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Assessment of Chest Radiographic Patterns in Newly Diagnosed Sputum-Positive Pulmonary Tuberculosis: A Cross-Sectional Study

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ABSTRACT

Background: Pulmonary tuberculosis is commonly associated with abnormalities on chest radiography. Advancing age may influence the radiographic presentation and pattern of lung involvement.

Methods: A cross-sectional study was conducted among 560 newly diagnosed sputum-positive pulmonary tuberculosis patients between December 2023 and September 2025 at a tertiary care hospital in Mangalore. Chest radiographic findings were documented and compared between elderly and adult patients.

Results: Male predominance was observed (62.3%). A significantly higher proportion of elderly patients had a high bacillary load (3+) than adults (40.2% vs. 13.1%, p<0.001). Infiltrative and cavitory lesions were common findings. Cavitory lesions were significantly more prevalent in adults than in older people (51.6% and 23.4%, p<0.05). Conversely, alveolar opacity (30.5% and 6.7%, p<0.05) was significantly higher among elderly patients. Right upper zone involvement was seen in the majority of cases (35.9%). Bilateral involvement was also significantly higher (p<0.05). All chest X-ray findings were significantly associated with high bacillary load (p<0.05), except fibrosis.

Conclusion: Chest radiographic abnormalities, particularly infiltrates and cavitary lesions, are common in sputum-positive pulmonary tuberculosis patients. Elderly patients exhibit a higher frequency of atypical radiological patterns and bilateral involvement, which may contribute to delayed diagnosis. A high index of suspicion is essential for timely identification and management in this population.

Key-words: Cavitory, Chest, Consolidation, Infiltrative, Pulmonary, Radiographic, Tuberculosis

INTRODUCTION

Tuberculosis (TB) is one of the foremost global health threats, resulting in a significant number of deaths annually. In 2017, around 10 million cases of tuberculosis were reported, leading to 1.6 million fatalities, including 300,000 deaths among individuals living with HIV [1]. From 2000 to 2017, effective diagnosis and treatment contributed to saving an estimated 54 million lives [1]. The incidence of TB is rising among individuals with existing health conditions and those receiving treatments that weaken their immune responses. The disease carries considerable morbidity and mortality risks, with over 95% of deaths occurring in low-income countries; it is also a primary cause of mortality for women aged 15 to 44 [2].

Radiological techniques are essential for detecting tuberculosis. Some researchers suggest that pulmonary TB in older adults may present atypically on radiographs.

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Previous research indicates that the presence of acid-fast bacilli (AFB) in sputum samples can be significantly affected by associated radiological findings [3]. Given the prevalent difficulties in recognizing the radiographic indicators of pulmonary tuberculosis, reviewing chest X-ray abnormalities in patients with sputum-positive TB could provide valuable insights. Chest X-ray manifestations linked to pulmonary tuberculosis include parenchymal infiltrates, patchy consolidations, nodular opacities, fibrotic changes (with or without loss of volume), cavitation (with or without air-fluid levels), as well as pleural effusions or thickening related to parenchymal lesions [4]. These abnormalities are generally found in the apical and posterior segments of the upper lobes and the superior segments of the lower lobes [5].

Despite acknowledgement of atypical clinical presentations and chest radiographic features within older populations, the elevated morbidity and mortality rates observed in this demographic are probably due to inadequate recognition of these subtle variations. Such oversights may result in delays in both diagnosis and the commencement of appropriate treatment [6]. As a result, this study seeks to document the radiological patterns associated with pulmonary tuberculosis in both young adults and the elderly.

MATERIALS AND METHODS

Study Design- This hospital-based cross-sectional study was conducted to evaluate chest radiographic patterns in patients newly diagnosed with sputum-positive pulmonary tuberculosis.

Study Setting- The study was carried out in the Department of Respiratory Medicine at a tertiary care hospital in Mangalore.

Study Population- The research involved 560 individuals aged between 18 and 70 years who were newly diagnosed with sputum-positive pulmonary tuberculosis. The study took place from December 2023 to September 2025. Prior approval from the institutional ethical committee was secured before initiating the research. Participants were selected based on predefined inclusion criteria, and informed consent was obtained from each individual. A patient classified as a new case of tuberculosis has either never received treatment or has been treated with anti-tuberculosis medications for less than one month [7]. Comprehensive data, including clinical history, demographic information, and chest X-rays, were collected for all patients diagnosed with this condition.

Inclusion Criteria

1. Newly diagnosed cases of smear-positive pulmonary tuberculosis.
2. Individuals aged between 18 and 70 years.

Exclusion Criteria

1. Patients with extra-pulmonary tuberculosis.
2. Individuals younger than 18 years.
3. Cases of relapse or treatment failure.
4. Patients who resumed treatment after being lost to follow-up.
5. Multidrug-resistant (MDR) tuberculosis.
6. HIV-positive individuals.
7. Patients with abnormalities in the chest wall.
8. Those with pre-existing parenchymal lung disease.

Statistical Analysis- Data analysis was performed using Version 10 of the Statistical Package for Social Sciences (SPSS). For inferential statistics between groups, qualitative variables were assessed using the chi-square test, while quantitative variables were analyzed using Student's t-test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 560 (252 adults and 308 elderly) patients with newly diagnosed smear-positive pulmonary tuberculosis were included in the study. Age-wise (Table 1) and gender-wise (Table 2) distribution showed that the majority of patients belonged to the elderly population, with male predominance in both groups.

Table 1: Age-wise distribution

Gender	Adult (18–50 Year)	Elderly (>50 Year)
Female Count (%)	95 (37.7%)	98 (31.9%)
Male Count (%)	157 (62.3%)	210 (68.1%)
Total	252	308

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Table 2: Gender wise distribution

Gender	Adult (18–50 Years)	Elderly (>50 Years)	Total
Female Count (%)	91 (36.1%)	106 (34.4%)	197 (35.1%)
Male Count (%)	161 (63.9%)	202 (65.6%)	363 (64.8%)

Bacillary load (Table 3) showed the majority with 3+. The distribution of bacillary load differed significantly between adults and elderly patients. Elderly individuals had a higher proportion of 3+ smear positivity (40.6%) compared to adults (13.1%). This association between age group and bacillary load was statistically significant (Chi-square test, p <0.001).

Table 3: Bacillary Load

Bacillary Load	Total
Scanty	59 (10.5%)
1+	165 (29.5%)
2+	178 (31.8%)
3+	158 (28.2%)

This association between age group and bacillary test was statistically significant (chi-square test, p<0.001) (Table 4).

Table 4: Comparison of Bacillary Load in Adults and Elderly

Bacillary Load	Adult (18–50 Years)	Elderly (>50 Years)	p-value
Scanty	39 (15.5%)	20 (6.5%)	<0.001
1+	86 (34.1%)	79 (25.6%)	
2+	94 (37.3%)	84 (27.3%)	
3+	33 (13.1%)	125 (40.6%)	
Total	252 (100%)	308 (100%)	

The majority of our cases showed Infiltration and Cavity as the main chest x-ray lesions in the sputum-positive pulmonary tuberculosis (Table 5).

Table 5: Chest X-Ray Lesions in Sputum-Positive Pulmonary Tuberculosis

Lesions	Total (%)
Fibrosis	30 (5.4%)
Cavity	202 (36.1%)
Alveolar Opacity	111 (19.8%)
Consolidation	201 (35.9%)
Infiltration	225 (40.2%)
Pleural Fluid	32 (5.7%)

Cavity lesions and alveolar opacity show a statistically significant difference between adults and older people. All other lesions are not significantly different. Cavity lesions were significantly more common in adults, while alveolar opacity lesions and consolidation were significantly more common in older people (Table 6).

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Table 6: Chest X-Ray lesion comparison in adult and elderly population

Lesions	Adult (18-50 years)	Elderly (>50	p-value
Fibrosis	13(5.2%)	17(5.5%)	0.85
Cavity	130 (51.6%)	72(23.4%)	<0.001
Alveolar Opacity	17(6.7%)	94(30.5%)	<0.001
Consolidation	83(33%)	118(38.3%)	0.27
Infiltration	98(38.9%)	127(41.2%)	0.60
Pleural Fluid	11(4.4%)	21(6.8%)	0.24

Lung zone-wise involvement showed that most of the lesions involved the right upper zone (Table 7).

Table 7: Lung zone-wise involvement

Lung zone	Total (%)
Right upper zone (RUZ)	324(57.8%)
Right middle zone (RMZ)	188(33.6%)
Right lower zone (RLZ)	80(14.3%)
Left upper zone (LUZ)	153(27.3%)
Left middle zone (LMZ)	48(8.6%)
Left lower zone (LLZ)	33(5.9%)

Lung zone involvement showed all the zones to be mostly affecting the elderly age group. However, no statistically significant was found in this table (Table 8).

Table 8: Comparison of lung zone involvement in the adult and elderly population

Lung zone	18-50 years	>50 years	p-value
Right upper zone (RUZ)	143(56.7%)	181(58.9%)	0.659
Right middle zone (RMZ)	76(30.1%)	112(36.4%)	0.145
Right lower zone (RLZ)	35(13.9%)	45(14.6%)	0.903
Left upper zone (LUZ)	68(26.7%)	85(27.6%)	0.947
Left middle zone (LMZ)	19(7.5%)	29(9.4%)	0.524
Left lower zone (LLZ)	15(6.0%)	18(5.8%)	1.000

In our study, it was noted that bilateral involvement was significantly higher in the elder group when compared to adults ($p<0.05$) (Table 9).

Table 9: Comparison of bilateral lesions in adult and elderly population

Bilateral involvement	18-50 years	>50 years	Total	p-value
Count (%)	40 (15.9%)	84 (27.2%)	124(22.1%)	0.002

There is a statistically significant association between bacterial load and most chest X-ray lesions. Cavity, alveolar opacity, consolidation, infiltration and pleural effusion show significant variation across bacterial load categories ($p<0.05$). Higher bacterial load categories (2+ and 3+) were more commonly associated with cavity formation, consolidation and pleural effusion. Fibrosis did not show a statistically significant association with bacterial load ($p=0.059$) (Table 10).

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Table 10: Relation between bacterial load and chest x-ray lesion

Chest X-ray lesion	Scanty	1+	2+	3+	p-value
Fibrosis	2(3.4%)	6(3.6%)	7(3.9%)	15(9.5%)	0.059
Cavity	8(13.5%)	51(30.9%)	76(42.7%)	67(42.4%)	<0.05
Alveolar opacity	5(8.5%)	28(19.7%)	32(18.0%)	46(29.1%)	<0.05
Consolidation	6(10.2%)	59(35.8%)	73(41.0%)	63(39.6%)	<0.05
Infiltration	31(52.4%)	73(44.2%)	52(29.2%)	69(43.7%)	<0.05
Pleural effusion	2(3.4%)	2(1.2%)	12(7.6%)	16(10.1%)	<0.05

DISCUSSION

This research was carried out among newly diagnosed sputum smear-positive pulmonary tuberculosis patients aged 18 to 70 years. This study was undertaken at a tertiary care center in Mangalore from December 2023 to September 2025. Among the 560 study participants, 308 (55%) were above 50 years of age, whereas 252(45%) belonged to the 18-50 years age group.

The increased occurrence of pulmonary tuberculosis among the elderly population could be attributed to an age-related decline in immune function. Macrophages and T lymphocytes play a crucial role in host immunity against tuberculosis [8].

Male predominance was observed in both age groups in the present study, consistent with the findings reported by Jagadish *et al.* [9]. Rathman *et al.* [10] also reported that males accounted for 72.6% of their study population. Likewise, a meta-analysis involving 12 studies by Carlos Perez-Guzman [11] demonstrated a higher prevalence among males. Comparable observations were also noted by Mukherjee *et al.* [12].

A higher bacillary burden (3+) was more common among elderly patients (40.6%) than among adults (13.1%). This finding suggests that elderly individuals may contribute more to disease transmission, underscoring the need for timely diagnosis and early treatment. Similar findings were reported by Tan *et al.* [13], who observed that elderly patients had more severe disease with greater bacteriological load than young adults.

In the current study, infiltrating lesions (40.2%) and cavitary lesions (36.1%) were the most frequently detected radiological abnormalities. Zaheer Akthar *et al.* [3], in their assessment of chest radiographic patterns among sputum smear-positive patients with pulmonary tuberculosis, similarly observed infiltration (56.6%) and cavitary lesions (40.8%) as the predominant findings. Rathman *et al.* [10] also documented a high occurrence of infiltration (81%) and cavitation (61%) among patients with sputum-positive pulmonary tuberculosis.

When adults and elderly patients were compared, cavitary lesions were significantly prevalent among adults, whereas alveolar opacities were more commonly identified in elderly patients (p<0.05).

Pleural involvement, however, did not demonstrate a statistically significant difference between the two groups. Similar observations were made by Sonja *et al.* [14], who reported a higher frequency of cavitary lesions in adults aged 18-59 years than in elderly individuals. Babu *et al.* [15] also found that cavitation and consolidation were more commonly associated with younger adults than elderly patients. Comparable findings were reported by Anand *et al.* [16]. In a study evaluating radiographic manifestations of pulmonary tuberculosis, Seyed Mohammed Alavi *et al.* [17] noted that classical radiographic features, such as cavitation, were less frequently observed in older individuals. Gupta *et al.* [18], in their study conducted at PGIMER, Chandigarh, observed that cavitary lesions and infiltrative changes occurred more often among adults (38% and 34%, respectively) than among elderly patients (32% and 26%).

The reduced occurrence of cavitary lesions in elderly patients may be explained by diminished immune function associated with aging. Cavity formation is primarily associated with caseous necrosis, and a lower prevalence of cavitary tuberculosis has been reported in other immunocompromised conditions [19].

Our study shows upper zone involvement as the predominant radiological finding in both age groups. Right upper zone involvement was more common in the

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elderly population than in adults. Similar observations have been reported in various studies, in which upper lobe predominance was attributed to higher oxygen tension, which favors the growth of tubercle bacilli [20].

Middle- and lower-zone involvement was less frequent in both groups, and no significant age-related variation was observed. Left-sided lung zone involvement also showed no statistically significant difference between younger and older patients. Overall, the present study demonstrated that upper-zone predominance remains the common radiological pattern across age groups [20].

Bilateral pulmonary involvement was significantly higher among elderly patients than among adults in the present study. The increased frequency of bilateral disease in the elderly may indicate more advanced or extensive pulmonary involvement at presentation. Similar findings have been reported in earlier studies, suggesting that delayed diagnosis, reduced immune response, and the presence of comorbid conditions in older individuals may contribute to wider radiological spread of disease [21].

In the present study, cavitary lesions and pleural effusion were more commonly seen in patients with high bacillary load (3+), and this association was statistically significant ($p<0.05$). Earlier studies have also shown a positive correlation between cavitary disease and increased sputum bacillary count. G. Rathman *et al.* [10] demonstrated that patients with cavitary lung lesions tend to have higher sputum bacterial loads, underscoring the importance of early recognition and treatment. Likewise, Murthy *et al.* [22] reported that more severe radiographic abnormalities on chest X-ray were associated with greater smear positivity, although the strength of association was modest. These findings support the observation that extensive radiological abnormalities may indicate a higher mycobacterial burden.

CONCLUSIONS

The present study identified infiltrative opacities and cavitary lesions as the predominant chest radiographic abnormalities among newly diagnosed sputum smear-positive pulmonary tuberculosis patients. A high bacterial burden was frequently observed among elderly patients at the time of diagnosis. Such manifestations in older individuals may contribute to diagnostic delay and postponement of treatment initiation. Therefore, clinicians should maintain a strong suspicion for tuberculosis in elderly patients to facilitate timely diagnosis and early treatment, thereby helping to reduce complications, mortality and disease transmission in the community.

CONTRIBUTION OF AUTHORS

Research concept- Muhammed Faseed CH, Philips Antony
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