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Metabolic Profileand Associated factors in Clinically Stable HIV Patients on Long term HAART in a resource limited setting; A Pilot Study

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Abstract:
Background: *As HIV epidemic progresses through time with increasing use and better adherence to HAART, AIDS related causes of death are significantly decreasing and non AIDS related causes with associated metabolic abnormalities are increasingly becoming relatively more frequent especiallyin developing countries.*
Objective: *To assess the metabolic profile and associated factors of body mass index and years on HAART in clinically stable HIV patients on long term HAART in a resource limited setting.*
Methods: *Thepilot study was conducted using a cross sectional methodology to assess 50 purposively selected clinically stable HIV infected participants with CD4 T cell counts of 350 cells/mm^3 or less.The metabolic parameter measurements taken were serum cholesterol, serum albumin, serum creatinine, serum urea, serum alkaline phosphatase, random blood sugar and liver enzymes.*
Results: *Half of the participants were either of normal weight or overweight and obese with a mean BMI of 24.9±4.1.More than half of the participants had high levels of serum urea, albumin, SGOT and SGPT. There were statistically significant relationships between body mass index and levels of random blood sugar (p=0.045), serum cholesterol (p=0.013), serum albumin (p=0.004) and SGPT (p=0.031) and also between the Years on HAART and levels of serum albumin (p=0.036) and serum cholesterol (p=0.040).*
Conclusion*: HIV patients on long term HAART appear to have abnormal levels of some metabolic parameters andBMI appears to have more significant relationships with the metabolic parameters, than the duration on HAART especially in resource limited settings.These observations and relationships need to be further explored with larger studies.*
Keywords:*Pilot study, metabolic parameters, HIV patients, resource limited setting*

I. Introduction

Human immunodeficiency virus/Acquired immunodeficiency syndrome (HIV/AIDS) remains a potentially fatal and devastating disease involving the immune systems but with the introduction of highly active anti-retroviral therapy (HAART), the mortality profile of HIV is changing and becoming more diverse; thus evolving into a chronic manageable disease with emphasis on viral control and minimization of the metabolic effects associated with age, HIV and HAART.[1]

The relatively long, effective and widespread use of HAART has been associated with significant reductions in the risk of death from both AIDS and non AIDS defining illnesses. The non AIDS defining illnesses associated with abnormal metabolic parameters are increasingly becoming major causes of mortality, and are typically classified as cardiovascular, hepatic, renal and malignant disorders which appear to have multi-factorial causes that are likely to be related to lifestyle, body mass index (BMI), older age, gender, long term HAART use e.t.c.[1-3]

Furthermore, the use of HAART has been observed to be accompanied by metabolic changes and these changes increase the risk of end organ pathology especially cardiovascular,which appears to be most common in HIV infected adults in sub Saharan Africa when compared to liver related non AIDS defining illnesses; probably due to the chronic inflammatory state that exists in HIV patients despite virologic suppression coupled

with lower rates of hepatitis C co-infection and the common use of HAART with intrinsic anti hepatitis B activity.[3-7] It has also been reported generally that there is a higher prevalence of traditional risk factors such as hypertension, diabetes and lipid abnormalities for cardiovascular diseases in HIV-infected patients when compared to non-HIV-infected controls. [8, 9]

Within the context of changing social and clinical demographics in HIV patients on long term HAART and the dramatic changes in the relative proportion of AIDS and non AIDS defining causes of death; monitoring of the metabolic parameters that appear to be associated with these changes due to increasing age and survival is critically necessary in order to effectively manage HIV and its likely co-morbidities.

In a UNAIDS report,[10] it was observed that the proportion of adults living with HIV aged 50 years and above is increasing especially in the low and middle income countries where it has been reported that they now constitute about 10% of the adult population living with HIV. So as we progress in time, an aging HIV infected population will present not only metabolic abnormalities which we must address but also the additional challenges that includes the management of drug interactions resulting from the treatment of chronic co-morbid conditions and HIV infection; which invariably implies an increasing burden of multi-morbidity and polypharmacy over time.[2, 11, 12]

Consequently, as HIV patients in resource limited regions are now living longer due to the widespread availability and use of HAART, the risk of non AIDS defining events as causes of mortality is becoming a major management concern among these patients, as a result it has become necessary to monitor more closely these metabolic markers of organ functionality, thus the study was conducted to assess the metabolic profiles of HIV patients on long term HAART in resource limited settings and in anticipation of the implementation of a larger study.

II. Methodology

2.1 Study Area

The study was conducted at the adult HIV clinic of Imo State University Teaching Hospital situated in Orlu Local Government Area (LGA) of Imo State in South Eastern Nigeria. Imo State covers an area of about 5100 sq km with a population density varying from 230-1400 persons per sq. km. The study centre was a tertiary health care facility with an ART clinic that has a total enrolment of 4,800 patients and offers comprehensive outpatient ART care services to about 900 clients monthly.[13]

2.2 Study Population

The study population comprised of adult HIV infected patients accessing HAART from the ART clinic who were either on the first or second line drug regimen consisting of Zidovudine, Lamuvidine, Emtricitabine, Tenofovir, Abacavir, Nevirapine, Efavirenz, Atazanavir and Lopinavir/Ritonavir.

2.2.1 Selection Criteria

The inclusion criteria were: having CD4 T cell counts of 350 cells/ul or less, receiving HAART for at least one year, a minimum clinic attendance of 95% and being clinically stable (having no fever, diarrhoea or cough). Exclusion criteria were: current or previous micronutrient supplement use within the last three months, pregnant women or women intending to get pregnant and breastfeeding mothers.

2.3 Study Design/Sampling Technique/Sample size

A cross-sectional design through purposive sampling was used to assess the clients in the adult ART clinic of Imo State University Teaching Hospital, Orlu.[13] Enrolment process began by identification of the eligible clients (500) from case files based on the inclusion criteria, and 115 of these clients responded to phone call invitation. The first fifty patients (10% of the eligible clients) that responded to the invitation who fulfilled the exclusion criteria and gave informed consents were enrolled.

2.4 Clinical/Laboratory Measurements

The database of the fifty participants enrolled was accessed using a pro-forma; their metabolic parameters and CD4 T cell counts were entered. The socio-demographics including years on HAART and all routine clinical measurements such as weight, height and blood pressure using standard measurement scales and blood pressure apparatus by the nurses were entered. The metabolic parameters included serum cholesterol, serum albumin, serum creatinine, serum urea, serum alkaline phosphatase, random blood sugar and liver enzymes i.e. serum glutamic-oxaloacetic transaminase (SGOT)and serum glutamic-pyruvic transaminase (SGPT).

These tests were performed by the principal medical laboratory scientist and assisted by medical laboratory technicians. The metabolic tests were performed using Randox diagnostic reagent Kits and the CD4 T Cell counts were measured by cytometry using Cyflow green which uses a single phycoerythrin conjugated-

monoclonal antibody. The laboratory established its own reference range of the metabolic parameters with guidance of the Randox kit expected normal values to reflect the age, sex, diet and geographical location of the population.

The Laboratory references for normal values were as follows: Serum GPT (<12U/L), Serum GOT (<12U/L), Serum Alkaline phosphatase (9-35IU/L), Serum Cholesterol (2.6-6.0mmol/L), Serum Urea (2.6-6.0mmol/L), Serum Creatinine (44-133µmol/L), Serum Albumin (38-42g/L) and Random Blood Sugar (3.3-8.3mmol/L).

2.5 Data Analysis

Data were collated, entered and analysed using International Business Machine Statistical Package for Social Sciences (IBM-SPSS) version 20. Descriptive analyses were done with frequencies and summary statistics. Chi square statistics were computed to determine significant relationships and fisher's exact test was used where appropriate. Statistical significance level was set at $p<0.05$.

2.6 Ethical Approval

Ethical approval was obtained from the Ethics Committee of Imo State University Teaching Hospital, Orlu, written informed consent was obtained from the participants and permission obtained for use of records. All authors declare that the study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

2.7 Limitations of Study

The small sample size in this study warrants caution in the conclusions and generalizations of the findings of this work and therefore highlights the need for further study in this population using a larger sample.

III. Results

3.1 Socio-demographic Characteristics

Fifty participants were assessed and more than half of the participants were females (58%), married (52%) and traders (56%).The mean age was 44±10 years and 90% had either primary or secondary school as their highest educational status. The median number of years the participants were on HAART was 3 years, with the majority (90%) receiving Zidovudine (AZT) based combination therapy. Table 1

Table 1: Socio-demographic Characteristics

Variable	Category	Frequency (%)
Age (years)	30-39	20(40.0)
	40-49	16(32.0)
	50-59	7(14.0)
Mean±SD=44±10 years	60-69	7(14.0)
Gender	Male	21(42.0)
	Female	29(58.0)
Occupation	Trading	28(56.0)
	Business	13(26.0)
	Artisan	5(10.0)
	Civil servant	4(8.0)
Marital Status	Single	8(16.0)
	Married	26(52.0)
	Separated	16(32.0)
Educational status	Primary	23(46.0)
	Secondary	22(44.0)
	Tertiary	5(10.0)
Years on HAART	1-2	20(40.0)
	3-4	19(38.0)
Median= 3 years	5-6	11(22.0)

HAART Combination[1]AZT Based 43(86.0)
[2]TDF Based 4(8.0)
[3]Lp/r Based 3(6.0)
1- Zidovudine, 2- Tenofovir, 3- Lopinavir/ritonavir

3.2 CD4 and Physical Parameter Characteristics

The mean CD4 count level of the participants was 197±81 cells/mm^3 with more than half of the participants (52%) being severely immune-deficient. Half of the participants were either of normal weight or overweight and obese with the mean BMI (24.9±4.1) of the participants within the normal range. The systolic and diastolic blood pressures of the participants were on the average within normal limits, with 42% of the participants having either an elevated systolic or diastolic pressure or both.
The average packed cell volumes of the participants according to gender were within normal laboratory reference range. Table 2

Table 2: CD4 and Physical Parameter Characteristics

Variable	Category	Frequency (%)	Mean±SD
CD4 (cells/mm^3)	Advanced (>200≤ 350)	24(48.0)	197±81
	Severe (≤ 200)	26(52.0)	
BMI (kg/m^2)	Normal(>18.5<25)	25(50.0)	24.9±4.1
	Overweight(≥25<30)	18(36.0)	
	Obese (≥30)	7(14.0)	
[a]			124 ±24
Blood Pressure	Normal	29(58.0)	[b]73 ±11
(mm/Hg)	Hypertension	21(42.0)	
***Packed cell volume**	Low	16(32.0)	[c]40±3
	Normal	34(68.0)	[d]36±4

a-Systolic, b -Diastolic, c- Male, d- Female, *Gender taken into account

3.3 Metabolic Parameter Characteristics

While more than half of the participants had normal levels of serum creatinine (94%), serum cholesterol (88%), serum alkaline phosphatase (68%) and random blood sugar (56%), more than half of the participants also had high levels of SGOT (82%), SGPT (70%), serum albumin (56%) and serum urea (54%). The mean levels of serum urea, albumin, SGPT and SGOT were above the normal laboratory reference range for the individual parameters.
Table 3

Table 3: Metabolic Parameter Characteristics

Variable	Category	Frequency (%)	Mean±SD
Cholesterol(mmol/L)	Low	5(10.0)	3.6±1.0
	Normal	44(88.0)	
	High	1(2.0)	
Urea(mmol/L)	Low	3(6.0)	**7.7±3.9***
	Normal	20(40.0)	
	High	27(54.0)	
Creatinine(umol/L)	Normal	47(94.0)	82.3±29.2
	High	3(6.0)	
RBS(mmol/L)	Low	21(42.0)	3.8±1.8
	Normal	28(56.0)	
	High	1(2.0)	

SGPT(U/L) Normal 15(30.0)**20.3±10.9***
High 35(70.0)

SGOT(U/L) Normal 9(18.0)**26.9±17.6***
High 41(82.0)

Alkaphos(IU/L) Normal 34(68.0) 31.4±11.7
High 16(32.0)

Albumin(g/L) Low 5(10.0)**42.8±4.6***
Normal 17(34.0)
High 28(56.0)

***Above normal laboratory reference range

3.4 Association between BMI and Metabolic Parameters

There was a statistically significant relationship between body mass index and levels of random blood sugar [$\chi^2(1)=4.02$, p=0.045], serum cholesterol[$\chi^2(2)=8.68$,p=0.013], serum albumin[$\chi^2(1)=8.12$, p=0.004] and SGPT[$\chi^2(1)=4.67$, p=0.031].

Table 5: Association between BMI and Metabolic Parameters

	Body Mass Index				
	Normal	Overweight/Obese			
	Freq(%)	Freq(%)	Total (%)	χ^2 df	p-value
Random Blood Sugar	4.021*				**0.045**
Low	7(28)	14(56)	21(42)		
Normal	17(68)	11(44)	28(56)		
High	1(4)	0(0)	1(2)		
Total	25(100)	25(100)	50(100)		
Cholesterol	8.682*				**0.013**[b]
Low	0(0)	5(20.0)	5(10.0)		
Normal	24(96.0)	20(80.0)	44(88.0)		
High	1(4.0)	0(0)	1(2.0)		
Total	25(100)	25(100)	50(100)		
Urea	2.01	1	0.156		
Low	1(4.0)	2(8.0)	3(6.0)		
Normal	13(52.0)	7(28.0)	20(40.0)		
High	11(44.0)	16(64.0)	27(54.0)		
Total	25(100)	25(100)	50(100)		
Albumin	8.12	1	*		**0.004**
Low	0(0)	5(20.0)	5(10.0)		
Normal	6(24.0)	11(44.0)	17(34.0)		
High	19(76.0)	9(36.0)	28(56.0)		
Total	25(100)	25(100)	50(100)		
Creatinine	0.36	1	1.000[a]		
Normal	23(92.0)	24(96.0)	47(94.0)		
High	2(8.0)	1(4.0)	3(6.0)		
Total	25(100)	25(100)	50(100)		
AlkPhos	1.47	1	0.225		
Normal	19(76.0)	15(60.0)	34(68.0)		
High	6(24.0)	10(40.0)	16(32.0)		
Total	25(100)	25(100)	50(100)		

SGOT 0.14 1 1.000[a]					
Normal 5(20.0)4(16.0)9(18.0)					
High 20(80.0)21(84.0)41(82.0)					
Total 25(100) 25(100) 50(100)					
SGPT4.67 1 [*]**0.031**					
Normal 11(44.0)4(16.0)15(30.0)					
High 14(56.0)21(84.0)35(70.0)					
Total 25(100) 25(100) 50(100)					

[*] Significant [a]Fisherexact[b] Likelihood ratio

3.5 Association between Years on HAART and Metabolic Parameters

There were statistically significant relationships between Years on HAART and levels of serum albumin [$\chi^2(1)=4.38$, p=0.036] and serum cholesterol [$\chi^2(2)=6.42$, p=0.040].

Table 6: Association between Years on HAART and Metabolic Parameters

	Years on HAART				
	1-3yrs	4-6yrs			
	Freq(%)	Freq(%)	Total (%)	χ^2 df	p-value
Random Blood Sugar				0.01 1	0.933
Low	14(42.4)	7(41.2)	21(42.0)		
Normal	18(54.6)	10(58.8)	28(56.0)		
High	1(3.0)	0(0)	1(2.0)		
Total	33(100)	17(100)	50(100)		
Cholesterol				6.422	[*]**0.040**[b]
Low	5(15.2)	0(0)	5(10.0)		
Normal	28(84.8)	16(94.1)	44(88.0)		
High	0(0)	1(5.9)	1(2.0)		
Total	33(100)	17(100)	50(100)		
Urea	0.241		0.623		
Low	3(9.0)	0(0)	3(6.0)		
Normal	13(39.5)	7(41.2)	20(40.0)		
High	17(51.5)	10(58.8)	27(54.0)		
Total	33(100)	17(100)	50(100)		
Albumin	4.38	1	[*]**0.036**		
Low	4(12.1)	1(5.9)	5(10.0)		
Normal	14(42.4)	3(17.6)	17(34.0)		
High	15(45.5)	13(76.5)	28(56.0)		
Total	33(100)	17(100)	50(100)		
Creatinine	0.001		1.000[a]		
Normal	31(93.9)	16(94.1)	47(94.0)		
High	2(6.1)	1(5.9)	3(6.0)		
Total	33(100)	17(100)	50(100)		
AlkPhos	0.85	1	0.357		
Normal	21(63.6)	13(76.5)	34(68.0)		
High	12(36.4)	4(23.5)	16(32.0)		
Total	33(100)	17(100)	50(100)		
SGOT	0.00	1	1.000[a]		
Normal	6(18.2)	3(17.6)	9(18.0)		
High	27(81.8)	14(82.4)	41(82.0)		
Total	33(100)	17(100)	50(100)		
SGPT	0.00	1	0.948		
Normal	10(30.3)	5(29.4)	15(30.0)		
High	23(69.7)	12(70.6)	35(70.0)		
Total	33(100)	17(100)	50(100)		

[*] Significant [a]Fisher Exact[b] Likelihood ratio

IV. Discussion

This study was conducted to assess the metabolic profiles and the relationship of associated factors such as body mass index and the number of years on HAART on the metabolic parameters in clinically stable HIV patients who have been on HAART for at least one year in a resource limited setting. The study revealed that a majority of the participants had high levels of serum albumin, serum urea and liver enzymes (SGOT, SGPT) and with respect to the other metabolic parameters, a majority of the participants had normal levels of serum cholesterol, serum creatinine, random blood sugar and serum alkaline phosphatase.

Furthermore it was observed that in these participants of which half them were either overweight or obese, there was a statistically significant relationship ($p< 0.05$) between body mass index and levels of random blood sugar, serum cholesterol, serum albumin and SGPT.Overweight and obesity have been reported to be more common than wasting in the therapeutic era of HAART and therefore has become a significant metabolic issue in HIV infected population as this could be due to improved clinical outcomes associated with the use of HAART.[14-16]

Also in these participants whose median number of years on HAART was 3 years, it was observed that there were statistically significant relationships between the number of years on HAART and the levels of serum albumin and serum cholesterol; but this was not the case for the other metabolic parameters.

The patterns of the distribution of the metabolic parameters among these participants gives only an indication of the probable risk factors that they are exposed to and the type of non AIDS defining illnesses that can develop. Among these participants the majority had normal cholesterol levels with the mean cholesterol level within normal laboratory range. This is contrary to reports from previous studies that have stated that HAART initiation especially Zidovudine based combination therapy was associated with increases in total cholesterol levels and as a consequence, high cholesterol appeared to be more common in HIV patients on HAART especially in the overweight and obese patients.[17-22] Probably, the observation in the present study may be attributed in part to the nature of the participant's diet amongst other factors.

The other metabolic parameters of these participants that showed a similar pattern of normal serum levels amongst the majority with mean levels within normal laboratory range includes serum creatinine, random blood sugar and serum alkaline phosphatase. These observations are contrary to reports from other studies were high levels of serum creatinine, alkaline phosphatase and random blood sugar have been associated with HIV patients on HAART.[23-27]Though a study by Kamga et al, reported that the mean serum creatinine was significantly higher in the HAART naïve group when compared to those who were already on HAART.[28]Generally, these observations have been attributed mostly to the use of HAART and more specifically with respect to random blood sugar, HAART has been associated with insulin resistance though the HAART most frequently implicated are the protease inhibitors.[29,30] This could possibly explain why the participants in the study had a mean random blood sugar level within normal limits as most of the participants (86%) were on zidovudine based combination therapy. Furthermore, this HAART combination used by most of the participants in the present study probably had less effect on thelevels of serum creatinine and alkaline phosphatase as observed in their mean serum levels.

On the other hand, the metabolic pattern of increased serum levels of albumin, urea and the liver enzymes (SGOT, SGPT) were observed in the majority of the participants with the mean levels above their normal laboratory reference range. Theseobservations of increased serum levels which have been reported in other studies were generally associated with the use of HAART.[23,31-35]Low serum albumin levels were generally associated with HIV disease severity and subsequently with a corresponding increase in serum levels following HAART treatment Improvement in clinical outcomes due to HAART could probably explain the mean albumin levels which are above the normal laboratory reference values, other possibilities may be due to the state of dehydration and intake of relatively high proteindiets among the participants.

The increased liver enzymes that have been associated with HAART treatment and duration could also be due to the presence of hepatitis C though not assessed in these participants or due to overweight and obesity which was established in 50% of the participants. This is probably supported by a study done in the United States of America byYounossi et al, who reported that non-alcoholic fatty liver disease was the most common cause of persistent elevated liver enzymes with obesity being an independent predictor.[36]

Furthermore, BMI appeared to have a significant relationship with some metabolic parameters observed among these HIV participants as the present study showed that, there were statistically significant relationships between BMI and random blood sugar, serum cholesterol, serum albumin and SGPT.($P<0.05$).However, some studies conducted in the general population have reported significant relationships between BMI and serum creatinine, serum cholesterol, SGPT, SGOT and random blood sugar,[37-40] though with respect to random blood sugar a study by Bakari et al reported a lack of significant relationship between BMI and random blood sugar.[41]

Likewise among these HIV participants in the present study, it was observed that only serum albuminand serum cholesterol had significant relationships with HAART duration. ($P<0.05$)Similarly, a study in

Cameroon byNsagha et al, reported a significant association between high levels of serum albumin and HAART treatment, though the HIV patients in that study were co-infected with Tuberculosis.Also Riddler et al, observed increases in total cholesterol upon HAART initiation. It is probable that the effect of HAART duration on serum albumin and serum cholesterol in the present study could be due to the HAART's overall effect in improving clinical outcomes in HIV patients.[42]

V. Conclusion

As observed in the present study, 42% of the participants were hypertensive and half were either overweight or obese with BMI having significant relationships with metabolic parameters such as random blood sugar, serum cholesterol and SGPT. This further highlights the potential risks for cardiovascular and liver related non-AIDS defining illnesses in HIV patients receiving long term HAART in resource limited regions and therefore the need to follow up this study with a larger study in order to further explore this observed patterns and relationships which are relevant issues of management concern as the HIV population on HAART ages.

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References

[1]. May M T, Ingle,S M, Costagliola D, Justice A C, de Wolf F, Cavassini M et al. Cohort Profile: Antiretroviral Therapy Cohort Collaboration (ART-CC). Int J Epidemiol. 2014;43(3): 691–702

[2]. Grinsztejn B, Luz P M, Pacheco A G, Santos D V, Velasque L, et al. Changing Mortality Profile among HIV-Infected Patients in Rio de Janeiro, Brazil: Shifting from AIDS to Non-AIDS Related Conditions in the HAART Era. PLoS ONE 2013; 8(4): e59768.

[3]. Wester C W, Koethe J R, Shepherd B E, Stinnette S E, Rebeiro P F, Kipp A M et al. Non-AIDS-defining events among HIV-1-infected adults receiving combination antiretroviral therapy in resource-replete versus resource-limited urban setting. AIDS. 2011; 25(12):1471–1479.

[4]. Gkrania-Klotsas E, Klotsas AE. HIV and HIV treatment: effects on fats, glucose and lipids. Br Med Bull. . 2007;84:49-68.

[5]. Kuller L H, Tracy R, Belloso W, de Wit S, Drummond F, Lane H C et al. Inflammatory and coagulation biomarkers and mortality in patients with HIV infection. PLos Med 2008;5:e203.10.1371.

[6]. Adewole O O, Anteyi E, Ajuwon Z, Wada I, Elegba F, Ahmed P et al. Hepatitis B and C virus coinfection in Nigerian patients with HIV infection. J Infect Dev Ctries. 2009;3(5):369–375.

[7]. Otegbayo J. A, Taiwo B O, Akingbola T S, Odaibo G N, Adedapo K S, Penugonda S et al. Prevalence of hepatitis B and C seropositivity in a Nigerian cohort of HIV-infected adults. Ann Hepatol. 2008;7:152–156.

[8]. Currier JS, Lundgren JE, Carr AC et al. Epidemiological evidence for cardiovascular disease in HIV-infected patients and relationship to highly active antiretroviral therapy. Circulation 2008; 118:e29-35

[9]. Obel N, Thomsen HF, Kronborg G et al. Ischemic heart disease in HIV-infected and HIV-uninfected individuals: a population-based cohort study. Clin Infect Dis 2007; 44:1625-1631.

[10]. UNAIDS. HIV and aging, a special supplement to the UNAIDS report on the global AIDS epidemic 2013. Online at http://www.unaids.org/sites/default/files/en/media/unaids/contentassets/ documents/unaidspublication/2013/20131101_JC2563_hiv-and-aging_en.pdf. Accessed February 2016.

[11]. Justice A C. HIV and aging: time for a new paradigm. Curr HIV/AIDS Rep 2010;7:69-76

[12]. Costagliola D. Demographics of HIV and aging. CurrOpin HIV AIDS 2014;9(4):294-301.

[13]. Iwu A C, Duru C B, Uwakwe K A, Obionu C N, Diwe K C, Abah S O et al. Effect of Multiple Micronutrient Supplementation on CD4 T Cell levels of Clinically Stable HIV patients on Highly Active Antiretroviral Therapy; A Randomized Control Crossover Trial. American Journal of Clinical Medicine Research 2016;4(1):1-6.

[14]. Amorosa V, Synnestvedt M, Gross R, Friedman H, MacGregor R R, Gudonis D et al. A Tale of 2 Epidemics: The Intersection Between Obesity and HIV Infection in Philadelphia. JAIDS Journal of Acquired Immune Deficiency Syndromes. 2005; 39(5):557-61.

[15]. Tedaldi E, Richardson J, Baker R, Weidle P, Buchacz K, Moorman A et al. Effect of body mass index (BMI) on response to highly active antiretroviral therapy (HAART) in HIV-1 Infected Patients on initial HAART regimen. Poster Exhibition: The 3rd IAS Conference on HIV Pathogenesis and Treatment. 2005; Abstract no. TuPe2.4C05"

[16]. Jaime P, Florindo A, Latorre M, Brasil B, Santos E, Segurado A. Prevalence of overweight and central obesity in HIV/AIDS patients treated with highly active antiretroviral therapy. Rev Bras Epidemiol. 2004; 7(1):65-72.

[17]. Gallant J E, DeJesus E, Arribas J R, Pozniak A L, Gazzard B, Campo R E et al. Tenofovir, emtricitabine, and efavirenz vs. zidovudine, lamivudine, and efavirenz for HIV. N Engl J Med. 2006;354:251-60.

[18]. Haubrich R H, Riddler S A, DiRienzo A G, Komarow L, Powderly W G, Klingman K, et al. Metabolic outcomes in a randomized trial of nucleoside, nonnucleoside and protease inhibitor-sparing regimens for initial HIV treatment. AIDS Clinical Trials Group (ACTG) A5142 Study Team AIDS. 2009; 23(9):1109-18.

[19]. Riddler S A, Smit E, Cole S R, Li R, Chmiel J S, Dobs A et al. Impact of HIV infection and HAART on serum lipids in men. JAMA. 2003; 289(22):2978-82.

[20]. Luísa Helena M L, Ana Beatriz de Mattos M S. Metabolic abnormalities and overweight in HIV/AIDS persons-treated with antiretroviral therapy. Rev.Nutr.2008; 21:3.

[21]. Yusuf R, Sambo A I, Mohammed M H, Abdulaziz H. Lipid profile of HIV/AIDS patients attending antiretroviral clinic in Zaria, North-Western Nigeria.
[22]. Sub-Saharan Afr J Med .2014;1:31-5.
[23]. Awah F M, Agughasi O. Effect of highly active anti-retroviral therapy (HAART) on lipid profile in human immunodeficiency virus (HIV) infected Nigerian population.
[24]. Afr J Biochem Res. 2011;5:282-6
[25]. Alo M.N, Okonkwo E.C, Onyebuchi A.K, Anyim C, Agah M.V. Assessment of the Effects of Highly Active Antiretroviral Therapy on the Renal Function of Patients with HIV-1 in a Rural Setting of South Eastern Nigeria Journal of Natural Sciences Research. 2012; 2:7
[26]. Ngala R A, Opoku D, Asare G, Effects of HIV Infection and Highly Active Antiretroviral Therapy (HAART) on the Liver of HIV Patients. Trends in Medical Research. 2015;10:1-11.
[27]. Ayelagbe O G, Akerele O P, Onuegbu A J, Oparinde D P. Drug hepatotoxicity in HIV patients on Highly Active Antiretroviral Therapy.(HAART) in South West Nigeria. IOSR Journal of Dental and Medical Sciences 2014;13(5):67-70.
[28]. Brown T T, Cole S R, Li X, Kingsley L A, Palella F J, Riddler S A et al. Antiretroviral Therapy and the Prevalence and Incidence of Diabetes Mellitus in the Multicenter AIDS Cohort Study. Arch Intern Med. 2005;165(10):1179-1184.
[29]. Jain R G, Furtine E S, Pedneault L, White A J, Lenhard J M. Metabolic complications associated with anti-retroviral therapy. Antiviral Res 2001; 51: 151 – 77.
[30]. Kamga H L F, Assob J C N, Njunda A L, Nde F P, Nsagha D S, Atanga M B S, et al. The kidney function trends in human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) patients at the Nylon District Hospital Douala. Cameroon J AIDS HIV Res. 2011;3(2):30–7.
[31]. Salehian B, Bilas J, Bazargam M, Abbasian M. Prevalence and incidence of diabetes in HIV infected minority patients on protease inhibitors. J Nat Med Ass 2005; 97: 1088-92.
[32]. Martínez E, Conget I, Lozano L, Casamitjana R, Gatell J M. Reversion of metabolic abnormalities after switching from HIV-1 protease inhibitors to nevirapine.
[33]. AIDS. 1999;13(7):805-10.
[34]. Olawumi H, Olatunji P. The value of serum albumin in pretreatment assessment and monitoring of therapy in HIV/AIDS patients. HIV Medicine. 2006; 7: 351–355.
[35]. Serpa J, Haque D, Valayam J, Breaux K, Rodriguez-Barradas M. Effect of combination antiretroviral treatment on total protein and calculated globulin levels among HIV-infected patients. International Journal of Infectious Diseases. 2010;14(3):e41-e44.
[36]. Bisaso K R, Owen J S, Ojara F W, Namuwenge P M, Mugisha A, Mbuagbaw L et al. Characterizing plasma albumin concentration changes in TB/HIV patients on anti-retroviral and anti –tuberculosis therapy. In Silico Pharmacology .2014; 2:3
[37]. Vajpayee M, Mendiratta S Chauhan N K, Mojumdar K. Haemoglobin and serum albumin as surrogate marker for HIV monitoring in resource-limited settings. AIDS 2008 - XVII International AIDS Conference: Abstract no. CDB0005.
[38]. Lucien K F H, Clement A N J, Fon N P, Weledji P, Ndikvu C P. The Effects of Antiretroviral Treatment on Liver function enzymes among HIV infected outpatients attending the Central hospital of Yaounde Cameroon. Afr J ClnExper. MicrobiolFR. .2010; 11(3): 174-178.
[39]. Younossi Z M, Stepanova M, Afendy M, Fang Y, Younossi Y, Mir H, Srishord M. Changes in the prevalence of the most common causes of chronic liver diseases in the United States from 1988 to 2008. ClinGastroenterolHepatol. 2011; 9(6):524-530.
[40]. X.-M. Li, Y.-T. Ma, X. Xie, Y.-N. Yang, X.-M. Li and Y.-Y. Zheng Relationship between serum creatinine and obesity in children in Xinjiang, China. Genetics and Molecular Research. 2014; 13 (2): 2409-2416
[41]. Innocent O, ThankGod O O, Sandra E O and Josiah I E. Correlation between body mass index and blood glucose levels among some Nigerian undergraduates. HOAJ Biology 2013, 2:4
[42]. Faheem M, Qureshi S, Ali J, Zahoor H, Abbas F, Gul A M,et al. DOES BMI AFFECT CHOLESTEROL, SUGAR, AND BLOOD PRESSURE IN GENERAL POPULATION? J Ayub Med Coll Abbottabad 2010;22(4):74-77
[43]. Hsieh M H, Ho C K, Hou N J, Hsieh M Y, Lin W Y, Yang J F et al. Abnormal liver function test results are related to metabolic syndrome and BMI in Taiwanese adults without chronic hepatitis B or C. International Journal of Obesity.2009; 33:1309–1317.
[44]. Bakari A G, Onyemelukwe G C, Sani B G, Aliyu I S, Hassan S S, Aliyu T M. Relationship between random blood sugar and body mass index in an African population Int J Diabetes & Metabolism.2006; 14: 144-145.
[45]. Nsagha D S, Pokam B T, Assob J C N, Njunda A L, Kibu O D, Tanue E A et al. HAART, DOTS and renal disease of patients co-infected with HIV/AIDS and TB in the South West Region of Cameroon. BMC Public Health. 2015; 15: 1040.