family members, partners and friends can play treatment partners role and will usually be willing to provide moral and material support[25].

In previous studies, patients with sub-optimal adherence were shown to have low viral suppression [26]. Some other reports have also suggested that virologic failure in resource limited countries could be associated with incomplete adherence and is a strong predictor of antiretroviral drug resistance [27][28]. Other findings have reported that in order to achieve satisfactory virologic control, adherence level of 70-90% may be enough and that, the emergence of resistance and virologic failure are not likely to occur at 95% adherence level [29]. However, the poor outcome of virological failure in this study was significantly associated with incomplete adherence to ART and this report is in resonance with what was previously reported in North Central Nigeria by Abah et al., 2016 [30].

This study showed that baseline CD4 cell count of less than 200cells/ul was significantly associated with virological failure though with a decreased odds, which is in tandem with a previous study conducted in Nigeria [17]. Similarly, study conducted by Skowron et al., 2001 demonstrated that CD4 T cell count is a better predictor of viral suppression[31]. Immunological failure in this study was significantly associated with baseline anaemia given an increased odd ratio. It was documented in previous studies that anaemia at the start of ART is a very useful factor in determining the immunologic outcome including short and long –term prognosis [32]. The result also correlates with previous studies in the North America and Europe which showed the association of anaemia with poorer outcomes where patients who started ART with moderate to severe anaemia at baseline continued to experience higher rates of AIDS and death than those without anaemia at baseline[33][34].

This study also revealed that immunological failure was associated with male gender and this is similar to result obtained from a previous study in Nigeria [17]. Also, the association between gender and immunological failure was reported in Burkina faso, where it was concluded that men on ART appeared more vulnerable to immunologic failure than women regardless of their HIV disease stage at ART initiation [35]. However, in some other studies gender was not associated with either immunologic failure or virologic failure[36][37].

The association between gender and immunologic failure might be linked to gender differences in pharmacokinetics and pharmacodynamics profiles of antiretroviral drugs [35]. Also male gender has been consistently associated with poor health seeking behaviours[38], poorer male adherence to HIV care and treatment which could be related to gender based socio cultural norms including busy schedule, job constraints, long waiting period in the clinic, stigma and more difficult communication with health care workers particularly female ones[39].

Non-adherence to antiretroviral treatment regimen was also found to diminish the immunological benefit of ART in this study. This result is in consistent with self-reported adherence rate and its association with sub-optimal adherence as reported in another study [40]. Similar study reported that patients with 95-99% adherence at 6months exposure to ART had increase CD4 counts [41]. However, this is not in resonance with the report from similar study carried out in Nigeria as there was no significant association between non adherence to ART and immunological failure[17].

This study clearly shows that non-disclosure of status, baseline anaemia, male gender, low educational achievement, unemployment and incomplete adherence were significantly associated with negative immunovirological outcomes. Therefore adequate information, proper education and communication campaigns against stigmatization are required in order to reduce and totally eliminate the social stigma associated with HIV status disclosure.

Adherence in this study was assessed only at a single point and this made it impossible to evaluate variations in adherence over time for an individual thus, it is recommended that adherence should be evaluated from time to time even within the same group of patients after ART initiation. Baseline HIV RNA viral load should be carried out on every infected patients before the commencement of ART for proper monitoring of the virological response to therapy.

Acknowledgement

We appreciate the study participants for their voluntary participation. The authors thank the staff of the Institute for Human Virology of Nigeria (IHVN-LAUTECH Teaching Hospital, Osogbo) for their co-operations. We are also grateful to the Medical Laboratory Scientists in the IHVN Lab at Obafemi Awolowo University Teaching Hospital, Ile-Ife for their technical assistance.

Conflict of interest

no competing interest exists

Authors' Contribution

BTS Collected data and wrote the manuscript, **OOO** conceived, designed and supervised the study, **MOA, OO** Review the manuscript, **MOS, AAA, KAA, JEA** Collected Data and analysis, **OA** Performed analysis and Supervised the work

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