COMPARATIVE CHEST RADIOGRAPHIC FINDINGS IN ADULTS PATIENTS WITH PTB ONLY AND THOSE WITH HIV+ PTB CO-INFECTION

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Abstract-
INTRODUCTION: Tuberculosis (TB) is an infectious bacterial disease caused by closely related gram-positive, acid and alcohol-fast bacteria known as the *Mycobacterium tuberculosis* complex. It most commonly affects the lungs resulting in pulmonary tuberculosis. TB is transmitted from person to person via inhalation of droplets (aerosols) with active pulmonary tuberculosis, especially those from cavities. Globalization, increasing population mobility, rising incidence of internally displaced persons, overcrowding in refugee camps of which Nigeria is not exempt, and population explosion in developing countries have shaped and sustained the TB/HIV co-infection. Pulmonary tuberculosis, therefore, remains a major public health concern. AIM: The aim of this study is to compare the patterns of chest radiographic findings in adult patients with PTB-only to that of patients diagnosed with HIV/PTB co-infection.
METHODS: The study was a cross-sectional, descriptive, and comparative evaluation of 250 subjects showing the chest radiographic findings of pulmonary tuberculosis in adult patients from multiple centres.
RESULTS: There were 106 females (42.4%) and 144 males (57.7%). There were 138 subjects (55.2%) and 112 subjects (44.8%) with PTB-only and HIV/PTB co-infection respectively. For the chest radiographic findings, the presence of normal chest radiographs and chest opacities among the PTB-only and HIV/PTB study groups showed a p-value of 0.005. In the left upper lung zone, a total of 41 patients (16.4%) had opacities, 25 (10%) and 16 (6.4%) in the PTB-only and HIV/PTB patient groups respectively with a p-value of 0.006.
CONCLUSION: The study showed that patients with PTB-only had higher chances for the development of all the abnormal chest radiographic findings except lymphadenopathy while those with HIV/PTB co-infection had very high chances of developing only lymphadenopathy compared to the rest of the other chest findings.

***Keywords*: chest, HIV/PTB co-infection, PTB-only, p-value, Tuberculosis.**

INTRODUCTION

Tuberculosis (TB) is an infectious bacterial disease caused by closely related gram-positive, acid and alcohol-fast bacteria known as the *Mycobacterium tuberculosis* complex. It most commonly affects the lungs resulting in pulmonary tuberculosis. Nearly one quartre of the world population has been infected with *Mycobacterium tuberculosis* (MTB) and there are more than 10 million new infections per year.[1]

The symptoms of active pulmonary tuberculosis include dyspnea, cough, fever, night sweats, weight loss, fatigue, etc. In healthy subjects, infection with *M. tuberculosis* often causes no symptoms since the person's immune system acts to wall off the bacteria.[2,3] TB is transmitted from person to person via inhalation of droplets (aerosols) containing a critical dose of bacilli from the throat and lungs of patients with active pulmonary tuberculosis and importantly those with cavities. The phagocytosed *M. tuberculosis* is affected by the destructive effects of lysozymes. Some bacilli may escape lysosomal destruction, multiply inside the macrophages, and spread through the lymphatics to the regional lymph nodes, from where they may spread further.[4,5]

Pulmonary tuberculosis (PTB) is classified as primary or post-primary tuberculosis. In primary tuberculosis, radiographic signs occur around the time of inoculation. These include mediastinal lymphadenopathy, middle and lower lung involvement, and pleural effusion. Post-primary pulmonary tuberculosis is the commonest type in adults. It is due to the reactivation of a latent primary infection (up to 90%) or less commonly following a repeat infection of a previously sensitized host. It usually presents with exudative inflammation. There may be satellite lesions which are located in the immediate vicinity of the main lesion. There is an initial involvement of the apical and posterior segment of the upper lobe or the superior segment of the lower lobe.[6,7,8] Radiographic findings are atypical in the immuno-compromised and resemble the primary type. Atypical distribution of the disease entails the involvement of the anterior segment of the upper lobe, the basal segments of the lower lobe, the right middle lobe, and the lingular segments. Others are diffuse lung infiltrates, mid-zone predilection, bilateral lung involvement, interstitial nodules, pleural effusion, mediastinal or hilar lymphadenopathy, and normal radiograph of the lung.[9] About one-third of the world's population is infected with tuberculosis (TB) but does not currently have an active infection (latent TB).[10] People with latent infection have a 10% lifetime risk of becoming ill with active tuberculosis. HIV infection increases the risk of TB 20 folds compared with HIV seronegative individuals in high HIV prevalence countries. In 2016, there were 2.5 million new cases of TB and 417,000 deaths from the disease in the African region. Forty percent of HIV deaths were also due to pulmonary TB.[11] The presentation of TB in HIV-negative patients conforms with known clinical features and investigation findings of TB infection. However, in patients with HIV and reduced immunity, there is a rise in extra-pulmonary forms of tuberculosis.[12] In 2017, the lifetime risk of pulmonary tuberculosis was 17-23 times greater in people living with HIV than in those without HIV infection.[13]

AIM

The aim of this study is to compare the patterns of chest radiographic findings in adult patients with PTB-only to that of patients diagnosed with HIV/PTB co-infection.

JUSTIFICATION

Globalization, increasing population mobility, rising incidence of internally displaced persons, overcrowding in refugee camps of which Nigeria is not exempt and population explosion in developing countries have shaped and sustained the TB/HIV co-infection.[14] Pulmonary tuberculosis, therefore, remains a major public health concern. New strains and recombinant forms of the HIV virus may alter the radiographic picture of pulmonary tuberculosis in an entirely new manner.[15] It is also reported that there is an increase in the prevalence and transmission of multidrug-resistant and totally drug-resistant MTB strains worldwide.[16] This study addresses the ever-present need for doctors and especially radiologists at this time to be abreast of the current and varied patterns of presentation of pulmonary tuberculosis. The study will yield information on the current patterns of presentation of PTB-only and HIV/PTB co-infection in Anambra state. It will renew the interest and equip doctors and other healthcare workers on the different chest radiographic appearances of tuberculosis.

METHODS

The study was a cross-sectional, descriptive, and comparative plain radiographic evaluation of the chest findings of pulmonary tuberculosis in adult patients from multiple centres. Institutional consent and authorization for the study were obtained from the various study centers following which ethical clearance was obtained from the Research and Ethics Committee of the Tertiary centre. A detailed explanation of the study was given and written informed consent was obtained from each patient. All patient information and data obtained were treated with the utmost confidentiality. Using the consecutive sampling method, eligible participants were recruited until the sample size was reached. A minimum sample size of 250 participants was used in order to take care of possible attrition and strengthen the authenticity of the study.

The study population was adults, 18 years and above referred from the PTB/DOTS clinics of the various centres to the Radiology departments on account of laboratory diagnosis of pulmonary tuberculosis and patients with HIV/TB co-infection who have not started HAART. Those excluded from the study are patients < 18yrs of age, patients already on HAART, and patients who did not give consent. The sociodemographic data and the patient's clinical history were entered into the proforma before the interpretation of the chest radiographs. The chest radiographic findings were then entered into the study datasheet.

Chest radiographs were taken with the patient standing erect facing the standing bucky of an x-ray machine, arms akimbo or hugging the bucky. The chin was extended and centered on the top and middle of the cassette. The chest was placed against the cassette. The median sagittal plane was adjusted at right angles to the middle of the cassette. The X-ray beam is centred at about the 5^{th}-6^{th} thoracic vertebra passes through the chest in a posteroanterior direction. A film focus distance of 120cm was used. All exposures were taken at full arrested inspiration.

Laboratory diagnosis of PTB was done using the National TB guidelines.[[17] Tests were carried out in the laboratory facilities of the various hospitals. All suspected PTB patients had two sputum samples for Ziehl-Neelson staining and one sample for GeneXpert analysis. Samples were collected in sterile dry containers. The first sputum sample was collected on the spot. The second sputum sample was an early morning sputum, collected without brushing the mouth or drinking water. A positive laboratory diagnosis of PTB was made if at least a single smear came out positive. Smear positivity was recorded as scanty corresponding to 1-9 AFB/1 length or 100 HPF or numerous with > 10 AFB/1 length or 100 HPF. Numerous AFB may be 1+ (10-99 AFB per 100 HPF), 2+ (1-10 AFB per 1 HPF on average), or 3+ (> 10 AFB per 1 HPF on average) according to the IUATLD and WHO grading system.[17] The GeneXpert method was used to make a diagnosis of PTB in smear-negative cases.[18] The GeneXpert uses automated cartridge-based nucleic acid amplification to identify *Mycobacterium tuberculosis* DNA and resistance to Rifampicin.[17]

The data was entered and analyzed using IBM Statistical Package for Social Sciences (SPSS) Statistics version 20.0 (USA; 2015) for Windows software. Frequency distribution and two-way tables were used to summarize the data. Chi-square(X^2) was used to determine the strength of association between independent and dependent variables

RESULTS

There were 106 females (42.4%) and 144 males (57.7%). The highest age-specific prevalence was seen in those aged 31-40 years, 59 (23.6%) and 41-50 years, 59 (23.6%). The 31-40 years age group had 29 females (11.6%) and males 30 (12%) while the 41-50 years age group had 28 females (11.2%) and 31 males (12.4%). The 81-90 years age group had 4 patients (1.6%) with 1 female (0.4%) and 3 males (1.2%). **Figure 1**

There were 138 subjects (55.2%) and 112 subjects (44.8%) with PTB only and HIV/PTB co-infection respectively. All were Nigerians, out of which 245 (98%) were Igbo and 5 (2%) were Hausa. Most were Christians, 245 (98.4%) while 5 (2.0%) were Muslims. Nine subjects (3.6%) had no formal education, 47(18.8%) had primary education, half of the study population, 125 subjects (50%) had secondary education, and 69 (27.6%) had tertiary education. A little less than half the study population, 120 subjects (48%) lived in urban residences, 83 (33.2%) lived in semi-urban areas while the least 47 subjects (18.8%) were from rural areas. One hundred and fifty-eight (63.5%) were never married while 91(36.5%) were married. There was no statistically significant relationship between patients' HIV status and tribe (p-value = 0.067), religion (p-value = 0.131), the highest level of education (p-value = 0.311), residence (p-value = 0.344), and marital status (p-value = 0.511). **Table 1**

A hundred and thirteen subjects (45.2%) slept alone in a room, 91 subjects (36.4%) slept two in a room, 37 subjects (14.8%) slept three in a room, 7 subjects (2.8%) slept four in a room while 1 subject each (0.4%) slept five and six in a room respectively. There was no statistically significant relationship between patient HIV status and the number that slept in a room, p-value = 0.330. Patients

who slept in cross-ventilated rooms were more, 166 (66.4%) compared to those whose rooms had no cross ventilation, 84 (33.6%). No statistically significant relationship exists between sleeping or not in a ventilated room and patient HIV status, p-value = 0.479. **Table 2** Based on patient occupation, traders were 65 (26%) which accounted for the highest number in the study population, the unemployed were 56 (22.4%), public servants 32 (12.8%) while the others were distributed among students, 29 (11.6%), farmers 27, (10.8%), artisans, 21 (8.4%) and transporters 20 (8%). **Figure 2**

For the chest radiographic findings, the presence of normal chest radiographs and chest opacities among the PTB-only and HIV/PTB study groups showed statistically significant differences. A total of 27 patients (10.8%) had normal chest radiographs; 8 (3.2%) in the PTB-only group and 19 (7.6%) in the HIV/PTB co-infected group, the p-value was 0.005. Patients who had one form of chest opacity or the other were 207 (82.8%). They numbered 124 (49.6%) and 83 (33.3%) in the PTB and HIV/PTB groups respectively. This difference was statistically significant with a p-value of 0.001. However, the presence and type of opacity, (nodular, interstitial, or reticulonodular) in the two study groups was not statistically significant. There was no statistically significant difference in the zonal distribution of right lung opacities. However, in the left upper lung zone, a total of 41 patients (16.4%) had opacities, 25 (10%) and 16 (6.4%) in the PTB-only and HIV/PTB patient groups respectively. This difference was statistically significant with a p-value of 0.006.

More participants with reticulonodular findings were seen in the PTB-only group (66 = 26.4%) than in the HIV-PTB co-infection group (36 = 14.5%). In both lungs, the upper lung zone was most affected especially in the PTB-only group 30(12%) for the right side while the value for the left side was 25(10%). While in the HIV-PTB co-infection group, 15(6%) was the value for the right lung and 16 (6.4%) was for the left lung. **Table 3**

Most patients had coughs lasting greater than two weeks. This was seen in 187 patients (74.8%), of which 110 (44%) had PTB-only while 77 (30.8%) had HIV/PTB co-infection. This was statistically significant, (p-value = 0.031). Peripheral lymphadenopathy of less than 2 weeks duration was the least clinical presentation and was seen in five patients, 3 (1.2%) with PTB-only and 2 (0.8%) with HIV/PTB co-infection. The other clinical presentations showed no statistically significant relationship with patient PTB or HIV/PTB co-infection status. **Table 4**

The chest radiographic findings observed in the PTB-only group in descending order of frequency were bronchopneumonia in 99 subjects (39.6%), nodularities in 84 subjects (33.6%), volume loss in 61 (24.4%), cystic changes in 56 subjects (22.4%), pleural effusion in 41 subjects (16.4%), cavities in 36 subjects (14.4%), lobar pneumonia in 26 subjects (10.4%), apical cap in 22 subjects (8.8%), lymphadenopathy and miliary opacities each seen in 9 subjects (3.6%), destroyed left lung in 6 subjects (2.4%), pneumothorax in 5 subjects (2%) and destroyed right lung in 1 subject (0.4%). The radiographic findings in the HIV/PTB group in decreasing frequency were bronchopneumonia in 66 subjects (26.4%), nodularities in 55 subjects (22%), pleural effusion in 37 subjects (14.8%), cystic changes in 30 subjects (12%), fibrosis in 23 subjects (9.2%), volume loss in 22 subjects (8.8%), lymph node in 20 (8%), cavities in 10 (4%) etc. Bronchopneumonia was seen in 165 patients (66%) of the 250 subjects, comprising 99 subjects (39.6%) and 66 subjects (26.4%) in the PTB-only and HIV/PTB co-infection groups respectively. This difference was statistically significant with a p-value of 0.027. The presence of cystic changes, fibrosis, and cavitation among the PTB and HIV/PTB co-infection groups showed statistically significant differences. Eighty-six patients (34.4%) had cystic changes; 56 (22.4%) and 30 (12%) in the PTB-only and HIV/PTB co-infected groups respectively with a p-value of 0.020. Seventy-two patients (28.8%) had fibrosis, 49 (19.6%) in the PTB-only and 23 (9.2%) in the HIV/PTB group. This difference between the two study groups was also significant with a p-value equal to 0.012. Lymphadenopathy was seen significantly more in the HIV/PTB co-infected group, 20 subjects (8%) compared to 9 subjects (3.6%) in the PTB-only group, the p-value was 0.005. Volume loss was seen significantly more in the PTB-only group, 61 subjects (24.4%) compared with 22 subjects (8.8%) in the co-infected group. This was very significant, the p-value was < 0.001. Lung destruction was seen more on the left, 6 subjects (2.4%) than on the right side, one subject (0.4%). **Table 5**

Cavitations were seen in 46 (18.4%) patients; 36 (14.4%), and 10 (4%) in the PTB-only and HIV/PTB groups respectively. This difference in the presence of cavities between the study groups was statistically significant with a p-value of < 0.001. Thick-walled cavities were seen in 25 subjects (10%) and it was higher in number compared to thin-walled cavities seen in 21 subjects (8.4%). The distribution of thick-walled cavities between the two study groups was statistically significant (p-value = 0.009) and it was seen in 20 subjects (8%) in the PTB-only group and 5 subjects (2%) in the HIV/PTB group. Similarly, the distribution of thin-walled cavities between the two study groups was significant (p-value = 0.013). Thin-walled cavities were seen in 17 subjects (6.8%) in the PTB-only group and 4 subjects (1.6%) in the HIV/PTB co-infection group. The presence of right mid-zone cavities between the PTB-only group with 2 subjects (0.8%) and 1 subject (0.4%) in the HIV/PTB co-infection group was statistically significant, the p-value was 0.009. Similarly, on the left mid-zone, 2 subjects (0.8%) had cavities in the PTB-only group compared with 1 subject (0.4%) in the co-infection group. This difference between the two study groups was significant, the p-value was 0.032. Cavities were more frequently seen in the upper lung zones on the right and left sides, in 29 subjects (11.6%) and 20 subjects (8%) respectively. The distribution of the cavities in the upper and lower lung zones in both study groups showed no statistically significant relationship. **Table 6**

In the PTB-only group, 96 subjects (38.40%) had a typical post-primary PTB pattern, while an atypical pattern was seen in 83 subjects (33.20%). For those with HIV/PTB co-infection, the atypical pattern was seen in 37 subjects (14.8%) while a typical pattern was seen in 36 subjects (14.4%). There was no significant relationship between the patient groups (PTB-only or HIV/PTB co-infection) and the presence of typical or atypical patterns. The p-value was 0.084. **Table 7**

Logistic regression analysis was done to evaluate the degree of association between PTB-only or HIV/PTB co-infection and the development of significant chest radiographic findings. Odd's ratio (OR) value greater than 1 means a positive association or increased chance while (OR) less than 1 means a negative association or decreased chance. In the group with HIV/PTB co-infection, only lymphadenopathy had an Odd's ratio greater than 1, (OR = 3.115, p-value = 0.007). The rest of the findings; opacities, bronchopneumonia, cystic change, fibrosis, cavity, thick-walled cavity, thin-walled cavity, and volume loss had OR less than 1

(0.323, 0.550, 0.529, 0.480, 0.267, 0.275, 0.263, 0.308) and p-values of 0.001, 0.028, 0.021, 0.013, 0.001, 0.013, 0.020, < 0.001) respectively. HIV/PTB co-infection is, therefore, a strong risk factor for the development of lymphadenopathy. **Table 8**

Of the one hundred and thirty-eight patients in the PTB only, the odds (chances) of the development of cavities was the highest, followed by volume loss and opacities (OR= 3.736, 3.240 and 3.094 and p-value = 0.001, < 0.001 and 0.001 respectively). The odds of development of fibrosis were higher than cystic change, bronchopneumonia, and lymph nodes among these patients (Odds ratio= 2.082, 1.889, 1.815, and 0.321 with p-value = 0.013, 0.021, 0.028, 0.007 respectively). Therefore, patients who had PTB only have a very high chance of developing these abnormal chest x-ray radiographic findings. PTB was negatively associated with lymphadenopathy development (OR = 0.321). **Table 9**

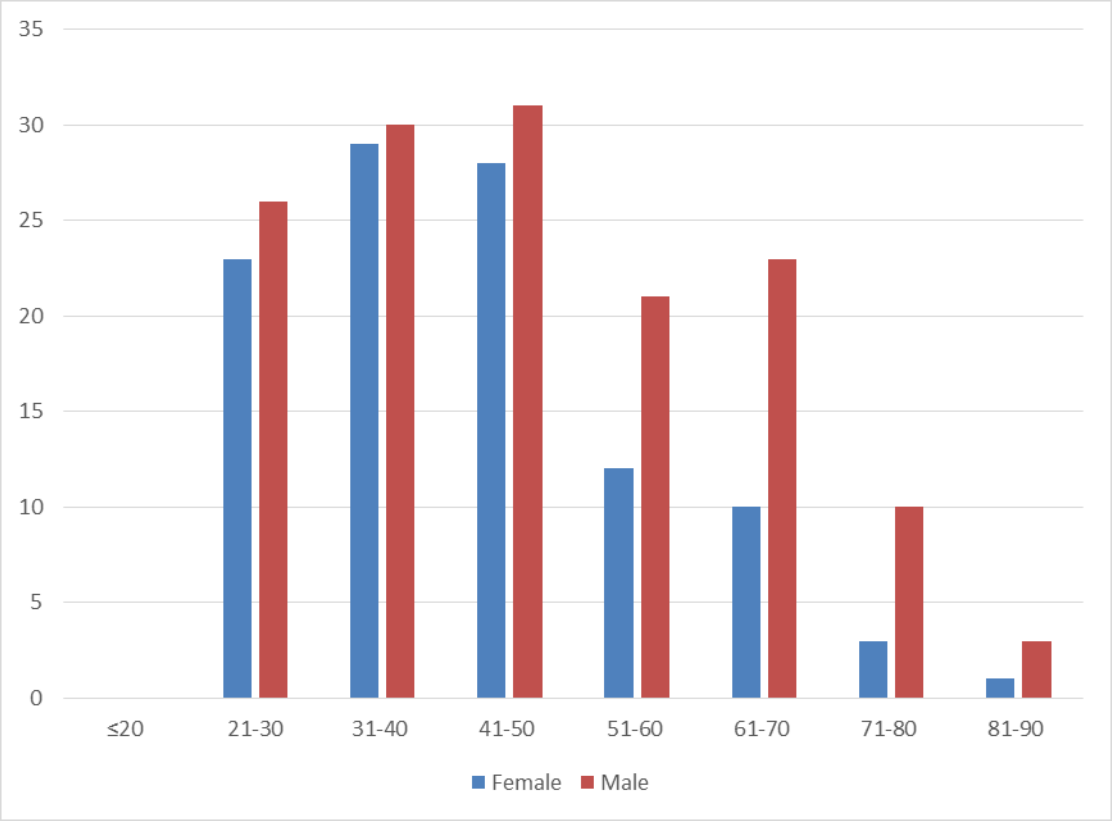

Figure 1: Bar chart showing the distribution of age ranges in males and females in the study population

Table 1: Chi-square analysis showing the relationship between sociodemographic characteristics of patients who are negative to HIV/AIDS (TB only) and positive to HIV/AIDS (Co-infection)

SOCIODEMOGRAPHIC CHARACTERISTICS	Freq (%) (n=250)	Patient status (%)			
		PTB only	HIV/PTB co-infection	χ^2 value	p-value
Nationality					
Nigerian	250 (100)	138 (55.2)	112 (44.8)		
Tribe					
Igbo	245 (98)	133 (53.2)	112 (44.8)	4.140	0.067
Hausa	5 (2)	5 (2)	0		
Religion					
Christianity	245 (98.4)	134 (53.6)	111 (44.4)	3.269	0.131
Islam	4 (1.6)	4 (1.6)	0		
Highest level of education					
None	9 (3.6)	6 (2.4)	3 (1.2)		
Primary	47 (18.8)	27 (10.8)	20 (8)	3.573	0.311
Secondary	125 (50)	62 (24.8)	63 (25.2)		

Tertiary	69 (27.6)	43 (17.2)	26 (10.4)		
Residence					
Rural	47 (18.8)	22 (8.8)	25 (10)		
Semi-urban	83 (33.2)	45 (18)	38 (15.2)	2.134	0.344
Urban	120 (48)	71 (28.4)	49 (19.6)		
Marital status					
Ever married	91 (36.5)	53 (21.2)	38 (15.2)	0.461	0.511
Never married	158(63.5)	85 (34)	73 (29.2)		

Table 2: Chi-square analysis showing the relationship between associated risk factors of tuberculosis in patients who are negative for HIV (PTB-only) and positive for HIV/PTB (Co-infection)

RISK FACTOR	**Freq (%) (n=250)**	**Patient status (%)**		**χ^2 value**	**p-value**
		PTB only	**HIV/PTB Co-infection**		
Number sleeping in a room					
Alone	113 (45.2)	62 (24.8)	51 (20.4)		
Two	91 (36.4)	49 (19.6)	42 (16.8)		
Three	37 (14.8)	24 (9.6)	13 (5.2)		
Four	7 (2.8)	2 (0.8)	5 (2)	5.521	0.330
Five	1 (0.4)	0	1 (0.4)		
Six	1 (0.4)	1 (0.4)	0		
Cross Ventilation					
Present	166 (66.4)	89 (35.6)	77 (30.8)	0.502	0.479
Absent	84 (33.6)	49 (19.6)	35 (14)		

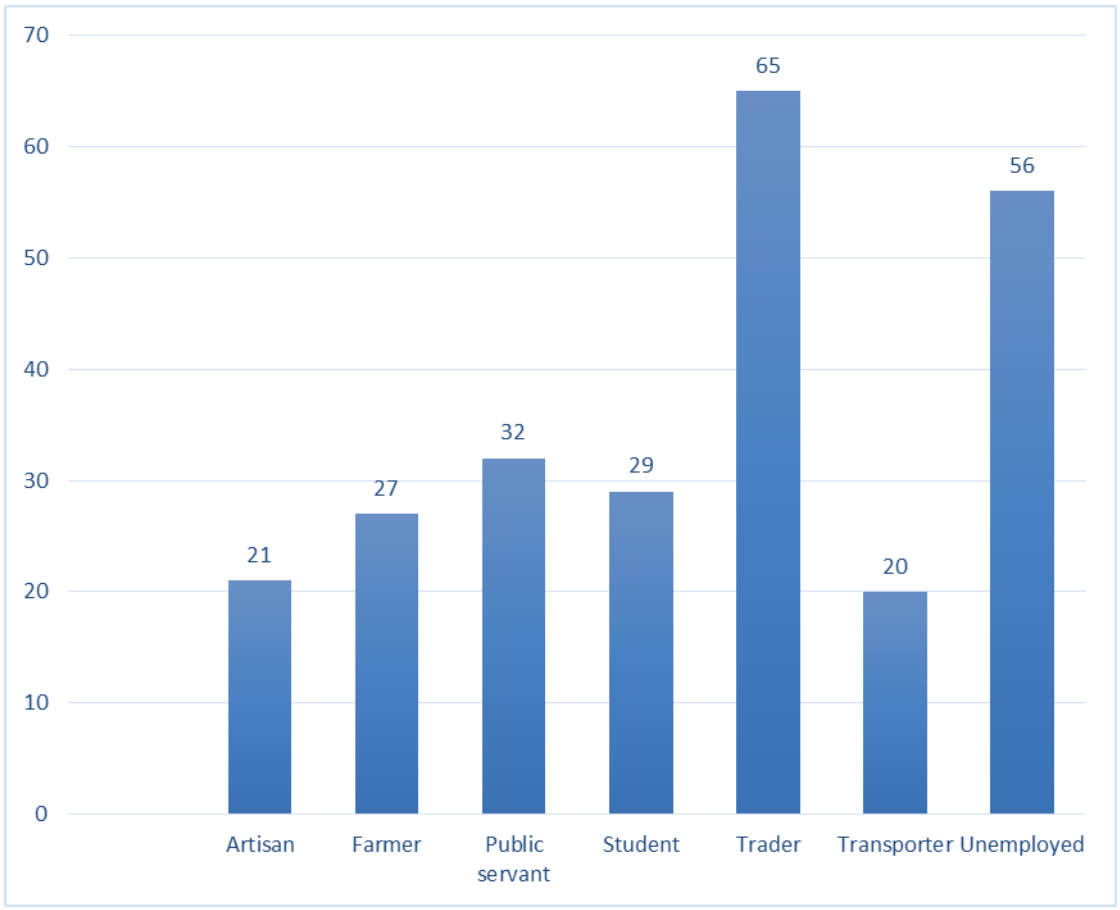

Figure 2: Bar chart showing the distribution of occupation among patients in the study population.

Table 3: Chi-square analysis showing the relationship of types of pulmonary opacities and their zonal distribution between patients who have PTB-only and those with HIV/PTB (co-infection).

CXR findings	**Total Freq (%)(n=250)**	**Patient status**		**χ^2 value**	**p-value**
		PTB alone	**HIV/PTB Co-infection**		
Normal	27 (10.8)	8 (3.2)	19 (7.6)	8.003	0.005*
Opacities	207 (82.8)	124 (49.6)	83 (33.2)	10.765	0.001*
Alveolar/Nodular	70 (28)	37 (14.8)	33 (13.2)		
Interstitial/Reticular	35 (14)	21 (8.4)	14 (5.6)	2.426	0.297
Reticulonodular	102 (40.8)	66 (26.4)	36 (14.4)		
Right lung					
Lower zone (L)	3 (1.2)	1 (0.4)	2 (0.8)		
Mid-zone (M)	8 (3.2)	3 (1.2)	5 (2)		
Mid + lower zone	16 (6.4)	9 (3.6)	7 (2.8)		
Upper zone (U)	45 (18)	30 (12)	15 (6)	12.981	0.052
Upper + lower zone (L)	1 (0.4)	0	1 (0.4)		
Upper + mid-zone	49 (19.6)	33 (13.2)	16 (6.4)		
U + M + L zones	57 (22.8)	32 (12.8)	25 (10)		
Left lung					
Lower zone	3 (1.2)	0	3 (1.2)		

Mid-zone	10 (4)	7 (2.8)	3 (1.2)		
Mid + lower zone	19 (7.6)	12 (4.8)	7 (2.8)		
Upper zone	41 (16.4)	25 (10)	16 (6.4)	18.575	0.006*
Upper + lower zone	1 (0.4)	0	1 (0.4)		
Upper + mid-zone	33 (13.2)	26 (10.4)	7 (2.8)		
U + M + L zones	49 (19.6)	26 (10.4)	23 (9.2)		

*= *significant p-value <0.05*

Table 4: Chi-square analysis showing the clinical presentations of tuberculosis in patients who are negative for HIV (PTB-only) and positive for HIV/PTB (Co-infection).

Clinical presentations	Freq (%) (n=250)	Patient status (%)		χ^2 value	p-value
		PTB only	HIV/PTB Co-infection		
Cough <2weeks	21 (8.4)	11 (4.4)	10 (4)	1.007	0.315
Cough >2weeks	187 (74.8)	110 (44)	77 (30.8)	4.673	0.031*
Fever <2weeks	28 (11.2)	12 (4.8)	16 (6.4)	1.760	0.185
Fever >2weeks	121 (48.4)	70 (28)	51 (20.4)	0.045	0.832
Hemoptysis < 2 weeks	23 (9.2)	13 (5.2)	10 (4)	0.017	0.896
Hemoptysis >2 weeks	40 (16)	22 (8.8)	18 (7.2)	0.001	0.993
Weight loss <2 weeks	27 (10.8)	9 (3.6)	18 (7.2)	3.244	0.072
Weight loss >2 weeks	161 (64.4)	96 (38.4)	65 (26)	0.931	0.335
Breathlessness <2weeks	30 (12)	16 (6.4)	14 (5.6)	0.001	0.975
Breathlessness >2weeks	76 (30.4)	48 (19.2)	28 (11.2)	2.362	0.124
Lymph node <2 weeks	5 (2)	3 (1.2)	2 (0.8)	0.036	0.850
Lymph node >2 weeks	11 (4.4)	5 (2)	6 (2.4)	0.450	0.502

*= *significant p-value <0.05*

Table 5: Chi-square analysis showing the relationship of specific CXR findings of PTB between patients who are negative for HIV (TB-only) and positive for HIV/PTB (co-infection)

CXR findings	**Total Freq(%) (n=250)**	**Patient status**		**χ^2 value**	**p-value**
		TB alone	**HIV/PTB co-infection**		
Bronchopneumonia	165 (66)	99 (39.6)	66 (26.4)	4.901	0.027*
Lobar pneumonia	43 (17.2)	26 (10.4)	17 (6.8)	0.802	0.370

Nodularity	139 (55.6)	84 (33.6)	55 (22)	3.706	0.054
Miliary	20 (8)	9 (3.6)	11 (4.4)	0.914	0.339
Cystic change	86 (34.4)	56 (22.4)	30 (12)	5.411	0.020*
Fibrosis	72 (28.8)	49 (19.6)	23 (9.2)	6.331	0.012*
Lymph Node	29 (11.6)	9 (3.6)	20 (8)	7.746	0.005*
Pleural Effusion	78 (31.2)	41 (16.4)	37 (14.8)	0.318	0.572
Effusion right side	44 (17.6)	26 (10.4)	18 (7.2)	0.326	0.567
Effusion left side	45 (18)	23 (9.2)	22 (8.8)	0.371	0.542
Apical Cap	35 (14)	22 (8.8)	13 (5.2)	1.058	0.304
Volume loss	83 (33.2)	61 (24.4)	22 (8.8)	16.815	<0.001*
Pneumothorax	5 (2)	5 (2)	0	4.140	0.067
Tuberculoma	0	0	0	0	0
Destroyed Lung- R	1 (0.4)	1 (0.4)	0	0.833	1.000
Destroyed Lung- L	6 (2.4)	6 (2.4)	0	4.989	0.034*

**= significant p-value <0.05*

Table 6: Chi-square analysis showing the relationship of lung cavities in patients with PTB between those negative for HIV (PTB-only) and those positive for HIV/PTB (co-infection)

CXR findings	**Total Freq (%)(n=250)**	**Patient status**		**χ^2 value**	**p-value**
		TB alone	**HIV/PTB Co-infection**		
Cavities	46 (18.4)	36 (14.4)	10 (4)	12.951	<0.001*
Thick-walled	25 (10)	20 (8)	5 (2)	6.908	0.009*
Thin-walled	21 (8.4)	17 (6.8)	4 (1.6)	6.148	0.013*
Cavities-Right Lung					
Mid zone	3 (1.2)	2 (0.8)	1 (0.4)	7.974	0.009*
Upper zone	29 (11.6)	23 (9.2)	6 (2.4)		
Cavities-Left Lung					
Lower zone	1 (0.4)	1 (0.4)	0		
Mid zone	2 (0.8)	1 (0.4)	1 (0.4)	10.570	0.032*
Upper zone	20 (8)	17 (6.8)	3 (1.2)		
Upper + mid-zone	2 (0.8)	2 (0.8)	0		
Number of Cavities					

One	29 (11.6)	23 (9.2)	6 (2.4)		
Two	12 (4.8)	10 (4)	2 (0.8)	0.935	0.812
Three	3 (1.2)	2 (0.8)	1 (0.4)		
Four	2 (0.8)	2 (0.8)	0		

**= significant p-value <0.05*

Table 7: Chi-square analysis showing the relationship between post-primary PTB pattern and patient HIV infection status.

Post-primary PTB	**Total Freq (%)(n=250)**	**Patient status**		X^2 **value**	**p-value**
		PTB alone	**HIV/TB co-infection**		
Atypical	83 (33.20)	46 (18.4)	37 (14.8)		
Typical	96 (38.40)	60 (24)	36 (14.4)	5.016	0.084

Table 8: Bivariate Logistic regression analysis showing the association between the patients with HIV/PTB co-infection and the development of significant abnormal chest radiographic findings.

Findings	**(HIV/PTB co-infection)** ***(n=112)***				
	OR	**Std. Error**	***P-value***	**(95% CI)**	
				Lower	Upper
Opacities	0.323	0.114	0.001*	0.161	0.647
Bronchopneumonia	0.550	0.149	0.028*	0.323	0.936
Cystic change	0.529	0.145	0.021*	0.308	0.907
Fibrosis	0.480	0.141	0.013*	0.269	0.854
Cavities	0.267	0.102	0.001*	0.126	0.566
Thick-walled	0.275	0.142	0.013*	0.099	0.760
Thin-walled	0.263	0.150	0.020*	0.086	0.807
Lymph Node	3.115	1.321	0.007*	1.357	7.152
Volume loss	0.308	0.090	<0.001*	0.173	0.548

Note: *For Outcome variables, absent= reference recoded as 0*
For predictor variables, PTB-only patients = reference recoded as 1
*OR = Odds ratio, * = significant p-value*

Table 9: Bivariate Logistic regression analysis showing an association between patients with PTB only and the development of significant abnormal chest radiographic findings.

Outcome Variables	***Predictor variable*** **(PTB-only patients)** ***(n=138)***			
	Odds Ratio	**Std. Error**	***P-value***	**(95% CI)**

Findings				Lower	Upper
Opacities	3.094	1.098	0.001*	1.543	6.205
Bronchopneumonia	1.815	0.491	0.028*	1.068	3.086
Cystic change	1.889	0.520	0.021*	1.101	3.240
Fibrosis	2.082	0.612	0.013*	1.169	3.707
Cavities	3.736	1.431	0.001*	1.763	7.916
Thick-walled	3.627	1.877	0.013*	1.315	10.001
Thin-walled	3.793	2.167	0.020*	1.238	11.622
Lymph Node	0.321	0.136	0.007*	0.139	0.736
Volume loss	3.240	0.950	<0.001*	1.824	5.757

Note: *For Outcome variables, absent= reference, recoded as 0*
For predictor variables, HIV/PTB co-infected patients = reference recoded as 1

DISCUSSION

Chest radiography remains a cornerstone in the assessment of various pulmonary pathologies in both adults and children. It is sensitive but non-specific in the detection of pulmonary tuberculosis. It is widely employed and relatively cheap. This study involved 250 patients with pulmonary tuberculosis (PTB). They comprised 138 patients with PTB-only infection and 112 patients with HIV/PTB co-infection who had not started anti-retroviral therapy. Each posteroanterior chest radiograph was reviewed and reported.

The study population showed a slight male preponderance with the M: F ratio of 1.36:1. This is similar to M: F ratio of 2.6:1 reported by Akhigbe et al[19] in Lagos and 1.2:1 reported by Ikuabe, Ebuenyi et al[20] in Yenegoa. This male predominance supports the fact that men are more likely to report risk factors associated with PTB exposure while women convert faster to negative smear culture than men.[21] Men are also disadvantaged in accessing PTB care in many settings because global health bodies tend to treat gender issues in health with some bias as being synonymous with women's health.[22] These reasons will make the prevalence of PTB higher in men. On the contrary, females were more affected in the study by Singh and Tiwari.[23]

The highest age-specific prevalence was in the age groups 31- 40 years and 41- 50 years age brackets who were affected equally, 59 subjects (23.6%) respectively. This agrees with studies by Ojiezeh et al[24] and Adetunji et al[25] who found PTB most prevalent in those aged between 25- 40 years and 31-40 years respectively but is contrary to a national study by Ogbo et al[26] where the highest TB burden was found in those aged 50-69 years. The variance between the lower age-specific prevalence of PTB in this study compared to the higher prevalence in the aforementioned national study which lasted from 1990-2016, may be an indication of rising disease prevalence in young adults over decades. In the present study, the high disease burden in young adults may be due to improvements in case reporting, rising levels of unemployment, and the migration of young adults to overcrowded urban areas is a known risk factor for PTB.

Our study found that PTB was most prevalent among traders, 65 (29%), and the unemployed, 56 (22.4%) with most of the patients 125 (50%) attaining secondary school as the highest level of education. There is some similarity in the study by Ogboi et al[27], Northern Nigeria where the disease prevalence was highest in the unemployed 200 patients (28.9%) and traders 100 patients (14.4%). Similar findings were also reported by Yusuf et al[28] where a majority of 1048 (43%) had no formal education and most 996 (41%) were unemployed. These similarities may be due to the prevailing high rate of unemployment in the country and economic meltdown. Illiteracy, ignorance, and over-exposure to the risk factors of PTB are also contributory. In this study, half of the study population attained secondary school. Most patients in the study by Yusuf et al[28] were quaranics and may often congregate in over-crowded areas during religious activities thus increasing disease prevalence. Slightly less than half of the study population were urban dwellers. These studies buttress the link between pulmonary tuberculosis, overcrowding, poor housing, and living conditions in urban slums where most unemployed patients live. Another reason for this high PTB burden among urban dwellers may be that the disease is not perceived to be very serious due to inadequate sensitization programs [29]. Subjects in the PTB-only group, 89 (35.6%) as well 77 (30.8%) in the HIV/PTB co-infection group had cross-ventilated apartments in the present study. This may be because other risk factors played stronger roles in the communication and spread of the disease in the study population. This is in contrast to a study in Nasarawa State, Nigeria that reported absent cross ventilation as one of the most significant independent predictors of PTB.[30]

More than half of the patients, 187 (74.8%) presented with coughs of greater than 2 weeks duration. Weight loss greater than 2 weeks duration was the next most common symptom seen in 161 patients (64.4%). This varies from the work reported by Ndubuisi et al[31] who found cough (86%) and fever (76%) as the most frequent symptoms. The study by Lawson et al[32] reported chest pain, fever, and weight loss in decreasing order of frequency as the frequent symptoms. These differences may be affected by the patient's ability to clearly remember the timeline or chronology of their symptoms.

In this study, cavities were seen in a total of 46 patients (18.4%), 36 patients (14.4%) versus 10 (4%) in PTB and HIV/PTB groups respectively. This was statistically significant (X^2= 12.951 with p-value < 0.001). There were more cavities in the left upper lung

zone 20 (8%) than in any other zone. This was not statistically significant. The predominance of cavities in the left upper lobe is a general reflection of more frequent colonization of the upper lobe by MTB, an obligate aerobe, and is similar to that reported by many authors.[19,33,] On the converse, Olatunji et al[34] reported that cavities were predominant in the lower lung zones. Cavities whether thick or thin-walled were also significantly higher in the PTB-only group than in the HIV/PTB group. There were more thick-walled cavities 20 (8%) in the PTB-only group than 5 (2%) in the HIV/PTB group (X^2= 6.908, p-value = 0.009) and more thin-walled cavities 17 (6.8%) in the PTB-only group than 4 (1.6%) in the HIV/PTB groups (X^2= 6.184, p-value = 0.013). There were significantly more cystic changes 56 (22.4) in the PTB group than 30 (12%) in the HIV/PTB group (X^2 = 25.411, p-value= 0.020), and significantly more fibrosis 49 (19.6%) in the PTB group than 23 (9.2%) in the HIV/PTB group (X^2 = 6.33, p-value = 0.012). This does not agree with the findings in the studies by Ikuabeetal[20] and Assefa et al[33]that found cavities in up to 196 subjects (63.8%) and 91 patients (71%) respectively. These differences in cavities, fibrosis, and cysts among the PTB and HIV/PTB groups may be due to higher levels of immunity in the PTB-only group who tend to mount a better immune response against the infection and contain the infection. The distribution of cavities in the mid zones bilaterally was statistically significant with p-values of 0.009 and 0.032 for the right and left sides respectively. On the right side, this may be due to additional involvement of the superior segment of the right lower lobe projected over the mid-zone.

Lymph nodes were seen more in the HIV/PTB group 20 (8%) compared to 9 (3.6%) in the PTB group. This was statistically significant with a p-value of 0.005. On the other hand, pleural effusion was more frequent in the PTB-only group 41 (16.4%) than in the HIV/PTB group 37 (14.8%). Pleural effusion is slightly more common on the left than right, 45 (18%) versus 44 (17.6%). This contrasts with findings by Ravi et al[9] where lymphadenopathy was more in the PTB-only group (20.83%) compared to HIV/PTB group (14.8%) and pleural effusion more in the HIV/PTB group (28.57%) than (19.44%) in the PTB-only group. In this study, the more common finding of pleural effusion in the PTB-only group may be an indication that the prevalence of primary pulmonary tuberculosis is increasing.

Patients in the PTB-only group significantly had more volume loss 61 (24.4%) compared to 22 patients (8.8%) in the HIV/PTB group with a p-value < 0.001. This may be a result of increased chronicity of the disease, better healing processes, and increased mobilization of fibrogenic cytokines in the PTB-only group.[35] On the contrary, Raji et al[9] in their study of 100 patients with PTB-only and HIV/PTB co-infection reported no volume loss. The difference may be a result of differences in sample size.

In our study, the majority of the destroyed lungs seen were on the left 6 (2.4%) compared to the right 1 (0.4%) and only in the PTB-only group. Similar findings were made by Fawibe et al[36] who reported unilateral lung destruction in 76 patients (1.3%) most of which were on the left, 49 (66.2%). This suggests that the process of destruction may be related more to lung cicatrization in post-primary PTB and less to airway obstruction from hilar or peri-bronchial lymphadenopathy. The left-sidedness may be due to the fact that the left main bronchus is longer and smaller in luminal caliber than the right and crosses a narrow anatomical space, the aortopulmonary window.[37]

More patients had bronchopneumonia, 165 (66%) patients than lobar pneumonia, 43 (17.2%) patients. Both bronchopneumonia and lobar pneumonia were seen more in PTB-only patients, 99 (39.6%) patients and 26 (10.4%) patients respectively. While in the HIV/PTB co-infected patients, 66 (26.4%) patients and 17 (6.8%) patients respectively. The difference in occurrence of bronchopneumonia between PTB and HIV/PTB patients was statistically significant, (X^2 = 4.91, p-value = 0.027). PTB patients were significantly (X^2 = 8.003, p-value = 0.005) less likely to have normal chest radiographs, 8 for PTB-only (3.2%) versus 19 for HIV/PTB co-infection (7.6%) and more likely to have nodular (14.8% versus 13.2%), reticular (8.4% versus 5.6%) or reticulonodular opacities (26.4% versus 14.4%) than HIV/PTB co-infected patients. The higher frequency of opacities in PTB-only patients 124 (49.6%) versus 83 patients (33.2%) in the HIV/PTB group is statistically significant (X^2= 10.765, p-value = 0.001). Similar results were reported by Kisembo et al.[38] These pattern differences between PTB and HIV/PTB groups may be a reflection of the severity of the disease, late presentation to the hospital, and the immunity-dependent response to the infection in the PTB-only group.

The PTB-only group had more typical post-primary PTB patterns in 60 (24%) patients than atypical patterns in 46 (18.4%) patients while in the HIV/PTB group, the atypical pattern was found slightly higher, 37 (14.8%) patients than typical pattern, 36 (14.4%) patients. This was not statistically significant, the p-value was 0.084. This is similar to findings in the study by Lau et al[39] and Tahir et al[40] both showed higher percentages of atypical patterns in the HIV/PTB group

Using bivariate logistic regression, the odds ratio (OR) or chances for the development of significant chest radiographic findings in PTB were highest for cavity formation (OR = 3.736) and lung volume loss (OR = 4.240). This is in keeping with the well-documented reports of the destruction of lung collagen and elastin fibers in PTB by excess matrix metalloproteases (MMP) expression. MMP is a family of zinc-dependent proteases expressed mostly in diseased tissues that are undergoing repair and remodeling.[41] This process leads ultimately to cavity formation, alveolar destruction, and volume loss. This is appreciated in the study with the PTB-only group having more cases of cavities and volume loss when compared with HIV/PTB co-infection group. The “OR” of the development of lung cavity and volume loss in HIV/PTB co-infection was less compared with the PTB-only group. This is due to the fact that tuberculosis-induced MMP concentrations are suppressed by HIV infection.[42]

CONCLUSION

In conclusion, the distribution of normal chest radiographs and various types of chest radiographic findings including volume loss, bronchopneumonia, cavities, fibrosis, and cystic changes showed significant differences between PTB-only and HIV/PTB co-infection The study showed that patients with PTB had very high chances for the development of all the abnormal chest radiographic findings except lymphadenopathy while those with HIV/PTB co-infection had very high chances of developing only lymphadenopathy compared to the rest of the other chest findings**.**

LIMITATIONS:
Possible occult immunodeficiency states could have altered the exact radiographic pattern of PTB infection in the PTB-only group. In the apparently normal radiographs, very small abnormalities could have been missed in the hidden areas of the lung.

RECOMMENDATIONS
The high age-specific prevalence of pulmonary tuberculosis among young adults in this study shows that the disease is still very much around us and has not abated. This necessitates further actions on PTB prevention and control across all levels of health care, health agencies, and governments.
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