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Original Article

Internal Medicine Section

Clinical and Microbiological Profiles of Bronchial Anthracosis: A Hospital-based Cross-sectional Study in the Kashmir Valley, India

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ABSTRACT

Introduction: Bronchial anthracosis is a chronic respiratory condition characterised by the deposition of carbon particles in the bronchial mucosa. It is frequently associated with prolonged exposure to environmental pollutants, biomass smoke, and occupational dust, particularly in low-resource and rural settings.

Aim: To elucidate the clinical and microbiological profile of patients with bronchial anthracosis in the mountainous valley of Kashmir, India.

Materials and Methods: This cross-sectional study involved 88 patients diagnosed with bronchial anthracosis who were recruited from a tertiary care hospital. Data were collected on demographics, co-morbidities, exposure history, and microbiological findings through Bronchoalveolar Lavage (BAL). Statistical analysis was performed using percentage distribution and logistic regression analysis.

Results: The mean age of the patients was 62.4±8.7 years, with females comprising 59.0% of the study population. Biomass fuel exposure (34.1%) and smoking (39.8%) were identified as significant risk factors. Common co-morbidities included Chronic Obstructive Pulmonary Disease (COPD) and hypertension. The chief complaints were cough (26.1%) and breathlessness (13.6%). BAL analysis revealed various pathogens, with *Mycobacterium tuberculosis* identified in 10.2% of cases. Logistic regression analysis demonstrated significant associations between bronchial anthracosis and age, smoking, and biomass fuel exposure, emphasising the influence of environmental risk factors.

Conclusion: The findings highlight the significant role of environmental and occupational exposures—particularly biomass fuel use and smoking—in the development of bronchial anthracosis. Older adults, especially housewives and farmers, were the most affected groups, emphasising the need for targeted public health interventions. The association of bronchial anthracosis with respiratory infections and co-morbidities such as COPD underscores the importance of early detection and appropriate management. Preventive strategies, including reduction of indoor air pollution and implementation of smoking cessation programmes, are essential to mitigate the disease burden in the ethnic population of Kashmir, India.

Keywords: Chronic obstructive pulmonary disease, Environmental exposure, Radiological, Smoking

INTRODUCTION

Bronchial anthracosis is a chronic respiratory condition characterised by the deposition of carbon particles in the bronchial mucosa, frequently leading to inflammation, bronchial wall thickening, and clinical manifestations that mimic COPD and chronic bronchitis. It primarily arises due to prolonged exposure to particulate matter resulting from indoor biomass fuel combustion, tobacco smoke, or environmental pollutants such as vehicular emissions and industrial fumes [1,2]. Although the condition was traditionally considered a benign and incidental finding, increasing evidence indicates that bronchial anthracosis is associated with significant respiratory morbidity, structural airway changes, and increased susceptibility to infections—particularly in regions with heavy environmental exposure such as the mountainous Kashmir Valley [3]. The pathophysiology of bronchial anthracosis involves chronic inhalation of carbonaceous particles that accumulate in the bronchial epithelium. These particles, predominantly originating from the incomplete combustion of organic materials such as wood, animal dung, and fossil fuels, stimulate a local inflammatory response, leading to mucosal damage and potential fibrotic remodelling of the airways [4]. Prolonged exposure disrupts the mucociliary clearance mechanism, reduces pulmonary immunity, and predisposes individuals to chronic respiratory infections [5].

Several studies have demonstrated a strong association between indoor air pollution and bronchial anthracosis. Biomass fuel smoke, commonly used for cooking and heating in low-income and rural settings, is a primary contributor [5]. A study conducted in rural India showed a significantly higher prevalence of bronchial anthracosis among individuals exposed to biomass smoke compared to those using cleaner fuels [6]. Similarly, elevated rates of bronchial anthracosis have been reported in urban populations in China exposed to ambient air pollution and vehicular emissions [7]. The disease burden is influenced by geographic and environmental factors, emphasising the importance of region-specific epidemiological assessments. Clinically, patients with bronchial anthracosis often present with persistent cough, breathlessness, wheezing, and excessive sputum production. These symptoms closely resemble those of COPD and chronic bronchitis, which may lead to misdiagnosis [8]. In severe cases, bronchial fibrosis—referred to as anthracofibrosis—may result in airway obstruction and respiratory distress [9].

Accurate diagnosis relies on a combination of clinical history, radiological imaging, and bronchoscopic evaluation. High-Resolution Computed Tomography (HRCT) of the chest typically reveals bronchial wall thickening, nodular opacities, atelectasis, lymphadenopathy, and mass-like consolidations with calcification [10]. Bronchoscopy often reveals black pigmented lesions on the bronchial mucosa, which are considered pathognomonic for the condition [11]. A significant correlation has been observed between radiological findings and the extent of exposure to particulate matter. Studies using HRCT have consistently demonstrated thickened bronchial walls and intraluminal nodules in affected individuals [12]. Moreover, bronchoscopy provides direct visualisation of anthracotic plaques and facilitates microbiological sampling from the bronchial tree for the detection of concurrent infections [13].

The reported prevalence of bronchial anthracosis varies across regions and diagnostic settings. In bronchoscopy-based studies, prevalence rates have ranged from 3.4-21% [14]. In India, among individuals with long-term biomass fuel exposure, up to 28.3% were diagnosed with bronchial anthracosis, with 40% demonstrating features of anthracofibrosis [15]. These findings underscore the influence of domestic fuel use and occupational exposure on disease prevalence. Bronchial anthracosis is also associated with recurrent respiratory infections due to impaired mucosal immunity and bronchial remodelling. *Streptococcus pneumoniae* and *Haemophilus influenzae* are frequently isolated pathogens in affected patients [16]. *Mycobacterium tuberculosis* represents another major concern, with evidence suggesting a possible causal association or opportunistic reactivation in anthracotic lungs [17]. Additionally, an increased frequency of fungal infections has been reported, likely due to disruption of the mucosal barrier and local immunosuppression [18].

Smoking remains a well-established risk factor for bronchial anthracosis. Tobacco smoke acts synergistically with environmental pollutants to cause bronchial injury and carbon deposition [19]. However, even non smokers exposed to biomass smoke demonstrate a substantial disease burden, highlighting the importance of indoor air pollution control. Biomass fuel use is particularly prevalent in underdeveloped and mountainous regions where alternative cooking and heating methods are limited. Research findings have shown that traditional biomass fuels such as wood, cow dung, and crop residues emit high concentrations of fine particulate matter ($PM_{2.5}$), which is directly implicated in the development of bronchial anthracosis [20].

The Kashmir Valley presents a unique ecological and socio-environmental landscape that increases the risk of bronchial anthracosis. Its cold climate necessitates extensive biomass fuel use for heating, while traditional cooking practices persist, particularly in rural households. Owing to the region's geographical topography—being encircled by the Himalayas—temperature inversion during winter months traps pollutants near ground level, thereby prolonging exposure [21]. Furthermore, unregulated vehicular emissions and localised industrial activities contribute to outdoor air pollution.

Occupational exposure is another important determinant of risk. Agricultural workers, bakers, and artisans are frequently exposed to organic dust and smoke. In a study by Sofi I et al., over 60% of households in Kashmir reported using biomass fuels, with women being disproportionately affected due to prolonged exposure during cooking. Smoking prevalence among adult males further compounds the risk [22].

Bronchial anthracosis is often accompanied by co-morbid conditions such as COPD and cardiovascular diseases, which complicate clinical management. Chronic inflammation and airway remodelling contribute to progressive pulmonary function decline and systemic effects. One study demonstrated a strong correlation between bronchial anthracosis and COPD, recommending integrated disease management approaches [23]. The presence of co-morbidities not only worsens respiratory symptoms but also increases the risk of hospitalisation and mortality.

Despite its increasing clinical relevance, bronchial anthracosis remains under-recognised and underreported, particularly in high-risk regions. Public health strategies aimed at reducing dependence on biomass fuels, promoting cleaner energy alternatives, and regulating outdoor emissions are urgently needed. Early detection through clinical-radiological correlation and bronchoscopic examination is crucial for preventing complications. In view of the limited available data and the high prevalence of known risk factors, this study aims to fill critical knowledge gaps and support targeted health interventions [22,23].

The objectives of the study were to evaluate the association of bronchial anthracosis with demographic variables, biomass fuel exposure, smoking, co-morbidities, and a past history of pulmonary tuberculosis. Additionally, the study sought to assess the clinical, radiological, and microbiological profiles of bronchial anthracosis among patients in the Kashmir Valley and to identify associated environmental and occupational risk factors.

MATERIALS AND METHODS

This cross-sectional study was conducted at the Government Chest Disease Hospital, Srinagar, a tertiary care referral centre for the region, from June 2023 to June 2024. The Department of Pulmonology facilitated the identification and recruitment of cases. The study population comprised 88 patients diagnosed with bronchial anthracosis. Institutional ethical clearance was obtained (Ref No: IRBGMC/CD30), and written informed consent was obtained from all participants.

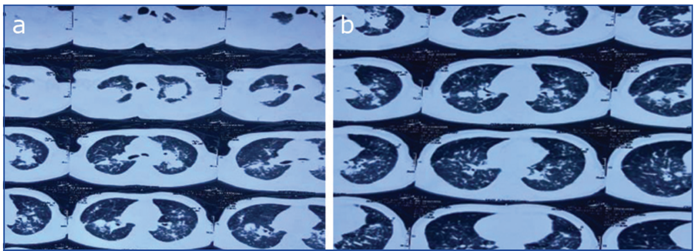
Inclusion criteria: Patients aged 18 years and above who were diagnosed with bronchial anthracosis confirmed through bronchoscopy. The diagnosis was based on characteristic bronchoscopic findings, such as black pigmentation of the bronchial mucosa, with or without associated bronchial narrowing, and was supported by relevant clinical and radiological features. These inclusion criteria ensured that only patients with a definitive diagnosis, established through direct visualisation of the airways, were included in the study.

Exclusion criteria: Patients with active pulmonary tuberculosis at the time of evaluation, as the presence of this condition could confound the clinical and microbiological findings related to bronchial anthracosis. Additionally, individuals who declined to undergo bronchoscopy were excluded, as this procedure was essential for confirming the diagnosis and collecting relevant clinical data. This approach helped maintain diagnostic accuracy and minimise potential confounding factors.

Data collection: Data collection was conducted from June 2023 to June 2024. A structured questionnaire was used to gather information on demographic characteristics, clinical symptoms, occupational history, smoking status, biomass fuel exposure, past history of pulmonary tuberculosis, and co-morbidities. The questionnaire was administered by trained pulmonologists.

Clinical assessment: Clinical assessment included a comprehensive physical examination and documentation of symptoms such as chronic cough, dyspnoea, sputum production, and other respiratory or systemic manifestations.

Radiological assessment: Patients with HRCT chest findings suggestive of bronchial wall thickening, mass-like consolidation with calcification, nodules, lung collapse, or lymph node calcification were subjected to bronchoscopy [Table/Fig-1].



[Table/Fig-1]: a) Mass like consolidation seen in bilateral upper lobe; b) Bilateral nodular opacites with areas of hyperinflation seen in radiological assessment.

Bronchoscopic assessment: Bronchoscopy was performed in all cases to visually confirm the presence of black pigmentation of the bronchial mucosa, indicative of bronchial anthracosis. Bronchoscopic findings were recorded and correlated with clinical and radiological data [Table/Fig-2].

[Table/Fig-2]: Pictures showing black pigmentation with anatomical distortion of the opening of a bronchus by bronchoscopy.

Microbiological assessment: The BAL samples were collected from all participants for microbiological analysis. The samples were tested for common bacterial and fungal pathogens, and culture and sensitivity testing were performed to identify the causative organisms. Microbiological assessments were routinely conducted in the hospital laboratory as per standard protocols, and laboratory records were reviewed and documented accordingly.

Exposure assessment: Exposure to potential risk factors was assessed using detailed questionnaires that included smoking history, biomass fuel exposure, and occupational dust exposure. Occupational exposure was evaluated by recording the participants' job histories.

STATISTICAL ANALYSIS

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 21.0. Descriptive statistics, including frequencies and percentages, were used to summarise categorical variables, while continuous variables such as age were expressed as mean±Standard Deviation (SD). The Chi-square test and Fisher's exact test were used to assess associations between categorical variables, including comorbidities, biomass fuel exposure, smoking status, and BAL microbiological findings. Logistic regression analysis was performed to evaluate the association between bronchial anthracosis and various risk factors, including smoking, biomass fuel exposure, and co-morbidities, after adjusting for potential confounders. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to determine the strength of associations. A p-value of <0.05 was considered statistically significant. Results were presented in tables and figures for improved visualisation and interpretation of data trends and associations.

RESULTS

[Table/Fig-3] shows that the majority of patients (89.8%) were aged 61 years and above, with 45.5% in the 61-70-years age group and 44.3% aged over 70 years. The lowest prevalence was observed in the 41-50-year age group, with only one patient (1.1%). A higher proportion of females (59.1%) were diagnosed with bronchial anthracosis compared to males (40.9%). Housewives constituted the largest occupational group affected by bronchial anthracosis, accounting for 59.1% of cases. Farmers (19.3%) and labourers (12.5%) were the next most commonly affected groups. Other occupations, including business (4.5%), drivers (2.3%), and government employees (2.3%), showed a lower prevalence.

[Table/Fig-4] indicates that the majority of patients (55.7%) did not have any co-morbidities. Hypertension was the most common co-morbidity, observed in 15 patients (17.0%). COPD was identified in 12 patients (13.6%), making it the second most common comorbidity. Bronchiectasis, hypothyroidism, and diabetes mellitus were each present in three patients (3.4%). Bronchial asthma, gastritis, and malignancy were observed in one patient each (1.1%).

Variable	n (%)
Age distribution (years)	
41-50	1 (1.1)
51-60	8 (9.1)
61-70	40 (45.5)
>70	39 (44.3)
Gender	
Female	52 (59.1)
Male	36 (40.9)
Occupation	
Housewife	52 (59.1)
Farmer	17 (19.3)
Laborers	11 (12.5)
Business	4 (4.5)
Driver	2 (2.3)
Govt Employee	2 (2.3)

[Table/Fig-3]: Demographics and occupational distribution of patients with bronchial anthracosis (n=88).

Co-morbidity	n (%)
No co-morbidity	49 (55.7)
Hypertension	15 (17.0)
Chronic Obstructive Pulmonary Disease (COPD)	12 (13.6)
Bronchiectasis	3 (3.4)
Hypothyroidism	3 (3.4)
Diabetes mellitus	3 (3.4)
Bronchial asthma	1 (1.1)
Malignancy	1 (1.1)
Gastritis	1 (1.1)

[Table/Fig-4]: Distribution of comorbidities in patients with bronchial anthracosis (n=88).

In [Table/Fig-5], cough was the most common presenting complaint, reported by 23 patients (26.1%). Breathlessness was reported by 12 patients (13.6%). Sputum production was a major complaint in 15 patients (17.0%).

Chief complaint	n (%)
Cough	23 (26.1)
Cough and breathlessness	18 (20.5)
Sputum production	15 (17.0)
Breathlessness	12 (13.6)
Cough and sputum production	8 (9.1)
Haemoptysis	6 (6.8)
Chest pain	3 (3.4)
Cough and chest pain	3 (3.4)

[Table/Fig-5]: Distribution of chief complaints in patients with bronchial anthracosis (n=88).

[Table/Fig-6] shows that a significant proportion of patients 30 (34.1%) reported exposure to biomass fuel. The high prevalence of smoking among patients 35 (39.8%) indicates a strong association between tobacco use and bronchial anthracosis. Additionally, 21.6% of patients reported a past history of pulmonary tuberculosis. Only four patients 4 (4.5%) reported no exposure to biomass fuel, smoking, or a history of pulmonary tuberculosis.

In [Table/Fig-7], the majority of BAL samples (56 of 88 patients; 63.6%) showed no microbial growth. *Mycobacterium tuberculosis* and *Pseudomonas* species were the most frequently identified pathogens, each accounting for nine cases (10.2%). *Candida* species were detected in five patients (5.7%). Two cases (2.3%) were positive for methicillin-resistant *Staphylococcus aureus* (MRSA), and one

Variables	n (%)
Smoker	35 (39.8)
Biomass fuel exposure	30 (34.1)
Past history of Pulmonary Tuberculosis (PTB)	19 (21.6)
Nil exposure or history	4 (4.5)

[Table/Fig-6]: Distribution of biomass fuel exposure, smoking status, and past history of Pulmonary Tuberculosis (PTB) in patients with bronchial anthracosis (n=88).

Microorganism detected	n (%)
No growth	56 (63.6)
Pseudomonas	9 (10.2)
Mycobacterium tuberculosis	9 (10.2)
Candida	5 (5.7)
Methicillin-Resistant *Staphylococcus aureus* (MRSA)	2 (2.3)
Acinetobacter ursingii	1 (1.1)
Aspergillus fumigatus	1 (1.1)
Escherichia coli (E. coli)	1 (1.1)
Methicillin-Sensitive *Staphylococcus aureus* (MSSA)	1 (1.1)
Non *mycobacterium tuberculosis*	1 (1.1)
Streptococcus mitis	1 (1.1)
Yeast cells	1 (1.1)

[Table/Fig-7]: Distribution of BAL microbiology findings in patients with bronchial anthracosis (n=88).

case (1.1%) was positive for methicillin-sensitive *Staphylococcus aureus* (MSSA). Rare pathogens such as *Acinetobacter ursingii* (1.1%), *Aspergillus fumigatus* (1.1%), *Streptococcus mitis* (1.1%), and yeast cells (1.1%) were identified in individual cases. One patient (1.1%) tested positive for a non *Mycobacterium tuberculosis* species.

[Table/Fig-8] summarises that the majority of BAL cytology reports (78 of 88 cases; 88.6%) were labelled as inconclusive. Chronic inflammation was observed in seven patients (8.0%). Atypical cells were identified in one patient (1.1%). One patient (1.1%) was diagnosed with Non Small Cell Carcinoma (NSCLC) on BAL cytology. Squamous metaplasia was observed in one patient (1.1%).

Cytological finding	n (%)
Inconclusive	78 (88.6)
Chronic inflammation	7 (8.0)
Atypical cells	1 (1.1)
Non Small Cell Carcinoma (NSCLC)	1 (1.1)
Squamous metaplasia	1 (1.1)

[Table/Fig-8]: Distribution of BAL cytology findings in patients with bronchial anthracosis (n=88).

[Table/Fig-9] demonstrates that the strongest association was observed with COPD (OR: 3.49, p-value<0.001), while biomass fuel exposure (OR: 3.16, p-value=0.001) and a history of tuberculosis (OR: 2.84, p-value=0.003) also posed substantial risks.

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Age (>60 years)	1.78	1.12 - 2.83	0.034*
Gender (Female)	1.25	0.70 - 2.22	0.431
Occupation (Housewife)	2.01	1.14 - 3.53	0.019*
Smoking (Yes)	2.57	1.42 - 4.67	0.002*
Biomass fuel exposure (Yes)	3.16	1.75 - 5.68	0.001*
Past history of PTB (Yes)	2.84	1.47 - 5.48	0.003*
COPD (Yes)	3.49	1.84 - 6.62	<0.001*
Chronic inflammation on BAL	2.12	1.05 - 4.30	0.037*
Presence of pseudomonas	1.78	0.95 - 3.34	0.071
No co-morbidity (reference)	1.00	-	-

[Table/Fig-9]: Logistic regression analysis of risk factors associated with bronchial anthracosis (n=88).
Variables with a p-value <0.05 were considered statistically significant and are marked with an asterisk (*).

DISCUSSION

Bronchial anthracosis is characterised by carbon deposition in the bronchial walls, primarily resulting from prolonged exposure to inhaled pollutants such as biomass fuel smoke, occupational dust, and tobacco smoke [18,19]. This cross-sectional study aimed to elucidate the clinical and microbiological profiles of patients with bronchial anthracosis in the mountainous Kashmir Valley. The findings demonstrate significant associations between bronchial anthracosis and several risk factors, including advanced age, occupational exposure, smoking, and the presence of co-morbidities.

The demographic analysis presented in [Table/Fig-1] revealed that bronchial anthracosis predominantly affects older adults, with 89.8% of cases occurring in individuals aged over 60 years. These findings align with previous research suggesting that cumulative lifetime exposure to airborne toxins, combined with age-related decline in pulmonary function, significantly contributes to the development of chronic respiratory diseases [18,19]. Furthermore, a higher prevalence was observed among females (59.0%), likely attributable to prolonged exposure to indoor air pollutants from biomass fuel combustion in poorly ventilated households [20]. Similar trends have been reported in studies highlighting the increased vulnerability of women to indoor pollution–related respiratory diseases in low-income and rural settings [20].

Occupational exposure was also identified as a critical risk factor, with housewives and farmers representing the most affected groups. Farmers are frequently exposed to soil dust and organic particulates, whereas housewives experience chronic exposure to biomass fuel emissions during cooking and heating activities ([Table/Fig-2]). These observations are consistent with studies linking traditional agricultural practices and indoor biomass fuel use to increased respiratory morbidity [4,5].

Co-morbidities such as COPD (13.6%) and hypertension (17.0%) were commonly observed among the study population, reinforcing the concept that bronchial anthracosis often coexists with other chronic conditions sharing similar risk factors [6]. Notably, more than half of the patients (55.7%) had no documented co-morbidities, suggesting that bronchial anthracosis may develop independently of pre-existing lung disease, thereby underscoring the direct impact of environmental exposures [7].

[Table/Fig-3] highlights the predominant clinical manifestations, with cough (26.1%) and breathlessness (13.6%) being the most frequently reported symptoms. These findings are consistent with previous studies identifying persistent respiratory symptoms as hallmark features of bronchial anthracosis [20,21]. The presence of haemoptysis in 6.8% of patients is clinically significant, as it may indicate severe bronchial inflammation or an underlying malignancy, warranting further diagnostic evaluation [22].

Sputum production (17.0%) was another common complaint, supporting the hypothesis that chronic irritation from inhaled pollutants leads to increased mucus secretion as part of the inflammatory response [23]. The role of biomass fuel exposure and smoking in the pathogenesis of bronchial anthracosis was evident in [Table/Fig-4], where 34.1% of patients reported biomass fuel exposure and 39.8% were current or former smokers [24]. The association between biomass fuel use and chronic respiratory diseases is well documented, with numerous studies demonstrating that prolonged exposure to combustion by-products causes airway inflammation and structural damage. Similarly, logistic regression analysis [Table/Fig-8] confirmed smoking as a major independent risk factor, with an OR of 2.57 (p-value=0.002), emphasising the cumulative impact of tobacco smoke and airborne pollutants in the development of bronchial anthracosis [25].

Microbiological analysis of BAL samples [Table/Fig-5] revealed that 63.6% of cases showed no microbial growth, indicating that bronchial anthracosis often occurs in the absence of concurrent bacterial infection. However, *Mycobacterium tuberculosis* was detected in 10.2% of patients, highlighting the potential overlap between tuberculosis and bronchial anthracosis, particularly in endemic regions [26,27]. The isolation of *Pseudomonas* species in 10.2% of cases suggests that patients with chronic bronchial damage may be susceptible to secondary bacterial colonisation, warranting careful monitoring for opportunistic infections [27]. Additionally, fungal organisms such as *Aspergillus fumigatus* and *Candida* species were identified in some patients, raising concerns about fungal colonisation in individuals with chronic airway disease [27].

BAL cytology findings [Table/Fig-6] demonstrated that 88.6% of samples were inconclusive, which may reflect sampling limitations or the subtle cytopathological changes associated with bronchial anthracosis [6]. Nevertheless, the presence of atypical cells in one patient underscores the importance of vigilant follow-up, as chronic airway inflammation has been implicated in an increased risk of bronchogenic carcinoma [6]. The identification of squamous metaplasia in another patient further supports the potential for malignant transformation in long-standing cases of bronchial anthracosis.

Logistic regression analysis [Table/Fig-9] provided critical insights into factors strongly associated with bronchial anthracosis. In addition to smoking and biomass fuel exposure, a history of pulmonary tuberculosis emerged as a significant predictor, suggesting that prior infections may predispose individuals to anthracotic changes within the bronchial tree. These findings underscore the need for targeted interventions to reduce environmental exposures and enhance early detection, particularly in high-risk populations.

Given the high burden of biomass fuel use and occupational exposure in the Kashmir Valley, this study highlights the urgent need for public health strategies aimed at mitigating indoor air pollution and promoting respiratory health awareness. Measures such as encouraging the use of cleaner cooking fuels, improving household ventilation, and implementing smoking cessation programmes could substantially reduce the incidence of bronchial anthracosis and its associated complications. Furthermore, healthcare providers should maintain a high index of suspicion for bronchial anthracosis in patients presenting with chronic respiratory symptoms, particularly in regions where biomass fuel use and tuberculosis remain prevalent. These findings reinforce the critical role of environmental and occupational exposures in disease pathogenesis and emphasise the importance of early diagnosis and preventive interventions.

Limitation(s)

This study was limited by its single-centre design and relatively small sample size, which may affect the generalisability of the findings. Additionally, the cross-sectional nature of the study limits the ability to establish causal relationships between exposure factors and bronchial anthracosis. Further longitudinal research is warranted to evaluate long-term outcomes in affected individuals and assess the effectiveness of public health interventions aimed at reducing exposure to respiratory toxins.

CONCLUSION(S)

This study highlights a significant association between bronchial anthracosis and environmental as well as occupational exposures, particularly biomass fuel use and smoking. Older adults, housewives, and individuals with COPD or a history of pulmonary tuberculosis were identified as higher-risk groups. The findings emphasise the need for targeted public health interventions, including reduction of indoor air pollution and promotion of smoking cessation. Given the potential complications associated with bronchial anthracosis, early detection and appropriate management are essential. Further research is required to explore long-term outcomes and develop effective preventive strategies.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Dec 03, 2024
- Manual Googling: Sep 06, 2025
- iThenticate Software: Sep 09, 2025 (7%)

ETYMOLOGY: Author Origin

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AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

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