Section: Physiology

Original Research Article

STUDY OF PULMONARY FUNCTIONAL CHANGES IN STONE QUARRY WORKERS OF BIJAPUR CITY IN KARNATAKA

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Received *: 04/06/2026*
Received in revised form *: 01/08/2026*
Accepted *: 15/08/2026*

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DOI: 10.70034/ijmedph.2026.3.593

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 3813-3817

ABSTRACT

Background: A Comparative study of Lung function tests was carried to determine the effect of stone dust in stone quarry workers on pulmonary functions and their correlations with duration of exposure. Workers exposed to a variety of Stone dust have been shown to exhibit occupational asthma, lung function deficits, and elevated levels of respiratory symptoms and health effects of exposures to Stone dust.

Materials and Methods: The cross sectional study was conducted in the premises of a tertiary health care center under Medical College at Bijapur group consisted of 50 male subjects working in stone quarry exposed to stone dust. The control group comprised of 50 age matched male subjects of similar socio economic status selected from among the employees of Medical College, Bijapur, by applying inclusion and exclusion criteria. Detailed anthropometric and physiological data were collected. Pulmonary functions were recorded by using Computerized Spiro excel. Parameters recorded were Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st sec (FEV1), & FEV1 %, Peak Expiratory Flow Rate (PEFR) was recorded by mini Wright's Peak flow meter and Maximum Expiratory Pressure (MEP) was recorded by Modified Black's apparatus. **Statistical analysis** was done by calculating Mean±SD by using student's t-test. Correlation between duration of exposure and pulmonary functions was done by Pearson's correlation.

Conclusion: We conclude that airborne particulate materials like asbestos, lead, silica dust, concrete, cement, stone, sand and other dusts adversely affect the pulmonary function parameters such as FVC, FEV1, FEV1/FVC%, PEFR and FEF25-75% and cause an obstructive pattern of lung function impairment.

Keywords: Lung function tests, PEFR (Lit/Min), MEP (mmHg), Stone quarry workers.

INTRODUCTION

The prevalence of occupational health hazards in India, particularly occupational lung diseases, remains a critical yet neglected concern, especially for unprotected laborers.[1]

While occupational health is often mistakenly associated solely with large industries, millions of Indians engage in unorganized labor like street sweeping, stone grinding, weaving, and quarrying.[2]

Lungs, being in direct contact with atmospheric air, bear the initial brunt of air contaminants.[3] Inhaled ambient particles interact with lung cells, triggering the release of cytokines that cause inflammation and tissue injury.[4]

Reduced lung functions are widely documented among cotton workers, coal miners, grain mill

workers, and those exposed to various organic and inorganic dusts.[5,6,7]

A quarry involves excavating dimension stone, rock, or sand, differing from open-pit mineral mines.[8]

Stone quarry and crushing workers form a scattered unorganized sector engaged in cutting, loading, and crushing. Stone crushers produce essential construction materials but emit substantial fine fugitive dust, causing respiratory hazards for workers and nearby populations while degrading environmental aesthetics.[9] Similarly, construction sites generate high airborne dust levels from concrete, silica, cement, and sand.[10]

Long-term exposure to airborne crystalline silica (quartz) from stone work causes Silicosis, a disabling and potentially fatal lung disease. Inhaled microscopic silica particles form permanent scar tissue, restricting oxygen intake. Symptoms progress from fatigue and shortness of breath to chest pain, heart strain, respiratory failure, bronchitis, tuberculosis, and lung cancer.[11]

Given that various organic and stone dusts cause severe health impacts.[12,13] early recognition of altered lung function is vital for industrial workers.Pulmonary function tests (PFT) are time-tested parameters for assessing respiratory health amid rising pollution from urbanization, industrialization, and automobiles.[14,15,16]

Because the stone quarry and polishing industry is a major regional employer and livelihood source, this study determines the prevalence of respiratory problems and impaired lung functions among stone quarrying workers in Bijapur.

Aims and Objectives of Study

1. To observe respiratory functional changes in stone quarry workers and to compare them with age and sex matched control subjects.
2. To correlate respiratory functional changes in relation to duration of exposure to stone dust particles.

MATERIALS AND METHODS

Source of Data: The study was conducted on the Stone quarry workers of Bijapur city in North Karnataka. The subjects of control group were selected among the employees of Medical College campus in Bijapur (same socio-economic group)

Method of collection of Data: Study group: This group consisted of 50 volunteered unskilled workers who were exposed to stone dust for more than 5years.

Control group: This group consisted of 50 volunteered skilled workers who were not exposed to dust from employees of Medical College campus in Bijapur (same socio-economic group)

Duration of study: From November 2012 to January 2014.

Age of the subjects: In both the groups, subjects more than 25years of age were included.

Sample size: 50 subjects each were included in study and control groups a total of 100 subjects. The age and sex of the subjects of the control group were selected so as to match with that of study group.

Sampling technique: Subjects were selected using convenience sampling method.

Inclusion criteria

Only healthy workers were included in the study. The apparent health status of each subject was ascertained through thorough clinical examination and history taking.

Exclusion criteria: The following subjects were excluded from the study:

1. Subjects with any known history of cardiopulmonary disorders.
2. Subjects with any known history of endocrine disorders.
3. Subjects with any known history of congenital defects
4. Smokers.

Anthropometric parameters-

Height, Weight, Waist circumference (WC), Hip circumference (HC) was measured.

Following parameters were used for assessment of obesity:

1) Body Mass Index (BMI): BMI was calculated with the following formula.

BMI (in kg/m^2) = Weight (kg)/Height (m^2)

2) Waist circumference (WC): Waist circumference cut-offs were taken as >90 cm for male and > 80 cm for female to define abdominal obesity[10.]
3) Percent body fat: Upper limit of percent body fat defining obesity are still debatable. Percent body fat was defined as indicative of obesity if it was >25% in male and >30% in female[13.] It is estimated by the following formula

Body fat % = (1.20 x BMI) + (0.23xAge)-(10.8xSex)-5.4

Sex: 1 for males and 0 for females.

Physiological Parameters: Systolic Blood Pressure (SBP, mmHg) and Diastolic Blood Pressure (DBP, mmHg) were recorded.

Recording of Pulmonary functions: Various lung volumes and capacities were recorded using Spiropac (MEDICAID). The subjects were informed regarding the procedure and demonstrated by investigator. The readings were taken in a comfortable upright sitting position. The readings were recorded in the morning between 9 to 12noon.

Forced Vital Capacity (FVC, L), Forced Expiratory Volume in first second (FEV_1, L/min), FEV_1/FVC%, Peak Expiratory Flow Rate (PEFR, L/min) and Maximum Expiratory Pressure in mmHg (MEP) of the subjects of all groups were recorded.

Statistical analysis: Statistical Analysis was done using SPSS. Data was expressed as Mean $\pm$ SD. Comparison between groups was done by using student's t-test. Correlation between duration of exposure and pulmonary functions was done by Pearson's correlation.

RESULTS

In present study sociodemographic and BMI values were insignificant among the various groups. [Table 1] No significant differences in SBP and DBP were recorded. [Table2] Significant differences in PEFR and MEP were observed. [Table 3] No significant changes observed with FVC, FEV_1, and FEV1/FVC %.

Table 1: Anthropometric Parameters of Study group Vs control group

Parameters	Study (n=50)	Control (n=50)	Level of significance
Age (years)	40.12± 12.66	38.44±11.32	0.49
Height (cms)	161.4± 8.07	161.1± 7.27	0.84
Weight (kg)	59.8± 13.9	58.42± 11.1	0.58
BSA (m^2)	2.18± 3.83	1.73± 0.37	0.40
BMI (kg / m^2)	22.86± 5.04	21.8± 4.87	0.32
HC(cms)	89.24± 8.9	87.04± 1.36	0.25
WC(cms)	85.6± 9.44	82.6± 9.42	0.10

Data are presented as Mean ± SD. *Indicates the level of significance, p>0.05: Not Significant, *p: <0.05: Significant, ** p: <0.01: Highly significant, *** p: <0.001: Very highly significant BSA- Body surface area. BMI- Body Mass Index, WC- waist circumference, HC- hip circumference.

Table 2: Physiological Parameters of Study group Vs Control group

Parameters	Study (n =50)	Control (n =50)	Level of significance
PR(beats/min)	77.26+8.39	74.3+8.02	0.07
RR(cycles/min)	18.82+2.22	18.26+1.98	0.18
SBP (mmHg)	128.48+17.1	125.3+50	0.32
DBP(mmHg)	80.34+11.4	78.9+11.6	0.56

Data are presented as Mean ± SD. *Indicates the level of significance, p>0.05: Not Significant, *p: <0.05: Significant, ** p: <0.01: Highly significant, *** p: <0.001: Very highly significant PR- pulse rate, RR- respiratory rate, SBP - Systolic blood pressure, DBP- Diastolic blood pressure.

Table 3: Pulmonary Parameters of study group Vs Control group

Parameters	Study	Control	P values
FVC (L)	3.5+11.9	3.03+8.26	0.82
FEV1 (L)	1.63+0.50	3.64+14.4	0.32
FEV1%	86.22+23.12	86.04+19.4	0.96
PEFR (L/min)	138.4+62.80	272.8+327.6	0.004**
MEP (mm Hg)	23.6+12.4	32.4+22.7	0.016*

Data are presented as mean ± SD. *Indicates the level of significance, p>0.05: Not Significant, *p: <0.05: Significant, ** p: <0.01: Highly significant, *** p: <0.001: Very highly significant.

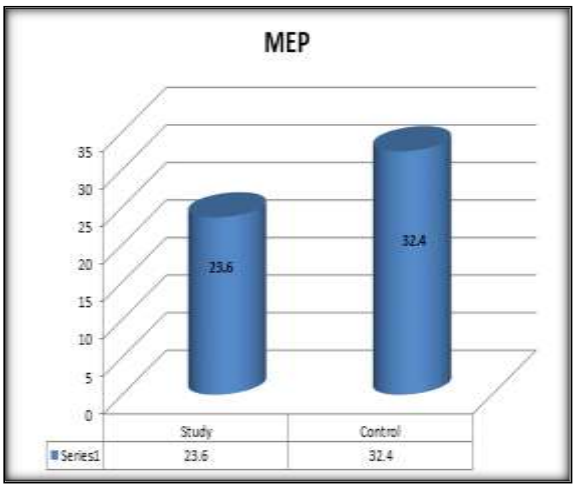

Figure 1: MEP among study and control group

MEP = Maximum Expiratory Pressure

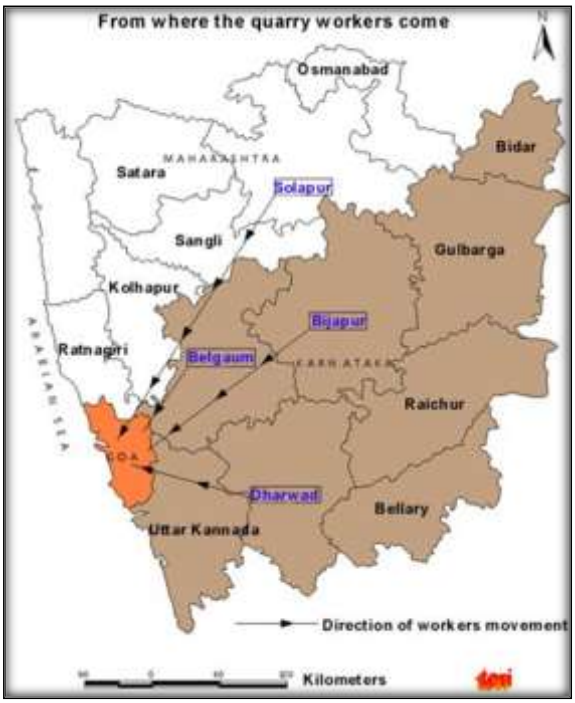

Image 1: Movement of Quarry workers tracing

Image 2: Working scenario and exposure of quarry workers.

Image 3: Assessment of parameters among Quarry workers

Image 4: Assessment of Lung function tests among quarry workers.

DISCUSSION

The present cross-sectional investigation was conducted on a cohort of 50 stone quarry workers chronically exposed to occupational stone and mineral dust, evaluated against rigorous inclusion and exclusion criteria. A detailed occupational, clinical, and medical history was compiled using a standardized questionnaire. To control for confounding variables, the experimental cohort was compared with a matched control group consisting of 50 healthy individuals from the non-teaching staff of a medical college, carefully matched for age, sex, and socioeconomic background. Comprehensive baseline anthropometric parameters—including age (years), body weight (kg), standing height (cm), and chest expansion (cm)—were systematically recorded for all participants. Physiological and Pulmonary Function Profile: Basic physiological metrics, such as resting pulse rate (beats per minute) and systemic arterial blood pressure (systolic and diastolic blood pressure in mmHg), were measured. Advanced pulmonary function test (PFT) parameters were assessed, specifically focusing on Forced Vital Capacity, Forced Expiratory Volume in the first second, the ratio of forced expiratory volume to forced vital capacity, Peak Expiratory Flow Rate, Maximum Expiratory Pressure.[17-18]

The comparative analysis revealed statistically significant reductions in key ventilatory parameters; most notably PEFR and MEP - among the stone quarry workers compared to the healthy control cohort. These structural and functional deteriorations are fundamentally attributed to the complex physicochemical properties of inhaled mineral and silica dust particles. Deposition of these particulates in the lower respiratory tract triggers chronic localized inflammation, airway hyper-responsiveness, tissue remodeling, and subsequent respiratory muscle fatigue or weakness.

Clinical Implications and Risk Assessment: Given the progressive and irreversible nature of dust-induced occupational lung diseases, regular surveillance is vital. We propose the serial, repeated administration of simple, cost-effective, non-invasive, and dynamic lung function tests-specifically PEFR and MEP as part of routine clinical practice for vulnerable populations. This approach allows for early identification of subclinical ventilatory impairment and better prognostic evaluation.

These findings align with previous literature. Research by Kiran Kumar et al. demonstrated that prolonged inhalation of silica-laden dust in stone quarry environments results in progressive pulmonary function decline, which exhibits a strong linear correlation with cumulative duration of occupational exposure.[19] Epidemiological evaluations in regions such as Jodhpur, Rajasthan, have similarly highlighted a high prevalence of chronic occupational lung diseases like silicosis among vulnerable, low-income quarry workers, emphasizing that strict preventative measures remain the primary defense.[20-21] Furthermore, recent multi-center and community-based epidemiological studies indicate that the health hazards of stone quarrying extend beyond direct workers.[22-23] Nearby resident populations living in proximity to quarry sites also face a statistically significant risk of deteriorating pulmonary function parameters due to ambient particulate dispersion.

Limitations of the study: Sample size is small. Females were not included in the study, to study for

the possible influence of sex on pulmonary functions and the associated occupational dust exposure. Other household variables like cooking system usually used in these workers home (gas, wood or any other) was not evaluated.

CONCLUSION

Based on the present study, we conclude that airborne particulate materials like asbestos, lead, silica dust, concrete, cement, stone, sand and other dusts adversely affect the pulmonary function parameters such as FVC, FEV1, FEV1/FVC%, PEFR and FEF25-75% and cause an obstructive pattern of lung function impairment. As MEP and PEFR were significantly reduced as compared to that of control group. We attribute this reduction in lung function tests to respiratory muscle weakness. Breathing exercises will help in strengthening the respiratory muscle and will improve the lung functions.

Acknowledgement

01. We thanks to the employees and employers of stone quarry workers of bijapur city for permitting us to conduct the study with full cooperation.

02. We thanks to the employees of BLDEU'S Shri B M Patil Medical College, Bijapur, for permitting us to conduct the study with full cooperation.

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