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A Retrospective Observational on Occupational and Environmental Determinants of Lung Cancer Under 50 Years of Age

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Abstract: ***Background:** Lung cancer remains the leading cause of cancer-related mortality worldwide. Although tobacco smoking is the principal risk factor, occupational exposure to carcinogens such as silica, asbestos, and chemical fumes contributes substantially to disease development, particularly in developing countries where workplace safety measures may be inadequate. This study aimed to evaluate the demographic profile, occupational and environmental exposure history, clinical presentation, histopathological subtypes, stage at diagnosis, and clinical outcomes among adults aged less than 50 years with primary lung cancer. The association between occupational exposures, histological subtype, and disease stage was also assessed. **Methods:** A retrospective observational study was conducted among 50 patients aged <50 years with histologically confirmed primary lung cancer. Never-smokers and smokers with <30 pack-years were included, while patients with metastatic lung disease, recurrent lung cancer, or ≥30 pack-years smoking history were excluded. Data regarding demographic characteristics, occupational and environmental exposures, smoking status, clinical features, radiological findings, histopathology, tumour stage, and clinical outcomes were analysed. Fisher's exact test was used to determine associations between occupational exposure, histological subtype, disease stage, and smoking status. **Results:** Most patients (56%) belonged to the 40–49-year age group, with males accounting for 60% of the cohort. Smokers comprised 52%, while 48% were never-smokers. Construction and mining workers (30%) formed the largest occupational group. Silica and mineral dusts (28%) and asbestos (24%) were the predominant occupational exposures. Adenocarcinoma was the commonest histological subtype (40%), followed by small cell carcinoma (30%) and squamous cell carcinoma (26%). Overall, 68% of patients presented with stage III disease and 32% with stage IV disease; none had stage I or II disease. No significant association was observed between occupational exposure and histology (p=0.291), stage (p=0.554), occupation and histology (p=0.850), occupation and stage (p=0.333), or occupation and smoking status (p=0.519). **Conclusion:** Early-onset lung cancer predominantly affected middle-aged adults and included a substantial proportion of never-smokers, highlighting the contribution of occupational and environmental carcinogens. Advanced-stage presentation was universal, emphasizing the need for improved occupational health surveillance, early detection strategies, and larger multicentre studies.*

Keywords: Lung cancer; Occupational exposure; Silica; Asbestos; Adenocarcinoma; Young adults; Never-smokers; Advanced stage.

1. Introduction

Lung cancer represents a profound and escalating global public health challenge, persistently ranking as the leading cause of cancer incidence and mortality worldwide. Recent estimates highlight the immense burden of this malignancy, recording approximately 2.5 million newly diagnosed cases and 1.8 million lung cancer-related deaths globally in the year 2022.(1) The disease is frequently diagnosed at advanced stages when therapeutic interventions offer limited survival benefits. Although historically perceived as a disease predominantly afflicting older adults with extensive histories of heavy tobacco smoking, the contemporary epidemiological profile is undergoing an alarming transformation.

In the Indian subcontinent, the epidemiological landscape of lung malignancies mirrors these shifting global patterns, presenting a growing strain on the national healthcare infrastructure. Current registry data indicates that lung cancer accounts for 5.9% of all new cancer cases and contributes to 8.1% of all cancer-related mortalities within the country.(2) The magnitude of this disease is emphasized by national surveillance reports documenting that approximately 114,000 new cases of lung cancer are diagnosed across India each year.(3)

Traditionally, active tobacco consumption has been universally acknowledged as the predominant risk factor for pulmonary malignancies. However, clinical evidence reveals that lung cancer occurring in non-smokers constitutes an entirely distinct biological entity, differing substantially from smoking-related cancers in its molecular pathogenesis, histological subtypes, and clinical presentation.(4) Alarmingly, studies suggest that up to 30% of lung cancer cases in India now occur in individuals who have absolutely

no history of smoking. Furthermore, there is a disproportionately high and growing incidence of this disease observed among younger demographics, specifically adults under the age of 50 years.

This rising incidence of early-onset lung cancer among non-smokers powerfully highlights the critical role of environmental determinants in cancer pathogenesis. Indoor air pollution acts as a highly potent environmental carcinogen, particularly in rural Indian households where the regular combustion of solid biomass fuels is heavily utilized for daily cooking and heating purposes.[5] Concurrently, rapid industrial expansion and urbanization in major metropolitan centers, such as Delhi and Mumbai, have drastically escalated population exposure to outdoor air pollution, chronically exposing younger individuals to dangerous levels of fine particulate matter.

Alongside these pervasive environmental hazards, occupational exposures contribute substantially to the pathogenesis of lung cancer, particularly affecting younger, active working populations. Industrial laborers engaged in construction, mining, and manufacturing face chronic, daily inhalation of established airborne carcinogens, including concentrated diesel engine exhaust, which significantly elevates the risk of early-onset pulmonary malignancies.[6] Furthermore, prolonged occupational exposure to agents like crystalline silica dust promotes sustained local alveolar inflammation and severe cellular oxidative damage, acting as a direct biological catalyst for lung tumor growth.[7]

Despite the acknowledged severity of these environmental and occupational hazards, there remains a critical paucity of focused epidemiological research evaluating their specific impact on younger populations. Understanding these non-tobacco risk factors is imperative for the future development of targeted primary prevention strategies and stricter occupational safety regulations.[8] Therefore, this retrospective observational study is designed to systematically analyze the environmental and occupational determinants of lung cancer in adults under 50 years of age, aiming to provide actionable insights to mitigate this emerging public health crisis.

2. Aims and Objectives

- To Assess Occupational and Environmental exposure profiles in young adults with Lung cancer.
- To Correlate Exposure patterns with Histopathological subtypes.
- To Determine stage at presentation in relation to exposure history.
- To Highlight the contribution of Non-tobacco risk factors in Early-onset Lung cancer.

3. Materials and Methods

Study design
This Retrospective, observational study was conducted in the Department of Respiratory medicine OPD and ward, Coimbatore Medical College Hospital on out patients and in patients for a period of 1 year

Sample size

$$n = [Z^2 \times P(1 - P)] / d^2$$

- n = Required sample size
- Z = Z-statistic for the desired confidence level (1.96 for a standard 95% confidence level)
- P = Expected prevalence or proportion based on prior literature
- d = Tolerable margin of error (precision)

This aligns with the study by Geoffrey R. Oxnardet al. who found that Approximately 15% of all lung cancers are diagnosed in individuals younger than 55 years. .[9] Applying this prevalence to our formula:
- Z = 1.96
- P = 0.15
- d = 0.099 (9.9% margin of error)

Applying this data to the above formula, sample size n = 49.97

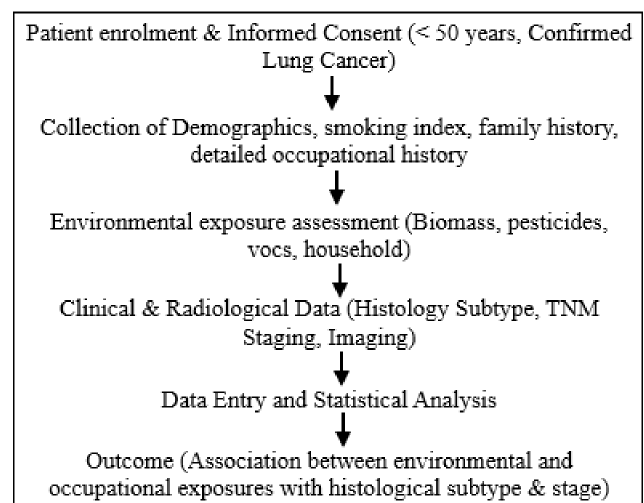
Rounding to the nearest whole number yields a sample size of **50 patients**.

Collabrating Department
Radiology, pathology

Inclusion criteria
- Both male and female with all age < 50 years
- Patients willing to participate and provide informed consent
- Histologically confirmed primary lung cancer
- Patients who are never-smokers or smokers with < 30 pack-years

Exclusion criteria
- Patients aged 50 years or above
- Metastatic lesions to the lung arising from primary cancers elsewhere
- Recurrent or previously treated primary lung cancer
- Heavy smokers (≥ 30 pack-years)

4. Methodology



5. Observations and Results

A total of **50 patients** aged less than 50 years with histologically confirmed primary lung cancer were included in the study. The demographic profile, occupational and environmental exposure history, clinical characteristics, radiological findings, histopathological subtypes, stage at presentation, and associations between occupational variables and disease characteristics were analysed.

The majority of patients (**56%**) belonged to the **40–49-year** age group, followed by 30–39 years (**26%**) and 20–29 years (**18%**). Males constituted **60%** of the study population, while females accounted for **40%**. Smokers comprised **52%** of the cohort, whereas **48%** were never-smokers.

Construction and mining workers formed the largest occupational group (**30%**), followed by manufacturing and textile workers (**26%**) and agriculture and farming (**18%**). The remaining participants were employed in painting and chemical work, office and domestic work, transportation and logistics (8% each), and service and hospitality (2%). Silica and mineral dusts (**28%**) were the most common occupational exposure, followed by asbestos (**24%**), chemical and combustion fumes (**18%**), organic and textile dusts (**16%**), agrochemicals (**10%**), and biomass and environmental smoke (**4%**). More than half of the patients (**52%**) resided in areas with low ambient air pollution, while **28%** and **20%** resided in areas with high and moderate pollution levels, respectively.

The commonest presenting symptoms were weight loss/fatigue (**26%**) and hemoptysis (**26%**), followed by cough (**20%**), shortness of breath (**16%**), chest pain (**8%**), and incidental diagnosis (**4%**). On computed tomography, a solitary pulmonary mass or nodule was the predominant finding (**36%**), followed by a central hilar mass (**30%**), multiple bilateral nodules (**14%**), cavitary lesions (**12%**), lymphadenopathy (**6%**), and peripheral lung mass (**2%**).

Adenocarcinoma was the most frequent histopathological subtype (**40%**), followed by small cell carcinoma (**30%**) and squamous cell carcinoma (**26%**). Adenoid cystic carcinoma and PEComa each accounted for **2%** of cases. Most patients presented with advanced disease, with **34%** each in stage IIIA and IIIB, while stage IVA, IV, and IVB accounted for **16%**, **14%**, and **2%**, respectively. No patient was diagnosed in stage I or II.

Fisher's exact test demonstrated no statistically significant association between primary occupational exposure and histological subtype (p=0.291) or stage at presentation (p=0.554). Similarly, no significant association was observed between occupation and histological subtype (p=0.850), occupation and stage at diagnosis (p=0.333), or occupation and smoking status (p=0.519).

Table 1: Age Distribution of Study Participants

Age Group (years)	Number (n)	Percentage (%)
20–29	9	18
30–39	13	26
40–49	28	56
Total	50	100

The majority of patients (56%) belonged to the 40–49-year age group

Table 2: Gender Distribution

Smoking Status	Number (n)	Percentage (%)
Male	30	60
Female	20	40
Total	50	100

Male patients constituted 60% of the study population.

Table 3: Smoking Status

Smoking Status	Number (n)	Percentage (%)
Smoker	26	52
Never-smoker	24	48
Total	50	100

Smokers accounted for 52% of the study population.

Table 4: Occupational Distribution

Occupation	Number (n)	Percentage (%)
Construction & Mining	15	30
Manufacturing & Textiles	13	26
Agriculture & Farming	9	18
Painting & Chemical Work	4	8
Office & Domestic	4	8
Transportation & Logistics	4	8
Service & Hospitality	1	2

Construction and mining workers constituted the largest occupational group (30%).

Table 5: Primary Occupational Exposure

Exposure	Number (n)	Percentage (%)
Silica & Mineral Dusts	14	28
Asbestos	12	24
Chemical & Combustion Fumes	9	18
Organic & Textile Dusts	8	16
Agrochemicals	5	10
Biomass & Environmental Smoke	2	4
Total	50	100

Silica and mineral dusts were the commonest exposure (28%).

Table 6: Ambient Air Pollution Level

Level	Number (n)	Percentage (%)
Low	26	52
Moderate	10	20
High	14	28
Total	50	100

More than half resided in low ambient air pollution areas.

Table 7: Presenting Symptoms

Symptom	Number (n)	Percentage (%)
Weight loss/Fatigue	13	26
Hemoptysis	13	26
Cough	10	20
Shortness of Breath	8	16
Chest Pain	4	8
Incidental Diagnosis	2	4
Total	50	100

Weight loss/fatigue and hemoptysis were the commonest presenting symptoms.

Table 8: CT Findings

CT Finding	Number (n)	Percentage (%)
Solitary Mass/Nodule	18	36
Central Hilar Mass	15	30
Multiple Bilateral Nodules	7	14
Cavitary Lesions	6	12
Lymphadenopathy	3	6
Peripheral Lung Mass	1	2
Total	50	100

A solitary pulmonary mass or nodule was the commonest CT finding.

Table 9: Histopathological Types

Histology	Number (n)	Percentage (%)
Adenocarcinoma	20	40
Small Cell Carcinoma	15	30
Squamous Cell Carcinoma	13	26
Adenoid Cystic Carcinoma	1	2
PEComa	1	2
Total	50	100

Adenocarcinoma was the predominant histological subtype.

Table 10: Stage at Presentation

Stage	Number (n)	Percentage (%)
IIIA	17	34
IIIB	17	34
IVA	8	16
IV	7	14
IVB	1	2
Total	50	100

Most patients presented with stage III disease (68%).

6. Discussion

The demographic analysis of our retrospective cohort reveals a profound and highly concerning transition regarding the premature onset of pulmonary malignancies in younger populations, particularly those without a history of tobacco use. Within our study, the majority of patients (52%) were situated in the 40-49 age group. Furthermore, young adults between 20 and 29 years accounted for an alarming 18% of the entire cohort, Regarding gender distribution, males (60%) were more commonly affected than females (40%). The smoking status of our cohort was nearly evenly divided, with smokers constituting 52% and non-smokers comprising a remarkably high 48% of the patient population.

This aligns with the study by Kolhe AP et al. who found that the standard mean age of lung cancer presentation on small biopsies was 55 years, demonstrating a much wider male-to-female ratio of 3.4:1.[10] Our cohort's deviation towards much younger patients and a higher female prevalence indicates a rapidly evolving biological profile. Furthermore, this aligns with the study on Lung Cancer Among Non-Smokers which found that up to 30% of all lung cancer cases in India occur in never-smokers, largely driven by changing environmental and occupational determinants rather than active tobacco consumption.[11]
When evaluating the impact of ambient air quality versus highly localized occupational hazards, our findings heavily implicate direct workplace exposures as the primary carcinogenic driver for this young demographic. Our geographic distribution indicated that more than half of the patients (52%) actually resided in low-pollution areas, establishing that their occupational environments superseded ambient atmospheric conditions in disease pathogenesis. This aligns with the study by Luo G et al. who found that 114,486 lung adenocarcinoma cases among men and 80,378 cases among women globally were exclusively attributable to ambient particulate matter pollution, highlighting a contrast where highly exposed occupational cohorts experience localized risks that completely override general background pollution.[12]

In our cohort, construction and mining workers (30%) constituted the largest occupational group, followed sequentially by manufacturing and textiles (26%), and agriculture and farming (18%). Interestingly, our analysis of occupation versus smoking status revealed that agriculture workers had the highest smoking rate (78%), whereas painting and chemical workers were predominantly non-smokers (75%). Construction and mining workers also possessed a high proportion of non-smokers (60%). The massive predominance of non-smokers in these specific chemical and construction trades completely confirms that their workplace hazards acted as the sole primary carcinogens.

Detailed exposure findings from our study further solidify the severe impact of industrial hazards on young adult workers, particularly emphasizing the dangers of chronic inhalation of carcinogenic particulate matter and chemical fumes. Primary exposure data demonstrated that silica and mineral dusts (28%) were the absolute most common workplace carcinogens, followed by asbestos (24%), chemical fumes (18%), and organic dusts (16%). Secondary exposures similarly featured silica and mineral dusts (28%) as the most frequent concurrent hazard, followed closely by chemical fumes (26%) and biomass smoke (24%), whereas asbestos was rarely identified as a secondary exposure (2%).

This aligns with the study by Olsson A et al. who found that joint occupational exposure to specific lung carcinogens created a synergistic effect, notably reporting a stronger effect than the sum of individual risks for lung adenocarcinoma for chromium (VI) combined with silica among men, and for small cell lung cancer for silica jointly exposed with asbestos, polycyclic aromatic hydrocarbons, or chromium(VI) among women.[13] The presence of these combined exposures in our mining and manufacturing groups likely accelerated the malignant transformation in these young patients.

Histological and morphological evaluations provided critical diagnostic insights into the patterns of early-onset lung cancer linked to these specific hazards. In our findings, adenocarcinoma (40%) was the most common subtype, followed by small cell carcinoma (30%) and squamous cell carcinoma (26%), with rare types like adenoid cystic carcinoma and PECOMA constituting the remaining 4%. This aligns with the study by Kolhe AP et al. who found a highly similar histological distribution among their evaluated biopsies, reporting 36.84% for adenocarcinoma, 34.21% for squamous cell carcinoma, and 15.79% for small cell carcinoma.[10]

Additionally, this aligns with the study by Luo G et al. who found that adenocarcinoma dominates globally, comprising 45.6% of the male lung cancer burden and 59.7% of the female burden, while small cell carcinoma accounted for only 11.5% in men and 9.7% in women.(12) Our notably higher 30% incidence of small cell carcinoma diverges from the global average, reflecting the aggressive nature of these specific occupational exposures. Furthermore, while no statistically significant associations were found between primary exposure and histological type (p=0.291) or occupation and histology (p=0.850), distinct clinical trends were observed. Silica exposure was strongly associated with squamous cell carcinoma (50%), which was also the most frequent subtype in manufacturing and textiles workers (38%), whereas small cell carcinoma was disproportionately high among painting, chemical, and transportation workers (50% each).

The clinical presentation, radiological staging, and ultimate survival outcomes of our cohort definitively underscore a critical systemic failure in the early detection and screening of occupational lung malignancies for high-risk workers. The primary symptoms at diagnosis for our young patients were constitutional symptoms (26%) and hemoptysis (26%), followed by persistent cough (20%) and shortness of breath (16%). Only 4% of the patients were entirely asymptomatic at diagnosis. Radiologically, a solitary spiculated mass or nodule (36%) was the most common CT finding, followed by a central hilar mass (30%). Most alarmingly, absolutely no stage I or II cases were seen in our entire cohort.

The vast majority (68%) presented with stage III disease, and 32% presented with stage IV disease, with asbestos (83%) and silica (79%) groups possessing the highest proportion of locally advanced stages.

7. Conclusion

Lung cancer in this cohort predominantly affected middle-aged adults (40-49 years), with a significant proportion of never-smokers (48%), underscoring the crucial role of occupational and environmental exposures in disease etiology. Construction and mining workers were the most affected group, with silica and asbestos being the leading exposures, highlighting the urgent need for workplace safety measures. Adenocarcinoma was the most common histological subtype, followed by small cell and squamous cell carcinoma, reflecting global epidemiological trends. All patients presented at advanced stages (III or IV), with no stage I or II cases, indicating delayed diagnosis and the complete absence of early detection programs in this resource-limited setting. Nearly one-third of patients had died at final follow-up, and treatment response rates were poor, with only 4% showing symptomatic improvement. The lack of statistical significance between exposures and outcomes may be attributed to the small sample size, and larger studies are warranted. There is an urgent need for occupational health surveillance, public awareness campaigns, and low-cost early screening strategies for high-risk populations in resource-limited settings.

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