**ABSTRACT**

**Introduction**: Renal Doppler resistive index (RI) and pulsatility index (PI) values are potentially more sensitive at detecting renal abnormalities when compared to standard laboratory indices in patients with HIV/AIDS. To the best of our knowledge, there are no published research articles on renal Doppler indices and their correlation with laboratory indices of HIV sero-positive adult individuals. This study was aimed at assessing the renal function of the HIV-sero-positive adults using RI and PI, and correlating them with laboratory indices.

**Methods**: A prospective cross-sectional study was conducted from July 2019 to April 2020. A purposive sampling method was employed and included 396 HIV sero-positive adult individuals. Sampling for the renal RI and PI was performed at the level of the inter-lober arteries, in between the medullary pyramids. An RI value above 0.70 and a PI value above 1.56 were considered abnormal. Serum creatine and urea together with evidence of proteinuria were recorded at the time of scanning.

**Results**: Forty-three (10.9%) men had an abnormal RI, 32 (8.1%) had abnormal PI, five (2.5%) had abnormal creatinine, two (1%) abnormal urea and eight (4.1%) with proteinuria. In women, 29 (7.3%) had abnormal RI, 22 (5.6%) abnormal PI, four (2%) abnormal creatinine and urea and six (3%) had proteinuria. There was a statistically significant weak positive correlation between RI and PI and serum creatinine and urea (r˃0.2, P˂0.05).

**Conclusion**: The proportion of patients with abnormal RI and PI was higher than the proportion of participants with abnormal serum urea, creatinine and proteinuria. Renal Doppler indices may have a role in the early assessment of renal function in HIV sero-positive adult individuals.

**Implications for practice:** Serum creatinine and urea are routinely used to evaluate renal function in patients with HIV/AIDS. Findings from this initial study show that RI and PI could potentially be more sensitive to detecting early renal abnormalities when compared to standard laboratory values.

**Introduction**

Human Immunodeficiency Virus (HIV) is a lentivirus that causes HIV infections and over time, if not treated, leads to Acquired Immunodeficiency Syndrome (AIDS)1. AIDS is a condition in humans in which progressive failure of the immune system allows life-threatening infections and cancers to thrive. Without treatment, average survival time after infection is estimated to be 9-11 years, depending on the HIV subtype2. HIV infects vital cells in the human immune system such as helper T cells, macrophages and dendritic cells3. People with HIV infection plus elevated viral loads or low CD4 are more likely to have chronic kidney disease.4Patients with HIV/AIDS receiving antiretroviral therapy live longer compared to drug naïve patients with HIV/AIDS, but kidney diseases have emerged as significant causes of morbidity and mortality4.

Doppler ultrasound has been extensively used in renal diseases, both in diagnostic, prognostic and therapeutic assessments due to the non-invasive, safe and low-cost method for the evaluation of the renal blood flow5. Several studies have documented grayscale sonographic renal changes in adult patients with HIV/AIDS.6,7,8 However, most of the grayscale sonography morphological features are observed in the later course of the disease9. Resistive index (RI) is commonly used as a measure of intrarenal arterial resistance. Several factors can influence RI independent of renal disease, including heart rate, vessel wall compliance, and systemic vascular resistance. A mean±RI value of 0.60±0.01 (mean ± SD) is usually taken as normal in adults with a value of 0.70 being considered the upper normal threshold10. Pulsatility index (PI) is a measure of the variability of blood velocity in a vessel, equal to the difference between the peak systolic and minimum diastolic velocities divided by the mean velocity during the cardiac cycle. The normal value of PI is 1.36–1.5611and has been found to correlate with renal vascular resistance, filtration fraction and effective renal plasma flow in chronic renal failure12. To the best of our knowledge, there are no published research articles on renal Doppler indices and their correlation with laboratory indices of HIV sero-positive adult individuals.

With improved survival afforded by highly-active antiretroviral therapy (HAART), chronic kidney disease has emerged as one of the primary comorbid conditions affecting HIV infected individuals. Increasing age has been associated with a decline in renal function.13 HIV associated nephropathy (HIVAN) usually occurs only in advanced cases of HIV infection and approximately 80% of patients with HIVAN have a CD4 count of less than 200 cells/mm3. Individuals with HIVAN usually presents with nephrotic syndrome and progressive kidney failure. Serum urea and creatinine are routinely used for the evaluation of renal function in patients with HIV/AIDS, either at the point of diagnosis or monitoring during during antiretroviral therapy. Early recognition of kidney diseases and diagnosis of the underlying cause is imperative in the management of individuals with HIV infection13.Sonographic RI and PI values may serve as early radiologic predictors of renal pathologic changes and as a prognostic indicator in patients with HIV/AIDS,14. This would be important in determining the necessity of early intervention in preventing or halting the progress of HIVAN14. This study was aimed at assessing the renal function of the HIV-sero-positive adults using RI and PI, and correlating them with laboratory indices.

**Materials and Methods**

A prospective cross-sectional study was conducted among HIV sero-positive adult individuals on highly active antiretroviral therapy from July 2019 to April 2020 at Aminu Kano Teaching Hospital, Kano, Nigeria. Ethical approval was obtained from the local Human Research and Ethics Committee. Informed consent was obtained from participants.

A purposive sampling method was employed and included 396 patients (198 males and 198 females). The sample size was calculated using the Magnani formula15as shown below: the formula used because the sample was derived from infinite population.



Where n = desired sample size

Z = the standard normal Z-Score = 1.96

P= population with the desire characteristics

m = margin error 5% (0.05)



= 384.16

The obtained sample size was increased to 396.

Adult patients living with HIV/AIDS, aged from 18-65 years were included in the study. All the studied participants were black Africans, therefore, at risk of developing HIVAN.13 The age of the participants in the study varied from 18 to 65 years. The duration of the antiretroviral therapy of the participants ranged 1 to 9 years (7.6 SD 4.5). Exclusion criteria included patients with a history of acute or chronic hepatitis B or C infection, patients with pre-existing renal diseases, diabetes, hypertension13, pregnant women, that were unable to hold their breath during the ultrasound scan and patients with abnormal greyscale renal parenchymal echogenicity.

A Sonoscape SSI–8000, 2014 digital colour Doppler ultrasound system (Sonoscape, Schenzhen, China), equipped with a 3.5MHz curvilinear transducer and electronic calipers were used for data collection. Inter- and intra-operator variability was tested and there was high agreement in each case (0.88 and 0.82). During the inter-operator variability testing two radiologists performed renal Doppler scans independently, at interval of at least 2 minutes between measurements without knowing the result of one another. In testing the intra-operator variability one radiologist performed the scan on two separate occasions at interval of least 2 minutes between measurements.

The protocol for generating renal Doppler indices, described by Viazzi et al.10, was adopted in this study and two operators performed the Doppler scan on the participants. Measurements were taken three times each; at the upper pole, middle portion and the lower pole, the average value of the three portions was recorded as the RI and PI of the kidney. The upper limit of RI and PI are 0.70 and 1.56 respectively. On completion of the renal Doppler scan, the patient was accompanied to the laboratory where a sample of blood and urine was collected for CD4+ count, serum creatinine and urea determinations, together with the presence of proteinuria. Usually, the CD4 lymphocyte count falls below 200 cells/ml of blood in advanced cases of the disease.16 If the normal functions of kidney failed, the plasma concentrations creatinine and urea are increased in the blood. As a result, they are used to determine renal function.17 Creatinine is commonly used as a measure of kidney function; the normal creatinine value is 72-106 mmol/L.18 The diagnosis of renal failure is usually suspected when serum creatinine is greater than the upper limit of the “normal” interval. The most frequently determined clinical indices for estimating renal function depends upon concentration of urea in the serum. The normal value is 2.5-3.5 mmol/L.18 Proteinuria is one of the earliest indicators of various types of kidney disease, indicating a disturbance of glomerular basement membrane permeability or renal tubular reabsorption.17

Data were analysed using the Statistical Package for Social Sciences SPSS V.22 (IBM SPSS, Armonk, NY). P values of less 0.05 were considered statistically significant. Data were assessed for normality using the Kolmogorov-Smirnov test (*P˃0.05*). All data were treated as parametric. Means, standard deviations (SD) and the range of the RI, PI, serum creatinine and urea were reported. Differences RI and PI, between males and females, were evaluating statistically using an independent t-test. Correlations were also reported using the Pearson’s r statistic.

**Results**

The mean±SD of age, weight, height, body mass index (BMI) and body surface area (BSA) for men was 42.7±11.2 years, 66.2±10.1 Kg, 167.8±5.1 cm, 23.4±2.9 Kg/m2 and 1.75 ± 0.14 m2, while the range was 19-63 years, 42-95 Kg, 152-200 cm, 14.20 Kg/m2 and 1.42-2.32 m2. The mean and SD of the age, weight, height, BMI and BSA for the females was 40.6±10.8 years, 61.5±11.5 Kg, 160.7±4.6 cm, 22.9±3.9 Kg/m2 and 1.7±0.14 m2, while the range was 19-52 years, 32-116 Kg, 152-183 cm, 11.84-40.10 Kg/m2 and 1.27-2.24 m2.

Table 1 shows the mean and SD values for the right and left RI and PI, CD4+, creatinine and urea for men was 0.64±0.04, 0.64±0.04, 1.38±0.12, 1.37±0.12, 567.59±230.52 cells/mm3, 68.84±19.50 mmol/L, and 3.14±1.08 mmol/L, respectively. For women these values were 0.63±0.04, 0.63±0.04, 1.33±0.16, 1.32±0.14, 583.89±239.47 cells/mm3 61.36±18.36 mmol/L, 2.98±1.16 mmol/L, respectively. Over five percent 11(5.7%) of the male participants presented with abnormal renal parenchymal echogenicity and 8(3.9%) abnormal renal parenchymal echogenicity was observed in female participants.

Table 2 shows that 89.1% of the men studied had a normal RI, while 10.9% of an abnormal RI was observed. Ninety two percent presented with normal PI, while 8.1% had an abnormal PI. For women, 92.7% presented with normal RI while 7.3% had an abnormal RI, 94.4% normal PI was observed while 5.6% presented with an abnormal PI.

Table 3 shows that 97.4% of the men presented with normal serum creatinine, 99% had normal serum urea and 89.8% their urine tested negative for protein. Furthermore, 2.6% and 1% had abnormal serum urea and creatinine and 11.2% their urine tested positive for protein. For women, 98% presented with normal serum creatinine and urea respectively, 92.3% their urine tested negative for protein. Furthermore, 2% had abnormal serum creatine and urea respectively and 7.7% their urine tested positive for protein.

Figure 2 shows that 60.7% of the men studied presented with CD4+ counts greater than 500 cells/mm3, 32.1% had CD+ counts of 200-499 cells/mm3 and a CD4 counts of less than 200 cells/mm3, was observed in 7.2% of the participants. For women, 60.6% presented with CD4+ counts greater than 500 cells/mm3 32.7% had CD+ counts of 200-499 cells/mm3 and a CD4 counts of less than 200 cells/mm3, was observed in 7.7% of the participants. Group 1, is considered normal, group 2, mild to moderate and group 3 severe as relates to the severity of the HIV infection.

Table 4 shows a statistical significant differences in right and left RI between males and females (*p*=0.017, *p*=0.038). A statistical significant difference in right and left PI was also observed between males and females (*p* =0.001, *p* <0.001)**.**

Table 5 shows a statistical significant difference in serum ceatinine between males and females (ρ=0.002). However, no significant difference in CD4 counts and urea was observed between males and females.

Table 6 shows a statistical significant difference in RI and PI between the participants with normal and abnormal serum creatinine, urea and urine protein (ρ˂0.05).

Table 7 shows a significant moderate positive correlation between the RI and PI with the age of the participants (*r*=0.690, ρ˂0.001 and *r*=0.775, ρ=0.001). However, no correlation was observed between the RI and PI and the duration of the antiretroviral therapy (*r*=0.005, ρ=0.946 and *r*=0.012, ρ=0.875).

Table 8 shows a significant moderate positive correlation was observed between the right and left RI with creatinine (*r*=0.235, ρ=0.000 and *r*=0.490, ρ=0.000) and, the right and left PI with creatinine (*r*=0.240, ρ=0.001 and *r*=0.268, ρ=0.000) in male participants. A significant moderate positive correlation was also observed between the right and left RI with serum urea (*r*=0.272, ρ=0.000 and *r*=0.245, ρ=0.000) and, the right and left PI with serum urea (*r*=0.212, ρ=0.003 and *r*=0.226, ρ=0.001). However, a weak positive correlation was observed between the right and left PI with CD4 counts (*r*=0.122, ρ=0.086 and *r*=0.119, ρ=0.096), but no correlation was observed between the right and left RI with CD4 counts (*r*=0.017, ρ=0.809 and *r*=0.017, ρ=0.810). Furthermore, a significant moderate positive correlation was observed between the right and left RI with creatinine (*r*=0.262, ρ=0.000 and *r*=0.227, ρ=0.001) and, the right and left PI with creatinine (*r*=0.240, ρ=0.001 and *r*=0.268, ρ=0.000) in female participants. A moderate positive correlation was also observed between the left RI and CD4 urea (*r*=0.210, ρ=0.007), but, a weak positive correlation between the right RI and urea (*r*=0.180, ρ=0.011), however, no correlation was observed between the right and left PI with the serum urea (*r*=0.020, ρ=0.003 and *r*=0.046, ρ=0.517). A weak positive correlation was also observed between the left PI and CD4 counts (*r*=0.108, ρ=0.978), but, no correlation was observed between the right PI, right and left RI with the CD4 counts (*r*=0.015, ρ=0.289; *r*=0.046, ρ=0.517; *r*=0.087, ρ=0.221 and *r*=0.091, ρ=0.202).

**Discussion**

Findings of this study show that mean age, BMI and BSA were comparable to what was reported by Sidi *et al*.6. In the study by Sidi *et al.*6 mean age, BMI and BSA were 42.87±10.1 years, 25.27±3.9 Kg/m2 and 1.72±0.20 m2 for male selected subjects and 35.87±9.9 years, 23.11±5.90 Kg/m2 and 1.60±0.22 m2 for females, respectively. Possible reasons of the similarity might be because the two studies were conducted in the same geographical region and in the same disease condition. Findings from the current study were similar to those reported by by Eze *et al*.7; Atsukwei*et al*.8 where mean age was 42.7 ± 9.4 years and 40.30 ± 9.32, respectively. Participants’ height, as reported by Eze *at al*.7, were similar to that of our study, however, the mean weight and BMI (70.4 ± 10.8 kg, 41.4 ± 5.1 kg/m2), reported by Eze*et al*.7, was higher. Mean age reported by Garko *et al*.19 (35±10.79 years) was lower than that reported in our study, this might result from our larger sample size. However, the previous studies reported greyscale renal changes in patients with HIV/AIDS. Increased renal parenchymal echogenicity is one of the indicators of HIVAN, and if remains untreated can progressed to end stage renal failure.16 In this study male participants presented with increased renal parenchymal echogenicity more than their female counterparts, therefore could be considered more at risk of developing HIVAN.6

The mean ± SD of the RI of a normal adult individual is 0.60±0.01, however, many authors considered a value of 0.70 being considered the upper normal threshold7. In Table 1, the mean and SD reported was above 0.60±0.01 for both male and females. The possible reasons for abnormal mean and SD values could be because of mild renal pathology as a result of the viral infection or antiretroviral drugs. RI values reported for men was higher than that of the female subjects by 0.01, however, the values for the right and left kidneys were the same in both genders. In Table 1, the mean and SD of the PI was within the normal range of 1.36 - 1.5611. The values reported for male subjects were higher than that of the females and in both genders the values of the right kidney were higher than that of the left kidney. The RI values in this study were lower than values reported by the studies Sperandeo *et al.*20 (0.69) and Atalabi *et al*.21 (0.72) in hypertensive and diabetes patients respectively. However, we are unable to suggest or provide explanation why the values of the right kidney were higher than that of the left kidney. To the best knowledge of the researchers’ knowledge, there are no published articles on renal Doppler indices of patients with HIV/AIDS. Therefore, no previous published findings were available for comparison. Findings of this study, as shown in Table 1, highlight that the mean values of the CD4+ counts reported were greater than 500 cells/mm3in both genders. However, the value for females was slightly higher than the males. Findings of the study are again in agreement with the findings of the studies conducted by Sidi *et al*.6; Atsukwei *et al*.8, both reported mean CD4+ greater than 500 cells/mm3. However, the findings are contrary to the findings of the studies conducted by Eze *et al*.7; Prakash *et al*.22; Adeyekun et al23 that both reported mean CD4+ of less than 500 cells/mm3.

Findings of this study, as shown in Table 2, also demonstrate that the mean serum creatinine and urea reported are within the normal range; 72-111 mmol/L and 2.5-6.9 mmol/L respectively18. Findings are almost similar to what was reported by the studies conducted by Celestine *et al*.18; Obirikorang *et al*.24 that reported 64.06 ± 15.06 mmol/L, 3.31 ± 1.17 mmol/L and 77.07 ± 22.25 mmol/L, 3.43 ± 1.22 mmol/L. Furthermore, in Table 2, male subjects had a greater incidence of abnormal RI and PI than females, and in both genders the right kidney was more affected than the left kidney. Doppler derived indices increase in various kidney diseases, and previous studies have shown associations of the indices with renal function and patient prognosis11. Increased indices may thus reflect one or more of the pathological mechanisms such as arterioloscelerosis and interstitial fibrosis and these histopathological features have been reported in patients with HIVAN7.

Table 3 shows that the number of the men with abnormal serum creatinine is greater than that of the females; however, the number with abnormal serum urea is the same for both genders. Findings of the study, as shown in Table 3, also show that the number of the men with proteinuria was greater than that for women. However, the number of the selected subjects with proteinuria was greater than that with abnormal serum creatinine and urea. The findings of our study show that the number of the selected subjects with abnormal renal Doppler indices was almost four times greater than those with abnormal serum creatinine and almost seven times that of abnormal serum urea. However, this was only slightly higher than those with proteinuria. Serum creatinine and urea, and the proteinuria are the common renal function tests being performed on patients with HIV/AIDS.25 However, the findings of this study show that some abnormal renal function missed by the laboratory indices was detected by the renal Doppler indices. This is critical in the management of patients with HIV/AIDS. The findings of this study (Figure 2) indicate that the majority of the selected subjects had CD4+ counts greater than 500 cells/mm3 with few subjects that had CD4+ of less than, 200 cells/mm3.

There was a statistical significant difference between the right and left RI and PI in males and females as shown in Table 4. A statistical significant difference in serum ceatinine was also observed between males and females as shown in Table 5. However, no significant difference in CD4 counts and urea was observed between male and female participants. A statistical significant difference was also observed in RI and PI between the participants with normal and abnormal serum creatinine and urea and urine protein as shown in Table 6.

There was a significant strong positive correlation between the RI and PI with the age of the participants. This was similar to the related study conducted by Dawha *et al*.26 on diabetic patients that reported strong positive correlation in RI and PI with age (r = 0.316, p = 0.04 and r = 0.339, p =0.03) . However, it was contrary to the related study conducted by Sperandeo *et al.* 20 that reported no relationship between RI and age (*p*˃0.05). Furthermore, a related study conducted by Isma’il *et al.*27 reported a statistical significant correlation between RI and age in normal adult participants. However, no correlation was observed between the RI and PI with the duration of the antiretroviral therapy (*r*=0.005, ρ=0.946 and *r*=0.012, ρ=0.875).

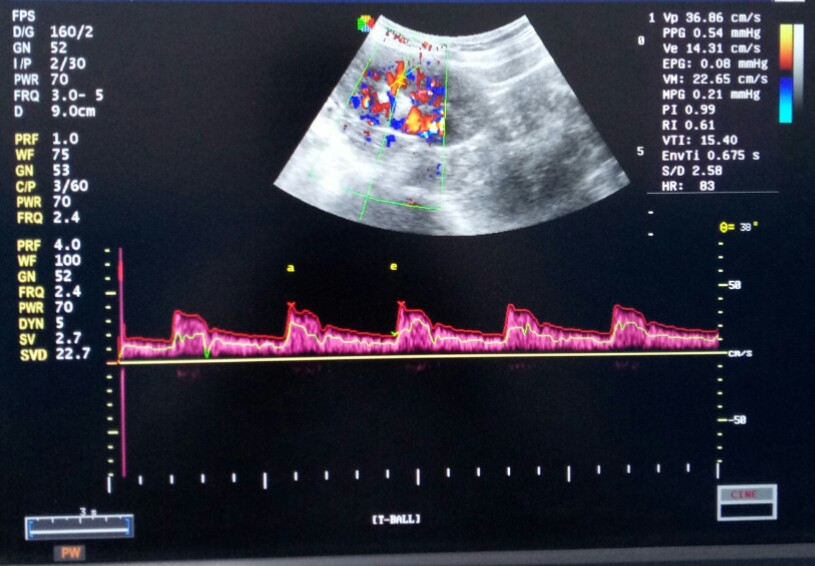
A significant moderate positive correlation was observed between the right and left RI and PI with serum creatinine and urea in male participants as shown in Table 8. However, a weak positive correlation was observed between the right and left PI with CD4 counts, but, no correlation was observed between the right and left RI with CD4 counts. Furthermore, a significant moderate positive correlation was observed between the right and left RI with creatinine in female participants as also shown in Table 8. A moderate positive correlation was observed between the left RI and CD4 urea, but, a weak positive correlation between the right RI and urea , but, no correlation was observed between the right and left PI with urea. A weak positive correlation was also observed between the left PI and CD4 counts, but, no correlation was observed between the right PI, right and left RI with CD4 counts.

**Conclusion**

The proportion of patients with abnormal RI and PI was higher than the proportion of participants with abnormal serum urea, creatinine and proteinuria. Renal Doppler indices may have a role in the early assessment of renal function in HIV sero-positive adult individuals.

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**Figure 1:** shows the technique for the measurement of RI and PI of the left interlober artery for 26 years sero-positive individual. The sample volume was 2.7 mm, the wave was acquired as shown above. The PI value was 0.99 and the RI was 0.61. Both values were within the acceptable limits.7,8

**Table 1: The mean, standard deviation and range of the right and left resistive and pulsatility indices, CD4+ counts, serum creatinine, serum urea and proteinuria of the selected subjects**

|  |  |
| --- | --- |
| **Gender** | **Doppler and Laboratory Variables** |
| **RRI LRI RPI LPI CD4+ Creatinine Urea**  **(cells/mm3) (mmol/L) (mmol/L)** |
| **Male** 0.64 ± 0.04 0.64 ± 0.04 1.38±0.12 1.37±0.12 567.59±230.52 68.84±19.50 3.14±1.08  **(n=198)** (58-76) (58-74) (0.93-1.61) (0.92-1.60) (24-1040) (11-154) (1.0-9.6)  **Female** 0.63 ± 0.04 0.63 ± 0.04 1.33±0.16 1.32±0.14 583.89±239.47 61.36±18.36 2.98±1.16  **(n=198)** (0.55-0.78) (0.53-0.74) (0.14-1.60) (0.76-1.58) (10-1346) (22-169) (1.4-9.4) | |

RRI: right resistive index, LRI: left resistive index, RPI: right pulsatility index, LPI: left pulsatility index

**Table 2: Frequency distribution of the normal and abnormal resistive and pulsatility indices of both males and females selected subjects**

|  |  |
| --- | --- |
| **Normal &**  **abnormal**  **RI &**  **PI** | **Gender** |
| **Male Female**  **(n=198) (n=198)** |
| **Right kidney Left kidney Total Right kidney Left kidney Total** | |
| **Normal RI** 172(86.9%) 181(91.4%) 353(89.1%) 182(91.9%) 185(93.4%) 367(92.7%)  **(≤ 0.70)**  **Abnormal RI** 26(13.1%) 17(8.6%) 43(10.9%) 16(8.1%) 13(6.6%) 29(7.3%)  **(˃ 0.7)**  **Normal P1** 181(91.4%) 183(92.4%) 364(91.9%) 185(93.4%) 189(95.5%) 374(94.4%)  **( ≤ 1.56 )**  **Abnormal PI** 17(8.6%) 15(7.6%) 32(8.1%) 13(6.6%) 9(4.5%) 22(5.6%)  **( ˃ 1.56)** | |

IR: resistive index, PI: pulsatility index

**Table 3: Frequency distribution of the normal and abnormal serum creatinine and urea, and proteinuria**

|  |  |
| --- | --- |
| **Gender** | **Normal and abnormal laboratory indices** |
| **Creatinine Urea Proteinuria**  **(mmol/L) (mmol/L)** |
| **normal abnormal normal abnormal normal abnormal**  **(≤ 111) (˃ 111) (≤ 6.9) (˃ 6.9) (-) (+) (++)** |
| **Male** 193(97.5%) 5(2.5%) 196(99%) 2(1%) 176(89.8%) 14(7.1%) 8(4.1%)  **(n=198)**  **Female** 194(98%) 4(2%) 194(98%) 4(2%) 183(92.5%) 9(4.5%) 6(3.0%)  **(n=198)**  **Total**  **(n=396)** 387(97.7%) 9(2.3%) 390(98.5%) 6(1.5%) 359(90.7%) 23(5.8%) 14(3.5%) | |

**Figure 2: Categorization of the selected subjects based on CD4+ counts**

**Group 1=CD4+ counts ˃ 500 cells/mm3, Group 2=200-499 cells/mm3, Group 3˂ 200 cells/mm3**

**Table 4: Comparison of RI and PI between male and female participants**

|  |  |
| --- | --- |
| **Doppler**  **indices** | **Males Females ρ-value**  **(n=198) (n=198)** |
| **Mean ± SD Mean ± SD** |
| **RRI** 0.6418±0.04 0.6315±0.04 0.017  **LRI** 0.6356±0.04 0.6270±0.04 0.038  **RPI** 1.381±0.12 1.337±0.16 0.001  **LPI** 1.367±0.12 1.319±0.14 0.000 | |

**Key: RRI=right resistive index, RPI= right pulsatility index, LRI=left resistive index, LPI= left pulsatility index.**

**Table 5: Comparison of the CD4 counts, serum creatinine and urea between male and female participants**

|  |  |
| --- | --- |
| **Laboratory**  **indices** | **Males Females ρ-value**  **(n=198) (n=198)** |
| **Mean ± SD Mean ± SD** |
| **CD4 counts**  567.59±230.52 583.89±239.47 0.491  **Serum** 68.84±19.50 61.36±18.36 0.002  **creatinine**  **Serum urea** 3.14±1.08 2.98±1.16 0.167 | |

**Table 6: Comparison of RI and PI between the participants with normal and abnormal serum creatinine and urea and urine protein**

|  |
| --- |
| **Lab/Doppler**  **indices Normal Abnormal Mean difference *P-*value** |
| **Creatinine (n=387) (n=9)**  **RRI** 0.61±0.04 0.65±0.05 -0.05 <0 .001  **RPI** 1.31±0.12 1.40±0.21 -0.09 0.017  **LRI** 0.60±0.05 0.63±0.08 -0.03 0.022  **LPI** 1.29±0.13 1.38±0.20 -0.09 0.024  **Urea (n=390) (n=6)**  **RRI** 0.61±0.04 0.70±0.00 -0.09 <0.001  **RPI** 1.31±0.13 1.48±0.15 -0.18 0.001  **LRI** 0.60±0.05 0.67±0.08 -0.06 0.001  **LPI** 1.29±0.13 1.47±0.14 -0.17 0.001  **Proteinuria (n=359) (n=37)**  **RRI** 0.61±0.04 0.64±0.05 -0.03 <0.001  **RPI** 1.30±0.12 1.38±0.16 -0.08 <0.001  **LRI** 0.60±0.04 0.63±0.06 -0.03 <0.001  **LPI** 1.29±0.12 1.36±0.17 -0.08 <0.001 |

RRI: right resistive index, LRI: left resistive index, RPI: right pulsatility index, LPI: left pulsatility index

**Table 7: Correlation of resistive index and pulsatility index with the age of the participants and the duration of the antiretroviral therapy**

|  |  |
| --- | --- |
| **Renal Doppler**  **indices** | **Age Duration of antiretroviral therapy**  **(years) (years)** |
| **r *P* r *P*** |
| **RI** 0.420, 0.000 0.005 0.946  **PI** 0.398 0.001 0.012 0.875 | |

RI: resistive index, PI: pulsatility index,

**Table 8: Correlation of the resistive index and pulsatility index with creatinine, urea and proteinuria in both males and females selected subjects**

|  |  |
| --- | --- |
| **Laboratory**  **Indices** | **Renal Doppler indices in male (n=198)** |
| **RRI RPI RRI RPI** |
| **r *P* r *P* r *P* r *P*** |
| **CD4+** 0.017 0.809 0.122 0.086 0.017 0.810 0.119 0.096  **counts**  **Serum**  **Creati-** 0.235 0.001 0.240 0.001 0.490 0.000 0.268 0.000  **nine**  **Serum** 0.272 0.000 0.212 0.003 0.245 0.000 0.226 0.001  **Urea**  **Laboratory Renal Doppler indices female (n=198)**  **Indices**  **(females)**  **CD4** 0.087 0.221 0.015 0.289 0.091 0.202 0.108 0.978  **counts**  **Serum** 0.262 0.000 0.022 0.001 0.2270.001 0.219 0.007  **create-**  **nine**  **Serum** 0.180 0.011 0.020 0.003 0.210 0.007 0.046 0.517  **Urea** | |

RRI: right resistive index, LRI: left resistive index, RPI: right pulsatility index, LPI: left pulsatility index