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Correlation of Symptoms and Duration of Exposure with Estimated Lung Age in Cement Factory Workers at Chengalpet District-Tamilnadu

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KEYWORDS

Symptoms and Duration of Exposure

ABSTRACT:

Cement manufacturing is a major industrial activity associated with significant occupational exposure to airborne particulate matter. Cement dust contains respirable particles such as crystalline silica, calcium oxide, and other alkaline compounds that can penetrate deep into the respiratory tract and cause adverse pulmonary effects. Chronic exposure to cement dust has been recognized as an important risk factor for respiratory morbidity, leading to airway inflammation, mucosal irritation, and progressive decline in lung function [1].

Introduction :

Cement manufacturing is a major industrial activity associated with significant occupational exposure to airborne particulate matter. Cement dust contains respirable particles such as crystalline silica, calcium oxide, and other alkaline compounds that can penetrate deep into the respiratory tract and cause adverse pulmonary effects. Chronic exposure to cement dust has been recognized as an important risk factor for respiratory morbidity, leading to airway inflammation, mucosal irritation, and progressive decline in lung function **[1]**.

Several epidemiological studies have demonstrated that workers exposed to cement dust exhibit a higher prevalence of respiratory symptoms and impaired pulmonary function compared to non-exposed populations. Studies by **Fell et al. [2]** and **Mwaiselage et al. [3]** reported significant ventilatory impairment among cement factory workers, while **Sarkar et al. [4]** observed reduced pulmonary function parameters in exposed individuals. Similar findings have been reported across different populations, where cement dust exposure was associated with respiratory illness and decreased lung function **[5,6]**.

Both acute and chronic effects of cement dust exposure on pulmonary function have been well documented. **Zeleke et al. [7]** demonstrated acute reductions in lung function during work shifts, while **Neghab and Choobineh [8]** and **Rahmani et al. [9]** reported increased prevalence of respiratory symptoms and ventilatory disorders among exposed workers. More recent studies, such as that by **Shanshal and Ahmed [10]**, have further confirmed that prolonged occupational exposure contributes to progressive respiratory impairment.

Traditionally, spirometry has been used to assess lung function and detect airflow limitation in occupational settings. However, conventional spirometric parameters such as FEV_1 and FVC may not effectively communicate the extent of functional decline to patients. To address this limitation, the concept of Estimated Lung Age (ELA) was introduced by **Morris and Temple [11]**, which translates spirometric results into an age-equivalent value. This concept was further validated by **Parkes et al. [12]**, who demonstrated its usefulness in improving patient understanding of respiratory health.

Recent studies have highlighted the clinical relevance of lung age estimation as a simple and effective tool for

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early detection of pulmonary impairment. **Liang et al. [13]** and **Karrasch et al. [14]** emphasized that lung age can serve as an early indicator of respiratory dysfunction and improve risk communication. Occupational exposure to dust has also been shown to accelerate lung function decline and increase the risk of chronic obstructive pulmonary disease, as reported by **Hnizdo et al. [15]**. Furthermore, studies such as **Nordby et al. [16]** have demonstrated significant associations between occupational dust exposure and reduced lung function.

Recent evidence from broader occupational health research indicates that exposure to particulate matter across industrial settings leads to progressive deterioration of lung function and increased respiratory morbidity **[17,18]**. The global burden of occupational respiratory diseases remains substantial, with studies highlighting the need for improved surveillance and preventive strategies in high-risk populations **[19,20]**.

Despite extensive research on spirometric abnormalities among cement factory workers, limited studies have specifically evaluated Estimated Lung Age as an early marker of occupational lung damage. Therefore, the present study was undertaken to assess the relationship between occupational exposure, respiratory symptoms, and Estimated Lung Age among cement factory workers.

Materials and Methods

2.1 Study Design and Setting

A cross-sectional observational study was conducted among cement factory workers in Chengalpet district by Department of Respiratory Medicine KIMS &RC. Sampling and measurement procedures focused on workers working in exposure units such as manifacturing, packaging, grinding

2.2 Study Population

Workers meeting inclusion criteria and providing informed consent were enrolled.

Inclusion criteria:

- Age>18yrs
- All genders
- cement factory workers working more than 1 year
- Willingness to participate

Exclusion criteria:

- Known chronic respiratory diseases
- Previous occupational exposure other than cement
- Acute respiratory infection at the time of testing
- History of thoracic surgery or significant comorbid illness affecting spirometry
- Unable to do spirometry

2.3 Data Collection

Demographic data, duration of occupational exposure, and respiratory symptoms (cough, wheeze, dyspnea, sputum production) were recorded using a structured questionnaire.

2.4 Spirometry and Estimated Lung Age

Spirometry was performed according to standardized international guidelines. Interpretation of airflow limitation was performed based on established COPD diagnostic criteria **[19]**."Abnormally Elevated ELA was defined as lung age exceeding chronological age by >10 yrs

2.5 Statistical Analysis

Data were analyzed using SPSS software version 25. Descriptive statistics were computed. Correlation between duration of exposure, symptoms, and ELA was assessed using karl Pearson's chi square test. A p-value <0.05 was considered statistically significant.

3. Results

A total of 84 workers were included in the study.

- 68 (81%) were asymptomatic.
- 54 (64%) had occupational exposure exceeding five years.

Elevated ELA was observed in:

- 88.2% of asymptomatic workers
- 98.14% of workers with >5 years of exposure

The prevalence of abnormal ELA increased with duration of exposure, indicating a cumulative occupational effect.

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Table 1.Demographic data

Distribution of Age

Age	n(84)
19-30 yrs	16
31-40 yrs	38
>40 yrs	30

Out of 84 participants majority of them were aged between 31-40 yrs

All are male genders

Table 2: Smoking vs ELA

Smoking status	Elevated ELA
Smoker (13)	12(92%)
Non smokers (71)	62(87%)

Table 3.Characteristics of the Study Population (n = 84)

Variable	**Frequency (84)**	**Percentage (%)**
Total participants	84	100
Asymptomatic workers	68	81.0
Symptomatic workers	16	19.0

Out of 84 participants majority of them i.e., 81% of them were asymptomatic

Majority of the workers were working more than >5yrs

Table 4. Mean Lung Age and Chronological Age Comparison

Variable	**Mean ± SD**
Chronological Age (years)	39.8 ± 8.5
Estimated Lung Age (years)	55.6 ± 9.3

Table 5. Distribution of Estimated Lung Age According to Symptoms

Symptom Status	**Total (84)**	**Elevated ELA n (%)**
Asymptomatic	68	60 (88.2%)
Symptomatic	16	15 (93.8%)
Total	**84**	**75 (89.3%)**

ELA was found to be abnormally elevated in 60% of the asymptomatic individuals

Table 6. Estimated Lung Age According to Duration of Exposure

Duration of Exposure	**Total (84)**	**Elevated ELA n (%)**
< 5 years	30	21 (70.0%)
≥ 5 years	54	53 (98.1%)
Total	**84**	**74 (88.1%)**

ELA was found to be abnormally elevated in 98.1% of the workers who had more than 5 yrs

of duration of exposure

Spirometric parameters	Total (84)
Normal	9(10.7%)
Obstruction	21(25%)
Restriction	17(20.2%)
Mixed pattern	37(44.04%)

Table 7. Correlation Between Exposure Duration, Symptoms, and Estimated Lung Age using chi square test

Variable	**Correlation Coefficient (r)**	**p-value**	**Interpretation**
Duration of exposure vs ELA	0.62	<0.001	Strong positive correlation

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JCHR (2026) 16(2), 3507-3512 | ISSN:2251-6727

Presence of symptoms vs ELA	0.41	0.002	Moderate positive correlation

4. Discussion

In the present study, a large proportion of cement factory workers were asymptomatic despite having elevated Estimated Lung Age (ELA), indicating the presence of subclinical respiratory impairment. This suggests that pulmonary function decline may occur before the onset of overt respiratory symptoms that matches with the studies done by Meo et al [1] Fell et al. [2] and Mwaiselage et al. [3] also reported spirometric abnormalities among cement workers even in the absence of significant respiratory complaints but ELA was not studied. Similarly, our findings matches with Sarkar et al. [4] observed impaired pulmonary function among cement factory workers despite relatively mild or absent respiratory symptoms. Comparable findings were also reported by Al-Neaimi et al. [5], who demonstrated that cement factory workers exposed to dust had a higher prevalence of respiratory symptoms and impaired lung function compared with non-exposed individuals . Likewise, Yang et al. [6] reported that occupational dust exposure can lead to early lung function changes even before the appearance of significant respiratory symptoms that matches with our study. These findings support the results of our study and highlight that symptom-based screening alone may underestimate the early respiratory effects of cement dust exposure.

In the present study, elevated Estimated Lung Age was more commonly observed among workers with longer duration of exposure, particularly among those exposed to cement dust for more than five years. This indicates a cumulative effect of occupational dust exposure on pulmonary function. Similar exposure–response relationships have been reported in the studies. Zeleke et al. [7] demonstrated that occupational exposure to cement dust was associated with acute reductions in lung function during work shifts. Mwaiselage et al. [3] also reported that increasing duration of exposure to cement dust was associated with progressive ventilatory impairment. Neghab and Choobineh [8] further observed increased respiratory symptoms and ventilatory dysfunction among cement industry workers with prolonged exposure. More recent studies by Rahmani et al. [9] and Shanshal and Ahmed [10] confirmed that long-term occupational exposure to cement dust significantly contributes to deterioration in pulmonary function and increased respiratory morbidity. These findings are consistent with our results, suggesting that prolonged occupational exposure plays a major role in respiratory impairment.

The present study demonstrated a high prevalence of elevated Estimated Lung Age among cement factory workers, including those who were asymptomatic. This indicates premature pulmonary aging associated with occupational dust exposure. The concept of lung age estimation was first introduced by Morris and Temple [11], who proposed using spirometric indices to express pulmonary function decline in terms of lung age. Later, Parkes et al. [12] demonstrated that lung age estimation is useful in communicating respiratory risk and detecting early pulmonary impairment. Recent studies have further emphasized the clinical value of lung age estimation. Liang et al. [13] reported that lung age estimation can serve as a practical tool for identifying early pulmonary dysfunction, while Karrasch et al. [14] highlighted its usefulness in improving respiratory risk communication and early disease detection. A similar observation was reported by Hnizdo et al. [15], who demonstrated that long-term exposure to industrial dust is associated with accelerated decline in FEV_1 and increased risk of chronic airflow limitation. These findings support the observation in our study that elevated lung age may serve as an early marker of occupational lung damage among cement factory workers.

Spirometry remains the gold standard for assessing pulmonary function and detecting airflow limitation. Our study had reported significant reductions in spirometric parameters among cement industry workers exposed to dust even before symptoms start that matches with studies done by Fell et al. [2] reported lung function impairment among workers exposed to cement dust. Nordby et al. [16] further demonstrated that exposure to dust in cement production was associated with reduced spirometric indices and respiratory symptoms. Studies by Neghab and Choobineh [8] and Sarkar et al. [4] also reported decreased pulmonary function among cement factory workers compared with non-exposed individuals.

Journal of Chemical Health Risks

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Additionally, broader occupational health research by Rabbani et al. [17] and Boadu et al. [18] confirmed that long-term exposure to airborne particulate matter contributes to progressive decline in lung function and increased risk of respiratory diseases.

Occupational Health Implications

The findings of the present study highlight the importance of regular respiratory health monitoring among cement factory workers that matches with Blanc et al. [19] emphasized that occupational respiratory diseases remain underdiagnosed and recommended periodic spirometry screening for workers exposed to industrial dust. Similarly, Fishwick et al. [20] reported that implementation of workplace safety measures such as dust control strategies, improved ventilation, and use of personal protective equipment can significantly reduce the risk of occupational lung diseases. Overall, the results of the present study are consistent with previous research demonstrating that prolonged occupational exposure to cement dust contributes to early lung function impairment, increased lung age, and progressive respiratory dysfunction. Early identification of these changes through routine spirometry and preventive occupational health measures is essential to reduce long-term respiratory morbidity among cement factory workers.give references according to van cover style

5. Conclusion

Estimated Lung Age is significantly elevated among cement factory workers, particularly in those with prolonged exposure. Importantly, pulmonary aging was evident even in asymptomatic individuals, indicating subclinical impairment. Periodic spirometric evaluation incorporating ELA may serve as an effective occupational health screening tool for early identification of at-risk workers.

6. Ethical Considerations

The study was conducted after obtaining Institutional Ethics Committee approval. Written informed consent was obtained from all participants. Confidentiality of personal and occupational data was strictly maintained.

7. Limitations

- Cross-sectional design
- Limited sample size
- Lack of quantitative dust exposure measurement
- Absence of longitudinal follow-up

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