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# Evaluation of Pulmonary Function Test Among Construction Site Workers

[1]P. Asvini jenifer, [2]M. Anita, [3]H.R. Haribabu and [4]K.R. Hasna Parveen

[1-4]*Department of Physiology, Tirunelveli Medical College, Tirunelveli India*

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**Corresponding Author**
P. Asvini Jenifer,
Department of Physiology, Tirunelveli Medical College, Tirunelveli Tamil Nadu India
asvinijenifer@gmail.com

**Author Designation**
[1,4]Postgraduate
[2]Professor and HOD
[3]Associate Professor

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**ABSTRACT**

Occupational lung diseases are one of the most neglected conditions across the globe. This is more so in cases of highly populated and resource-limited settings like India. Construction workers are exposed to wide variety of physical and chemical environmental factors that can make them prone to respiratory morbidity. Exposure to cement dust, wide range of inorganic respiratory allergens, welding fumes and so on in the construction site for a longer periods had been proved to reduce the lung function. Working in the construction industry has also been reported to be associated with marginally increased risk of lung cancer. This study aimed to evaluate the pulmonary function of construction workers by comparing the results of pulmonary function tests (PFTs) with those of age-and gender-matched controls. A total of 100 subjects participated in the study, consisting of 50 construction workers with at least 5 years of exposure to dust and 50 age-and gender-matched controls. Pulmonary function was assessed using computerised spirometry ((RMS Helios 401 software) following standardized protocols. Data analysis was performed using SPSS Version 29 and the Paired t-test was used to assess differences between groups. A p-value of <0.05 was considered statistically significant. The PFT parameters, including Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1) and the FEV1/FVC ratio, were significantly reduced among the construction workers compared to the control group. The pulmonary function profile of construction workers exhibited a tendency toward a restrictive pattern of lung disease. Construction workers exhibited significantly lower pulmonary function test values compared to age-and gender-matched controls, with a predominance of restrictive lung disease patterns. These findings underline the need for enhanced occupational health measures, including better dust control strategies and the implementation of engineering controls to minimize exposure to hazardous substances. Strengthening safety protocols and improving the working environment are essential to protect the respiratory health of construction workers.

## INTRODUCTION

Construction workers are especially exposed to high concentrations of dusts in closed spaces and breathe high levels of crystalline silica[1-11]. The International Agency for Research on Cancer (IARC), based on sufficient evidence of carcinogenicity, has classified crystalline silica as a group I carcinogen and a definite human carcinogen[12]. Silicosis is recognized as a restrictive pulmonary disease. It has been described as the most prevalent respiratory disease since 1968 due to silica dust exposure and is now considered a global problem[13-15]. Considering the nature of materials used in the construction industry, dust may contain significant amounts of crystalline silica[16-17]. There is substantial epidemiological evidence in relation to occupational exposure to respirable general dusts, which contain <1% silica and are classified as particulate not otherwise specified (PNOS), as well as respirable crystalline silica, associated with the development of various diseases, such as silicosis, lung cancer, tuberculosis and pulmonary obstructive disease[18-21]. Based on the National Institute for occupational safety and health (NIOSH report), the highest rate of mortality from silicosis was related to construction activities among all other industries during 1990-1999[22]. Respiratory problems, associated with changes in chest radiographs and pulmonary function, were also reported among construction workers[23,24]. Spirometric parameters can be used to distinguish obstructive and restrictive lung status in adults. According to the criteria by Ford *et al.* and Mannino *et al.*, obstructive and restrictive pulmonary status is defined as follows: severe obstructive impairment ($FEV_1$/FVC <0.70., $FEV_1$ <50% predicted), moderate obstructive impairment ($FEV_1$/FVC <0.70., FEV1 50%-<80% predicted), mild obstructive impairment (FEV1/FVC <0.70., FEV1≥80% predicted), and restrictive impairment (FEV1/FVC≥0.70., FVC <80% predicted)[25,26]. According to the International Labor Organization (ILO), silicosis, as a preventable silica for devising proper control measures[27,28]. Considering the high occupational exposure of construction workers to airborne dusts and absence of relevant studies, the aim of this study was to evaluate workers' exposure to respirable PNOS and crystalline silica and to examine their respiratory lung function status.

## MATERIALS AND METHODS

The study was a cross-sectional study, conducted in the Research Laboratory, Department of Physiology, Tirunelveli Medical College, Tirunelveli, Tamil nadu. This study included total of 100 adults of 35-50 years of age, among them 50 are construction site workers working as mason or daily Labourers for at least 5 years. Persons with history of Lung diseases, Heart diseases, history of chest or abdominal surgeries for the past 3 months, history of skeletal deformities-kyphosis, scoliosis, kypho-scoliosis and Smokers were excluded from the study. After getting Institutional Ethics Committee approval, the study was commenced. The subjects were taken to the Research Laboratory in the department of Physiology by 10 am. Informed written consent was obtained from the subjects. Demographic details including name, age, occupational details, personal history, family history, medical history, treatment history if any was collected interviewer administered semi-structured questionnaire. Anthropometric measurements were taken for both cases and controls. Pulmonary function tests were performed using a computerized Spirometry (RMS Helios 401 software) in the exposed and control groups. The subjects were asked to stand comfortably in front of the spirometer and then inhale and exhale into the mouth piece. Pulmonary Function parameters -FEV1, FVC, FEV1/FVC, PEFR, PIFR, FEF (25-75%), FIVC were recorded. The pulmonary status was described as restrictive or obstructive and the spirometric results were interpreted according to the American Thoracic Society (ATS) guidelines[29-31]. These data were recorded in Microsoft Excel sheet. SPSS software version 23 was used for analysis. Paired t test was used for analysis to <0.05 was considered to be significant.

## RESULTS AND DISCUSSIONS

Out of a total of 100 subjects of age group 35-50 years included in the study, 50 were construction site workers working for at least 5 years duration are compared with age and gender matched controls. The participants in the study were compared based on the age, height and weight. As shown in (table 1), no significant differences were observed in these parameters across the study population, ensuring homogeneity of the sample.

**Table 1: Comparison of Anthropometric Parameters Among Cases and Controls**

| Parameters | Cases N=50 mean ±SD | Controls N=50 mean ± SD | p value |
|---|---|---|---|
| Age | 43.88 ± 11.02 | 43.58 ± 8.6 | 0.89 |
| Height | 166.1± 6.08 | 166.06 ± 5.12 | 0.92 |
| Weight | 69.5 ± 7.5 | 69.54 ± 7.1 | 0.97 |

Pulmonary Function Parameters-FEV1, FVC, FEV1/FVC, PEFR, FIVC, FEF(25-75%), PIF were compared between construction site workers and controls. As shown below in (table 2), the mean values of FEV1, FVC are lower among construction site workers and they are statistically significant with p value <0.05.

**Table 2: Comparison of Pulmonary Function Parameters (FVC, FEV1, FEV1/FVC) Between Construction Workers and Controls**

| Pulmonary Function Parameters | Cases N=50 Mean ± SD | Controls N=50 Mean± SD | p value |
|---|---|---|---|
| FVC | 2.4 ± 0.60 | 3.1 ± 0.7 | 0.00 |
| FEV1 | 2.27 ± 0.54 | 2.92 ± 0.64 | 0.00 |
| FEV1/FVC | 95.16 ± 6.17 | 96.7 ± 9.48 | 0.29 |

In (table 3), other pulmonary function test parameters-PEFR, PIF, FIVC, FIF (25-75%) were compared, it shows PEFR values are decreased among construction site workers but not statistically significant whereas, PIF, FIVC, FEF (25-75%) are decreased among construction site workers and statistically significant with p value <0.05.

**Table 3: Comparison of PEFR, FIVC, FEF (25-75%),PIF**

| Pulmonary Function Parameters | Cases N=50 Mean ± SD | Controls N=50 Mean ± SD | p value |
|---|---|---|---|
| PEFR | 6.1 ± 1.8 | 6.8 ± 1.9 | 0.11 |
| FIVC | 2.1 ± 0.58 | 3.02 ± 0.84 | 0.00 |
| FEF (25 - 75)% | 3.23 ± 0.96 | 3.90 ± 1.03 | 0.001 |
| PIF | 2.02 ± 0.87 | 2.59 ± 1.18 | 0.006 |

Among various earthly happiness, good health is most important. Emphasizing the importance of health, Hippocrates, the father of Medicine wrote "Health is the greatest of human blessings".Occupational exposure to noxious material is one of the major risks affecting the health and well-being of an individual. Across the globe, skilled, semiskilled and unskilled workers in different types of industries like construction, agriculture, coal, petroleum etc. Are exposed to environment that increases the risk of inhaling particulate materials that adversely affects the respiratory system[32]. In this study, the effect of occupational exposure to construction materials on respiratory system was studied. In recent years, with increase in constructional work, workers are often exposed to cement, dust, sand and other material for longer period of time[33]. Estimation of pulmonary function using spirometer is essential for detection of deterioration of respiratory system[34]. In the present study, PFT of construction workers was studied using spirometer and compared to that of age matched healthy controls. Age, weight, height and smoking status are strongly influence the lung function and airway inflammation according to American Thoracic Society. The age, height and weight for the exposed workers and controls were not significantly different, thus these factors were successfully controlled. There were significantly lower FVC, FEV1%, FEF, PIF among construction site workers compared to age and sex matched controls ($p<0.01$). However, FEV1/FVC, PEFR were not statistically significant between construction site workers and controls. Restrictive disorders occur when FVC% and FEV1% is reduced <80%, FEV1/FVC% ratio is normal at >70%. Conversely, obstructive disorder occur when FEV1% is reduced to less than 80% and FVC% usually reduced to less than 80% but not <FEV1 %, whilst reducing the FEV1 /FVC% ratio to <70%[35-37]. Pulmonary function test variables were reduced among construction workers compared to controls which were possibly due to direct exposure to dust particles at work site. The construction workers probably showed a restrictive pattern of lung disease. The pathogenesis behind the development of occupational lung disease is that construction site workers are exposed to high concentration of dust particles at construction site. Particles <3µm enters distal lung, mucociliary and lymphatic system whereas particles >5µm, phagocytosed incompletely and retained leading to activation of macrophage. As a result, reticulin is secreted by fibroblasts, to entrap macrophage. When exposure continues, elimination system fails and there will be activation of reactive oxygen species leading to Cytosine release namely TNF, Interleukins resulting in fibrogenesis subsequently leading to development of Restrictive pattern of lung disease.

## CONCLUSION

Construction workers are at an increased risk of developing respiratory ailments due to prolonged exposure to harmful substances, such as dust, fumes, and chemicals, present in the construction environment. This study found that the pulmonary function test (PFT) values of construction workers were significantly lower than those of age- and gender-matched controls, with a more pronounced restrictive pattern of lung disease observed among the workers. To safeguard the health of construction workers, it is essential to implement effective engineering control measures to reduce exposure to dust and harmful substances. These measures could include improving ventilation systems, controlling dust concentration and ensuring the proper functioning of machinery. Additionally, educating workers on the importance of using protective equipment, such as masks, and conducting regular health check-ups will help mitigate respiratory morbidity. Regular pulmonary function testing should be incorporated into routine occupational health assessments for construction workers to detect any early signs of respiratory impairment. Early identification of lung function changes will facilitate timely intervention and treatment, potentially reducing the long-term health risks associated with prolonged exposure. In conclusion, enhancing preventive measures, along with regular monitoring of lung health, is crucial in reducing the burden of respiratory diseases among construction workers and improving their overall quality of life.

**Limitations:** This study design is cross-sectional, meaning it only provides a snapshot of lung function at a single point in time. It cannot establish a causal relationship between occupational exposure and pulmonary dysfunction. Longitudinal studies would be required to track changes in lung function over time and better understand the long-term effects of exposure This study includes a relatively small sample size (100 subjects). A smaller sample size may reduce the statistical power of the study and make it more

difficult to detect subtle differences or trends in pulmonary function. Spirometry, while a standard and widely used tool for assessing lung function, may not detect all types of respiratory impairment, particularly in the early stages of disease. Conditions such as interstitial lung disease or other subtle respiratory conditions could be missed. Incorporating imaging techniques like chest X-rays or CT scans could provide a more comprehensive understanding of lung health and potentially reveal milder or more complex forms of lung dysfunction that spirometry alone may not capture. The reliance on only spirometric measurements in this may lead to an underestimation of the full spectrum of respiratory issues experienced by workers.

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**Authors Contribution:** All authors in our study contributed to the data collection of the patients

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