Sonographic Evaluation of Renal Changes and their Correlation with CD4⁺ count among Human Immunodeficiency Virus Sero-positive Pregnant Women in Kano, Nigeria

Original Article

[1]Aliyu Abdullahi Hassan, [2]Joseph Chukwuemeka Eze, [3]Mohammed Sidi, [4]Anas Ya'u, *[4]Umar Mansur, [4]Abubakar Aminu Abubakar [1]Abdu Hamisu Dambatta, [1]Mansur Yahuza, [5]Sha'awa Abdullahi Mahmud

[1]Radiology Department, Aminu Kano Teaching Hospital (AKTH) Kano, Nigeria, [2]Department of Radiography/Radiological Sciences, Nnamdi Azikiwe University, Awka, Nigeria, [3]Department of Radiography and Radiation Sciences, Federal University of Health Sciences, Azare, Nigeria, [4]Department of Medical Radiography, Bayero University Kano, Nigeria, [5]Radiology Department, Murtala Muhammed Specialist Hospital, Kano, Nigeria

Corresponding author: umansur.radg@buk.edu.ng +2348034280010

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ABSTRACT

Background: The prevalence of Human Immunodeficiency Virus among pregnant women in Nigeria remains a major public health challenge with serious medical, economic, and social impact.

Aim. This study was aimed at evaluating renal changes and their correlation with CD^4 count among HIV sero-positive pregnant women in Kano, Nigeria.

Methods: A prospective cross-sectional work carried out from April 2021 to March 2022. A purposive sampling method was employed and included 196 patients. Mindray digital ultrasound machine with 3.5 MHz transducer was used as an instrument for data collection. The patients were scanned in supine and lateral decubitus positions. Data was analyzed using SPSS version 25.0. with a level of significance set at $\rho < 0.05$.

Results: The mean values of the right renal volume for the 1st, 2nd, and 3rd trimesters were 148.8 ±25.8cm^3, 168.1 ±35.6cm^3, and 185.2±35.8cm^3 respectively whereas the left renal volumes were 163.7 ±31.1cm^3, 182.4 ±40.2cm^3, 199.3 ±38.4cm^3. In 3rd trimester, patients had 4.55% and 1.52% increased renal parenchymal echogenicity on the right and left kidneys, respectively. A statistically significant difference in renal dimensions between trimesters was observed ($\rho < 0.05$). There was statistically significant weak positive correlation of right and left renal dimensions with anthropometric variables (r = 0.17- 0.25).

Conclusion: This study has established reference values for renal dimensions among HIV/AID seropositive pregnant women. A statistically significant difference in renal dimension between Trimesters was observed. The Renal dimensions had a week positive correlation with the anthropometric variables.

Keywords: HIV/AIDS, Kano, Pregnant women, Ultrasonography

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Introduction

Human Immunodeficiency Virus (HIV) is a ribonucleic acid (RNA) retrovirus that causes HIV infection by attacking the immune system of the human body, mainly the T-Lymphocytes, thereby predisposing the infected individual to infectious disease. And if not treated, it leads to acquired immunodeficiency syndrome (AIDS) [1]. Acquired immune-deficiency syndrome **(**AIDS**)** is a set of life-threatening diseases defined by severe immune deficiency, usually when the $CD4^+$ cell count is below 200 cells/mm^3 or if there is one or more opportunistic infections or cancers [2]. Human Immunodeficiency Virus-Associated Nephropathy (HIVAN), a renal parenchymal disease, is associated with HIV/AIDS.

The pathogenesis of HIVAN is idiopathic; however studies have shown that it may be a result of direct infection of the renal cells with HIV or as a result of the changes due to the release of cytokines as a result of the HIV infection [3]. Human Immunodeficiency Virus/acquired immunodeficiency syndrome (HIV/AIDS) among pregnant women remains a major global public health challenge with serious medical, economic, and social impact [4]. As at the end of 2024, more than 21 million women aged 15 years and above were living with HIV/AIDS globally, with 240,000 mortalities from HIV related causes. While 530, 000 new cases were reported [5]. In Nigeria, the estimated prevalence of HIV infection among pregnant women was 7.22% [4].

Ultrasound is a reliable, non-invasive, available, and cost-effective method for renal investigations, Especially during anti-natal checkup, because it has no adverse effects on the developing fetus and uses no ionizing radiation [6]. It allows clear visualization of the kidney in various planes, including the sagittal and transverse planes, both at rest and during dynamic maneuvers. Renal diseases are diagnosed at sonography using a combination of changes in renal size and parenchymal echogenicity [7]. Change in kidney size is an indicator of several physiological and pathological conditions, including HIVAN, diabetes mellitus, and chronic electrolyte imbalances [8]. The renal volume and length are shown to be the parameters that are affected by pregnancy and serve as important parameters used to assess the health of the kidneys during pregnancy [9].

In standard practice, all HIV-infected patients shall be screened for kidney disease at the time of HIV diagnosis or entry into care, and ultrasonography is one of the screening tools used [7]. This is imperative among HIV infected pregnant women, because early detection of kidney diseases, particularly 'HIVAN', is paramount in the management of HIV infection, which may allow for early intervention aimed at reducing morbidity and mortality during pregnancy. An intensive literature review shows that there is a paucity of data on renal dimensions as it correlates with anthropometric variables among HIV infected pregnant women. Hence, this prompted the researchers to conduct this study. The findings of this study will serve as a guide to radiologists, radiographers, and physicians in the diagnosis and management of pathological conditions affecting the kidneys during pregnancy among HIV infected women. This study was aimed at evaluating renal changes and their correlation with CD^+ count among Human immunodeficiency virus sero-positive pregnant women in Kano, Nigeria.

Materials and Methods

This was a prospective cross-sectional study conducted among HIV sero-positive pregnant women at Aminu Kano Teaching Hospital (AKTH) in Kano Nigeria, from April 2021 to March 2022. Ethical clearance to conduct the study was obtained from the Human Research and Ethics Committee of AKTH. Informed consent was obtained from each patient. A purposive sampling method was employed and included 196 patients (60 first trimester, 70 second trimester and 66 third trimester). The sample size of 196 was obtained using Cochran formula [10]. Pregnant women living with HIV/AIDS, aged from 18 to 45 years were included in the study. Exclusion included patients with a history of acute or chronic Hepatitis A, B or C infection, diffuse fatty liver disease, CCF, patients with cystic or solid renal

mass, patient with pre-existing renal disease, hypertension, and diabetes in keeping with a previous work [11]. Mindray digital diagnostic ultrasound imaging system, (Expert DC–6 model and P/N: 2111-CT0-S01) equipped with a 3.5MHz curvilinear transducer and electronic calipers were used for data collection.

The intra-operator variability was tested and there was high agreement (0.81). During the intra-operator variability testing one radiographer performed the scan on two separate occasions at interval of at least 2 minutes measurements. The patients laid supine on a couch with the radiographer on the right side of the patient. An ultrasound gel was applied to the patient's flanks. The right kidney was examined in supine position through the liver by angling the transducer obliquely, in keeping with the methods by Sidi, et. al [7]. In situations where there might be mild hydronephrosis which may be caused by mechanical compression of the bulky uterus, the patient was positioned in left decubitus for at least 5mins to relieve the weight of the pregnancy on the ureters. The probe was continuously manipulated until the appropriate coronal section was acquired.

With patient in the right decubitus, the arm was extended over the head, and using coronal approach the left kidney was visualized through the spleen [6]. The ultrasound machine automatically displayed the values of the renal volume, whenever the length, w
The data were assessed for normality test using the Shapiro Wilk test (p > 005). All data were treated as parametric. Both descriptive and inferential statistics were applied for the data analysis. The means, standard deviations, and ranges were obtained using descriptive statistics. Paired sample *t-test* used to compare the mean values between right and left renal dimensions. One-way ANOVA was used to compare the mean values of the renal dimensions, and $CD4^+$ cells count between different trimesters. Pearson's correlation was used to correlate the renal dimensions with anthropometric variables, and renal echogenicity with $CD4^+$ respectively. The data was analyzed using Statistical Package for Social Sciences (IBM SPSS) Version 22.0. Statistical level of significance was set at $p < 0.05$.

Results

The mean ± SD of the right renal volume for the 1st, 2nd, and 3rd trimesters were 148.8 ±25.8cm^3, 168.1 ±35.6cm^3, and 185.2±35.8cm^3 respectively whereas the left renal volumes were 163.7 ±31.1cm^3, 182.4 ±40.2cm^3, 199.3 ±38.4cm^3. In 3rd trimester, patients had 4.55% and 1.52% increased renal parenchymal echogenicity on the right and left kidneys, respectively. The mean ± SD of the CD4 cell count for the 1st, 2nd, and 3rd trimesters were 571.5 ± 197.9 Count/µL, 628.9 ± 208.2 Count/µL, and 561.9 ± 196.8 Count/µL respectively. A statistically significant difference in renal dimensions between trimesters was observed ($\rho < 0.05$). There was statistically significant weak positive correlation of right and left renal dimensions with anthropometric variables (r = 0.17- 0.25).

Table 1: Anthropometric variables among HIV seropositive pregnant women;

Table 2: Renal dimensions among HIV seropositive pregnant women;

Table 3: Renal parenchymal echogenicity grading among HIV seropositive pregnant women;

Table 4: $CD4^+$ cell count among HIV seropositive pregnant women;

Table 5: Comparison of renal dimensions between Right and Left kidneys among HIV seropositive pregnant women;

Table 6: Comparison of renal dimensions between trimesters among HIV seropositive pregnant women using one-way ANOVA;

Table 7: Comparison of $CD4^+$ cell count between the trimesters among HIV seropositive pregnant women using one-way ANOVA;

Table 8: Correlation of renal dimension with anthropometric variables among HIV seropositive pregnant women;

Table 9: Correlation of renal dimensions with $CD4^+$ cell count among HIV seropositive pregnant women;

Table 10: Correlation of renal parenchymal echogenicity with CD4+ cells count among HIV seropositive pregnant women.

Table 1: Demographic Variables of the patients

Variables	Trimesters			
	1st (n = 60)	2nd (n = 70)	3rd (n = 66)	Total (n = 196)
Age (year)	27.98±5.37	27.46±5.56	28.08±5.82	27.83±5.57
Height (cm)	160.95±4.42	160.67±6.13	161.06±5.47	160.89±5.40
Weigt (Kg)	62.37±14.12	58.68±9.29	63.96±10.32	61.59±11.47
BMI (Kg/m^2)	24.11±5.60	22.77±3.62	24.71±4.19	23.84±4.55
BSA (m^2)	1.66±0.19	1.61±0.13	1.69±0.14	1.65±0.16

Data is presented as mean ± SD. Key: BMI: Body mass Index BSA: Body surface area.SD: Standard deviation

Table 2: Renal dimensions and volume among HIV seropositive pregnant women

Trimesters	Right Kidney				Left Kidney			
	L(cm)	H(cm)	W(cm)	V(cm^3)	L(cm)	H(cm)	W(cm)	V(cm^3)
1st	10.4 ±0.6	6.1 ±0.4	4.5 ±0.4	148.8 ±25.8	10.9 ±0.8	6.2 ±0.5	4.6 ±0.4	163.7 ±31.1
2nd	10.7 ±0.9	6.5 ±0.7	4.6 ±0.4	168.1 ±35.6	11.1 ±0.7	6.4 ±0.6	4.8 ±0.6	182.4 ±40.2
3rd	11.2 ±0.8	6.4±0.6	4.9 ±0.5	185.2±35.8	11.5 ±0.7	6.7 ±0.7	4.9 ±0.5	199.3 ±38.4
Total	10.8 ±0.8	6.4 ±0.6	4.7 ±0.4	168.0 ±35.0	11.2 ±0.8	6.5 ±0.6	4.8 ±0.5	182.3 ±38.6

Data is presented as mean ± SD; L = Length, H = Height, W = Width,

Table 3: Renal parenchymal echogenicity grading among HIV seropositive pregnant women

Trimesters	Right Kidney Grades n (%)						Left Kidney Grades n (%)					
	0	I	II	III	IV	Total	0	I	II	III	IV	Total
1st	60(100)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	60(100)	60(100)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	60(100)
2nd	70(100)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	70(100)	70(100)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	70(100)
3rd	63(95.5)	0(0.0)	3(4.5)	0(0.0)	0(0.0)	66(100)	65(98.5)	1(1.5)	0(0.0)	0(0.0)	0(0.0)	66(100)

Data is presented as frequency and percentage. n = number of patients, % = percentage

Table 4: Mean distribution CD4+ cell count of the patients

CD4+ (Count/µL)	Trimesters			
	1st (n = 60)	2nd (n = 70)	3rd (n = 66)	Total (n = 196)
	571.5 ± 197.9	628.9 ± 208.2	561.9 ± 196.8	588.8 ± 202.5

Table 5: Comparison of renal dimensions between Right and Left kidneys among HIV seropositive pregnant women

Renal dimension	Right Kidney	Left Kidney	p-value
Length (cm)	10.8 ± 0.8	11.2 ± 0.8	0.000
Height (cm)	6.4 ± 0.6	6.5 ± 0.6	0.111
Width (cm)	4.7 ± 0.4	4.8 ± 0.5	0.004
Volume (cm^3)	168.0 ± 35.0	182.3 ± 38.6	0.000

RRL = Right Renal Length, RRH = Right Renal Height, RRW = Right Renal Width RRV = Right Renal Volume. LRL= Left Renal Length, LRH = Left Renal Height, LRW = Left Renal Width, LRV = Left Renal Volume

Table 6: Comparison of renal dimensions between trimesters among HIV seropositive pregnant women using one-way ANOVA

Renal Dimensions	Right Kidney				Left Kidney			
	Length	Heigh	Width	Volume	Length	Heigh	Width	Volume
F* ratio	20.1	7.0	12.9	18.0	10.2	9.5	5.5	13.6
P	0.000	0.001	0.000	0.000	0.000	0.000	0.005	0.000

Table 7: Comparison of CD4⁺ cell count between the trimesters among HIV seropositive pregnant women using one-way ANOVA

Laboratory variable	F* ratio	*P*
CD4⁺ (count/µL)	2.2	0.110

Keys: ** = Correlation is significance at the 0.01 level (2 tailed), * = Correlation is significance at the 0.05 level (2 tailed)

Table 8: Correlation of renal dimension with anthropometric variables among HIV seropositive subjects

Anthropometric variables											
Renal Dimensions	**Age**		**Weight**	**Height**	**BMI**		**BSA**				
	R	**p**	**R**							**p**	**r**
	p	**R**	**p**	**R**	**p**						
RRL (cm)	**0.03**	**0.671**	**0.18**	**0.011***	**0.15**	**0.038***	**0.13**	**0.075**	**0.19**	**0.009****	
RRH (cm)	**0.03**	**0.665**	**0.25**	**0.000****	**0.06**	**0.379**	**0.24**	**0.001****	**0.23**	**0.001****	
RRW (cm)	**0.08**	**0.261**	**0.09**	**0.209**	**0.03**	**0.208**	**0.09**	**0.208**	**0.08**	**0.243**	
RRV (cm3)	**0.03**	**0.718**	**0.24**	**0.001****	**0.11**	**0.112**	**0.21**	**0.003****	**0.23**	**0.001****	
LRL (cm)	**0.11**	**0.110**	**0.10**	**0.182**	**0.03**	**0.639**	**0.09**	**0.208**	**0.09**	**0.201**	
LRH (cm)	**0.05**	**0.462**	**0.15**	**0.034***	**0.06**	**0.434**	**0.14**	**0.048***	**0.15**	**0.041***	
LRW (cm)	**0.03**	**0.656**	**0.14**	**0.043**	**0.04**	**0.544**	**0.14**	**0.046***	**0.14**	**0.059**	
LRV (cm3)	**0.10**	**0.185**	**0.18**	**0.010***	**0.07**	**0.334**	**0.17**	**0.015***	**0.18**	**0.013***	

Table 9: Correlation of renal dimensions with CD4⁺ cell count among HIV seropositive pregnant women

Renal Dimension	CD4⁺ (count/µL)	
	R	***P***
Right Renal Length (cm)	0.01	0.877
Right Renal Height (cm)	0.15	0.042
Right Renal Width (cm)	0.09	0.218
Right Renal Volume (cm³)	0.10	0.179
Left Renal Length (cm)	0.01	0.948
Left Renal Height (cm)	0.08	0.286
Left Renal Width (cm)	0.08	0.239
Left Renal Volume (cm³)	0.08	0.260

Table 10: Correlation of renal parenchymal echogenicity with CD4⁺ cells count among HIV seropositive pregnant women.

Renal Echogenicity	CD4⁺ (count/µL)	
	R	***P***
Right Renal Length (cm)	0.071	0.810
Right Renal Height (cm)	0.102	0.155

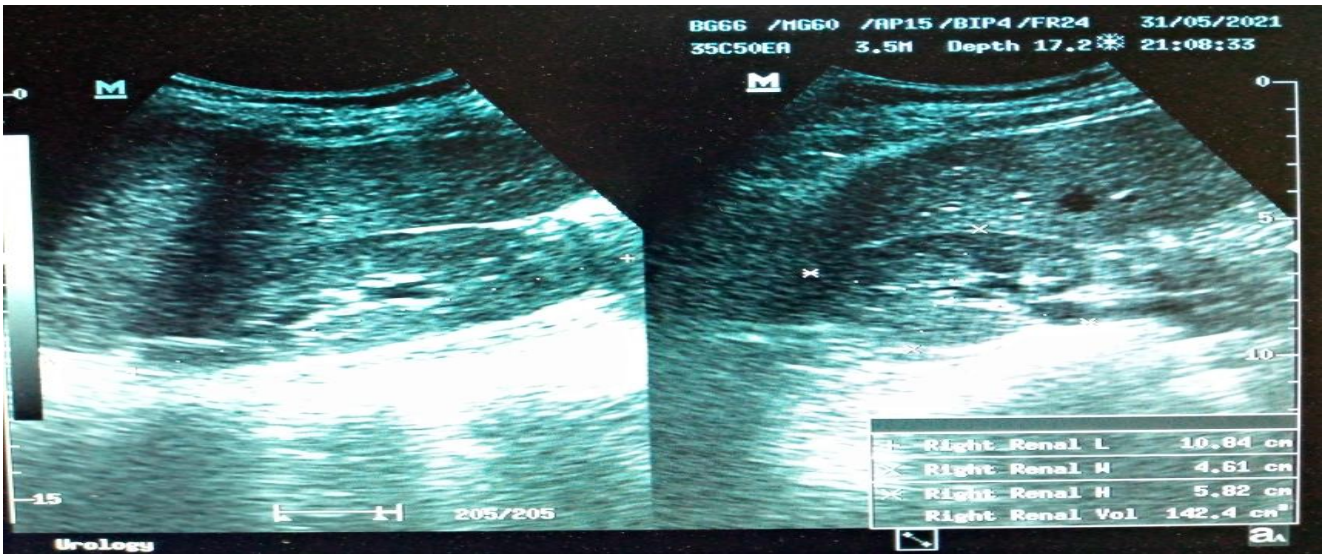

Figure 1.0: Shows sonogram of the right renal dimensions from both longitudinal and transverse plane.

Discussion

There was paucity of data on sonographic renal changes among pregnant women with HIV, nonetheless, a related study conducted by Ugochinyere *et al.* (2021) [12] on pregnancy induced hypertensive and normotensive women in Enugu, reported higher renal volumes in pregnancy induced hypertension than what was reported in this study. This difference might be due to increase in arterial blood pressure which may result in further increase in glomerular filtrate rate and interstitial space volume. Furthermore, Eze *et al.* (2017) [13] and Sidi *et al.* (2020) [7] reported a lower renal volume among HIV non-pregnant women than the renal volume in the current study. This difference might be due to renal physiologic changes in pregnancy which include increased in vasculature of the kidneys, they reported smaller mean renal volume than the mean renal volume reported in this study. This difference might be due to renal physiologic changes in pregnancy which include increased in vasculature of the kidneys, interstitial volume, and urinary dead space (Ugochinyere *et al.,* 2021) [12].

Similarly, a related study conducted by Kedir *et al.* (2020) [14] on hypertensive and normotensive non-pregnant women reported a finding contrary to the current findings with regard to renal length, width and volume in which they reported lower values. The possible reason for the difference might be due to

renal physiologic changes in pregnancy. However, racial, dietary, environmental and socioeconomic differences might also explain the difference. Jovanovic *et al.* (2013) [15] conducted a study involving healthy subjects and patients with chronic renal disease, reporting a mean length among patient with chronic renal disease similar to what was reported in this study. Furthermore, a related study by Desta *et al.* (2020) [16] on diabetic non pregnant women reported similar renal length and width to what was reported in the current study. However, The possible reason for the difference in renal volumes between the studies might be partly due to differences in pathological condition and partly due to renal physiological changes in pregnancy.

Ugochinyere *et al.* (2021) [12] reported higher renal size among hypertensive pregnant women compared to what was reported in this study. This is because, despite the fact that diabetic and hypertensive patients are characterized with hyperfiltration-induced nephromegaly (Zira, 2017) [17], yet renal size further increased during pregnancy due to changes in renal hemodynamic and tubular function.

The findings of the current study as show in Table 3 were in agreement with the study conducted by Sidi *et al.* (2020) [7]. This similarity may be due to the fact that both studies are conducted in the same study location. However, the findings were contrary to the finding of the studies conducted by Akimbami *et al.* (2015) [18] and Myer *et al.* (2013) [19]. The reason for the difference might be due to racial, socioeconomic or ethnic differences. The findings of this study as show in Table 4 were similar to a related studies conducted by Sidi *et al.* (2021) [11] and Gwom *et al.* (2021) [20]. These similarities might be due to the fact that both studies were conducted in the same location and the study population might be of the same socioeconomic status. Furthermore, this study reported highest mean CD4 cell count was reported in second trimester among HIV seropositive subjects followed by first and third trimesters respectively.

Findings of this study, as shown in Table 5 demonstrated that, a statistical significant difference between right and left renal length and volume across the entire trimesters. This was in agreement with related studies by Kamble and Kohar, (2017) [6] and Ugochinyere *et al.,* (2021) [12]. The similarity might be due to natural anatomical difference between right and left kidney. More so, the findings of this study as shown in Table 6 demonstrated a statistical significant difference in renal dimensions between different trimesters. The possible reason might be due to the progressive renal physiologic changes associated with pregnancy as the pregnancy advance [21, 12].

The findings of the current study as shown in Table 7 revealed no statistical significant difference in CD4 cell count between the trimesters. This might be due to the fact that all the selected patients were on active antiretroviral drugs.

As shown in Table 8 a statistical significant weak positive correlation between the right and left renal volume with weight, BMI and BSA was observed. A similar result was obtained in the right renal length with weight and BSA and right renal height with weight, BMI and BSA. Furthermore, significant weak positive correlation was observed in left renal height and width with weight. This agreed with the findings of a related study conducted by Desta *et al.* (2020) [16]. However, the findings of this study disagree with the findings of the related studies conducted by Jovanovic *et al.* (2013) [15] and Kedir *et al.* (2020) [14]. The possible reasons for the disagreement could be due to the fact that chronic kidney and hypertension are generally associated with increased in size especially in advance situation with corresponding loss of weight.

Findings of this study, as shown in Table 9 revealed a statistical significant weak positive correlation between renal height and CD4 cells count was observed. However, non-significant weak positive correlation between right and left renal length, width and volume and the CD4 cell count was observed. This is contrary to the findings of a related study conducted by Sidi *et al.* (2020) [7] that reported no significant weak positive correlation and weak negative correlation between right and left renal

volume and CD4 cells count respectively among drug dependent HIV women.

The findings of this as shown in Table 10 showed a weak positive correlation between the renal echogenicity and $CD4^+$ cells count among HIV pregnant women. This is contrary to the finding of the related studies conducted by Eze *et al.* (2018) (13), Abinaiye *et al.* (2014), (22) and Gwom *et al.* (2021) [20]. This difference might be due to the fact that the subjects involved in the previous studies were predominantly patient with HIVAN.

Conclusion

Reference values for renal dimensions, and $CD4^+$ cells count were established among HIV/AIDS seropositive pregnant women in Kano Metropolis Nigeria. There was a statistical significant difference in renal dimensions between trimesters. A week significant positive correlation between renal dimensions and anthropometric variables was observed.

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