International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 11s, 2025
https://theaspd.com/index.php

Environmental Exposure–Induced Respiratory Bronchiolitis–Interstitial Lung Disease (RB-ILD): A Case Report From The Brick Kiln Belt Of South India

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Abstract:

Background: In the absence of recreational or occupational exposure to ILDs, their contribution to dyspnea, wheeze and cough in non-smokers with chronic exposures should be increasingly recognized with regard to the role of indoor and environmental air pollutants. Biomass smoke, particularly firewood, synthetic forest products, cigarette smoke with co-exposures from unregulated emissions from brick kilns in semi-urban areas in India have a significant potential towards establishing subclinical airway inflammation, translating gradually into progressive ILD patterns including Respiratory Bronchiolitis–Interstitial Lung Disease (RB-ILD).Case presentation: A 50-year-old non-smoker female from a rural area of Salem district presented with a 14 days history of increasingly worse breathing problems with increasing dry cough. She has a history of firewood cooking (smoking, with average 21 hours/week) from poorly ventilated indoor air, and lived permits from many unregulated brick kilns that were fogging forests at that time. High-res CT thorax cross-sectional imaging of the pulmonary parenchyma demonstrated within the upper lobe predominance of centrilobular ground-glass nodules. Bronchoscopy with transbronchial biopsy confirmed a diagnosis of RB-ILD that she responded to corticosteroid treatment, and strict environmental exposure control.Conclusion: RB-ILD in environmental exposures is an unrecognized health burden in many endemic areas (especially women, with exposure of this nature from indoor cooking with biomass and industrial pollution exposure). Increased awareness of ILDs, screening for environmental health and regional emission control are important public health and clinical interventions for endemic environmental exposures.

Keywords: *RB-ILD, Interstitial Lung Disease. Biomass Smoke, Brick Kiln Emissions, Non-Smoker ILD, Salem, Environmental Pulmonology.*

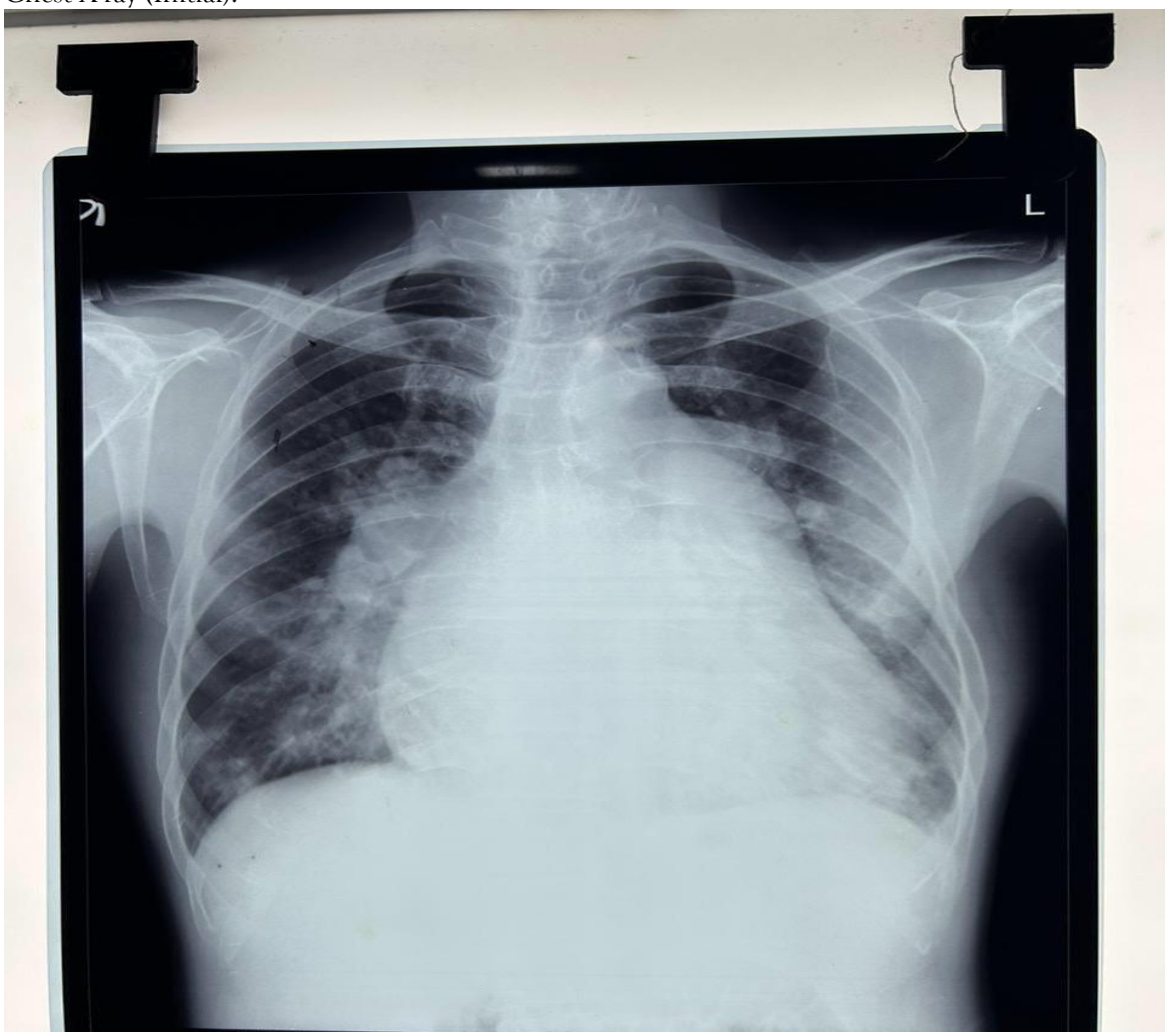
INTRODUCTION :

Respiratory Bronchiolitis-Interstitial Lung Disease (RB-ILD), a rare, smoking-related interstitial lung disease (ILD) that can also occur from chronic exposure to inhaled environmental toxins, affects women more due to cultural cooking habits and prolonged in-home exposure. In India, more than 60% of rural households use biomass fuels (i.e., firewood, cow dung and crop residues) for cooking. The problem is increasingly complicated with unregulated industries (e.g., brick kilns) located in the Salem district (Tamil Nadu). We present a rare case of biopsy-proven RB-ILD in a non-smoking female who lived next to a majority of industrial emission sources and had mild multi-decade exposure to biomass smoke.

Case Presentation :

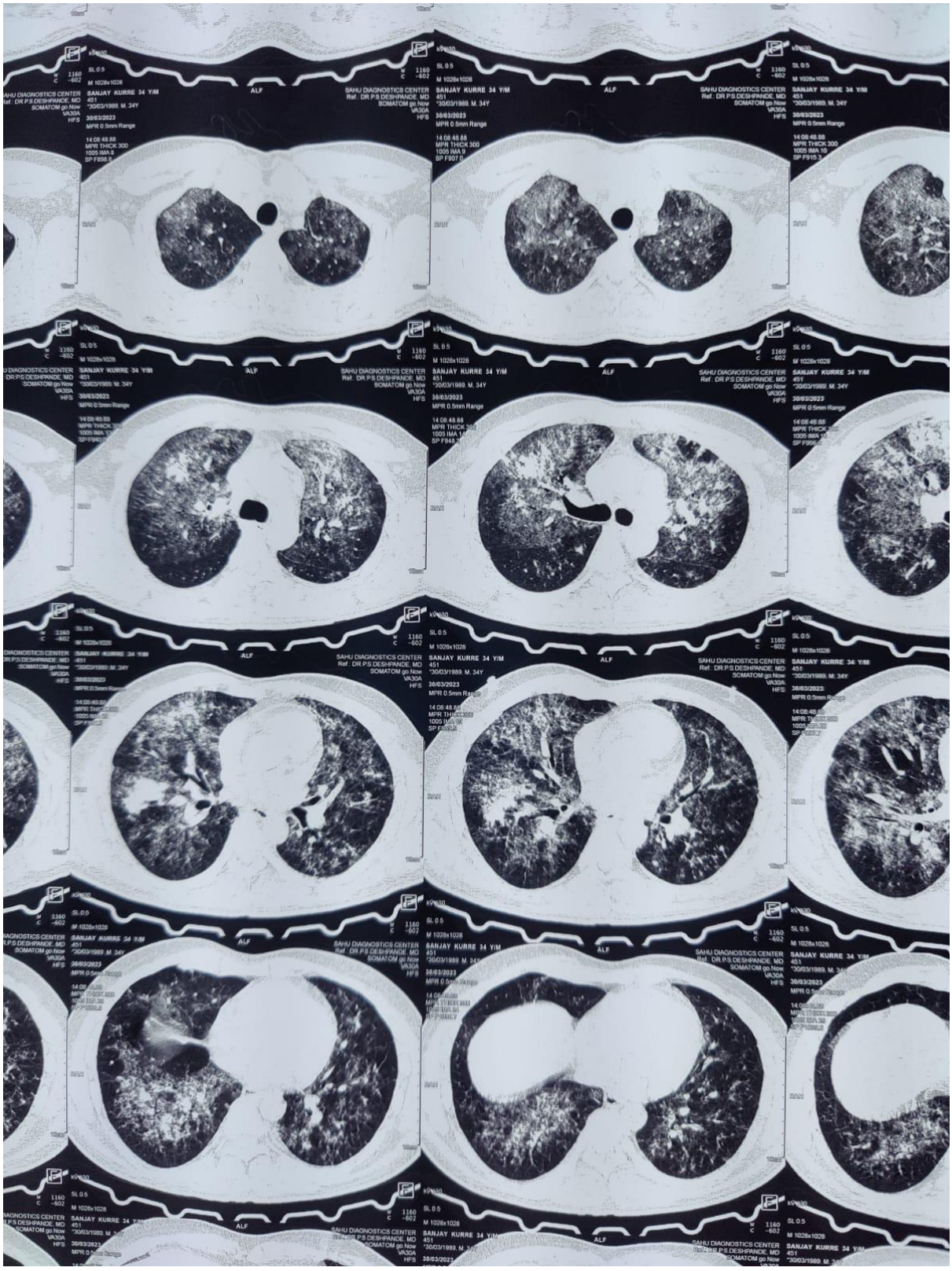
Demographic & Social History:

Age: 50 years
Sex: Female
Occupation: Homemaker
Location: Edappadi Block, Salem District, Tamil Nadu
Socioeconomic status: Lower middle income
Smoking status: Never smoked
Significant exposures:30 years of firewood cooking (unventilated mud kitchen)300-500m from three functional brick kilns continuing to emit visible smoke
Never employed with history of dust/silica/asbestos exposure
Clinical History:
Duration of symptoms: 14 months
Chief complaints:
Progressive exertional dyspnea (mMRC grade 1 to 3)
Persistent dry cough
Mild weight loss (4 kg over 6 months)
No fever, hemoptysis, or wheeze
No history suggestive of tuberculosis or autoimmune disease
3.Investigations:
1. Imaging Studies
Chest X-ray (Initial):



Mild upper and middle zone interstitial markings bilaterally
No signs of fibrosis or cavitation
cardiomegaly present

No pleural effusion
High-Resolution CT (HRCT) Thorax:



Findings:
Diffuse Bilateral centrilobular nodules and patchy ground-glass opacities
Upper lobe and middle lobe predominance
Peribronchiolar distribution of opacities with mild mosaic attenuation

Cardiomegaly present

Interpretation:
Suggestive of Interstitial lung disease, compatible with RB-ILD pattern
2. Pulmonary Function Tests (PFTs)

Parameter	Observed	% Predicted	Interpretation
FVC	1.59 L	68%	↓ (Restrictive)
FEV1	1.32 L	71%	↓
FEV1/FVC	0.83	Normal	Restrictive
DLCO	52%	Decreased	Impaired diffusion

6-Minute Walk Test:
Distance: 290 meters
Desaturation from 94% to 82% on room air
3. Bronchoscopy and BAL
BAL cytology and culture:
No malignant cells
Negative for acid-fast bacilli (AFB), fungal hyphae, or Pneumocystis
Neutrophil-predominant inflammation
BAL CD4/CD8 ratio: Not elevated
Histopathology – Transbronchial Biopsy
Microscopic Findings:
Accumulation of pigmented macrophages in the lumens of respiratory bronchioles and alveolar ducts
Mild chronic interstitial inflammation with thickened alveolar septa
Absence of granulomas, eosinophils, or vasculitis
Final Diagnosis:
Consistent with Respiratory Bronchiolitis–Interstitial Lung Disease (RB-ILD)
5. Serological and Autoimmune Work-up
ANA: Negative
Rheumatoid factor (RF): Negative
Anti-CCP: Negative
ANCA: Negative
Serum IgE: Normal
ESR: 28 mm/hr; CRP: Mildly elevated
HIV, HBsAg, Anti-HCV: Negative
Management:
Pharmacological Treatment :
Systemic corticosteroids:
Prednisolone started at 0.5 mg/kg/day (~30 mg daily) for 6 weeks - then a taper over the following 4 - 5 months depending on the clinical response as well as the side effects experienced.
Rationale: Corticosteroids decrease airway inflammation, relieve symptoms and potentially slow the progression of RB-ILD.
Inhaled therapy:
Inhaled corticosteroids (ICS) in addition to a long-acting beta-2 agonist (LABA) to address airway inflammation and obstruction and may have particularly been beneficial for symptomatic relief of cough and dyspnea.
Supportive therapy:
Supplemental oxygen therapy at 4-6 L/min during exertion was necessary due to exertional desaturation.

Antioxidant therapy (e.g. N-acetylcysteine) was discussed as a potential option to combat chronic inhalational injury-induced oxidative stress.

Environmental and Lifestyle Modifications :

A.Discontinuation of biomass exposure: The patient and family received extensive counseling on the risks for biomass smoke. They switched to cleaner fuels (where possible) e.g. LPG, or improved the existing stove design to include a chimney for venting.

Brick kiln exposures: They were advised to cut back on outdoors activities, particularly while brick kilns are actively firing. A temporary relocation for the duration of peak brick kiln activity was organized.

Indoor air quality: Chimneys were installed over the cooking area for venting smoke.

They were encouraged to clean regularly to reduce the dust and particulate load indoors.

Smoking cessation and general hygiene : Reinforced smoking cessation (the patient was a non-smoker).

Vaccination against influenza and pneumococcus was recommended

Outcome:

Symptom Improvement: Within 8 weeks of steroid therapy and environmental control, the patient reported significant reduction in dyspnea (mMRC grade improved from 3 to 1) and cough frequency decreased substantially.

Functional Gains:

6-minute walk distance improved from 290 m to 380 m.

Oxygen saturation no longer dropped below 90% during exertion.

Radiological Findings:

Follow-up HRCT at 3 months showed partial resolution of centrilobular nodules and ground-glass opacities. No progression to fibrosis or honeycombing.

Pulmonary Function Tests:

FVC improved to 75% predicted.

DLCO increased to 62% predicted.

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Quality of Life:

Patient returned to routine household activities with less fatigue and breathlessness.

DISCUSSION :

RB-ILD is a rare subtype of smoking-related interstitial lung disease, but it is increasingly recognized in patients exposed to non-tobacco environmental inhalants with chronic bronchiolitis, such as biomass smoke, occupational pollutants, and industrial emissions.

A. Environmental Background in Salem Region:

The Salem district is a well-known brick manufacturing region; the Edappadi, Omalur, and Sankari region in particular is known for brick kilns that combust wood, coal, and agricultural waste for brick production. Brick kilns produce excessive amounts of particulate matter (PM2.5 and PM10), carbon monoxide, and volatile organic compounds. The patient lived in close proximity (<500 meters) to three operating brick kilns and had constant exposure to brick kiln emissions. Additionally, the patient had over 30 years of biomass smoke exposure through traditional firewood cooking in a non-ventilated cooking space with a direct link to significant pulmonary inflammation and oxidative stress.

B. Pathophysiology:

Exposure to combustion by-products through inhalation activates alveolar macrophages and is associated with chronic bronchiolar inflammation. The accumulation of pigmented macrophages and peribronchiolar fibrosis in small airways is clinically and histologically consistent with RB-ILD, although RB-ILD is most commonly attributed to smoking. Environmental equivalents of smoking (e.g., biomass smoke and brick kiln smoke) exert similar airway toxicity.

C. Diagnostic Highlights:

RB-ILD requires correlation with clinical, radiological, and histopathological findings.

Upper lobe predominance with centrilobular nodules and GGO on HRCT, restrictive pattern on PFTs with ↓ DLCO, and pigmented macrophages noted on lung biopsy are the classical findings.

BAL excluded infections or eosinophilic pneumonitis, and the autoimmune panel was negative thus ruling out other ILDs such as NSIP or CTD-ILD.

D. Treatment Considerations :

Corticosteroids should always be applied if there is clinically significant symptoms or functional impairment.

It's similarly important to consider environmental factors—lessening exposures is top priority.

Education on indoor air quality and the installation of chimney or flue options can be a large factor in limiting continued lung injury.

E. Public Health Implications :

This case represents a preventable type of environmental ILD. Rural women in India are exposed to environmental risks that have increased: Domestic use of firewood, Construction limitations for ventilation infrastructure, Unrestricted small industries that will build near the home This combination is also a syndemic and thus is paralleling socio-environmental factors that could be amplifying non-communicable diseases such as ILD.

CONCLUSION

This case report of biopsy-proven RB-ILD in a non-smoking woman from rural Salem, India squarely implicates biomass smoke and brick kiln emissions as likely causative exposures. Despite classical association with tobacco smoke, this case expands the epidemiological perspective of RB-ILD, to include exposure from the environment that can occur commonly in low-resource contexts.

Follow-up management included efforts not only with pharmacotherapy but also in relation to environmental control.

RB-ILD requires clinical, radiologic, and histopathologic correlation.

The upper lobe-predominant centrilobular nodules with GGO on HRCT, restrictive PFT pattern with ↓ DLCO, and pigmented macrophages on lung biopsy are classical.

BAL excluded infections or eosinophilic pneumonitis, and autoimmune panel was negative, ruling out other ILDs like NSIP or CTD-ILD.

This case highlights the urgent need for:

Clinical awareness of environmental ILDs in India, Public health interventions to reduce exposure (chimneys, clean cookstoves, zoning regulations), Policy-level control of unregulated emissions in rural industrial clusters, Recognizing and managing such conditions early can improve quality of life, reduce healthcare burden, and prevent progression to fibrotic ILD.

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DECLARATIONS:

Ethics Approval: Not applicable (single anonymized case report)
Consent: Informed written consent obtained from the patient
Conflict of Interest: None declared
Funding: No external funding received
Author Contributions: All authors contributed equally
Acknowledgements: We thank the Department of Pulmonary Medicine.