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Original Research Article

Study of Pulmonary Function Test in Factory Workers of Gujarat Population

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Abstract:

Background: Respiratory diseases are often diagnosed in laborers working in industries (factories) where they are exposed to toxic materials that are fatal to respiratory organs, mainly the lungs.

Method: 100 (one hundred) factory workers suffering from respiratory diseases were studied. The pulmonary function test was assessed three times, and the best out of three was noted. Sixty healthy volunteers were also subjected to the pulmonary function test. The values of factory workers and healthy volunteers (controlled) were compared. Moreover, among factory workers, pulmonary function tests of smokers and non-smokers were also noted and compared. The spirometric parameters were recorded using an electronic, computerized portable spirometric vitalograph in the sitting posture.

Results: Comparison of spirometric parameters FVC, FEV1, FVC%, and PEFR among smokers and non-smokers among workers. Moreover, these spirometric parameters in factory workers and healthy volunteers were compared, and the p value was highly significant in every parameter ($p<0.001$).

Conclusion: The present pragmatic study has concluded that the decreased spirometric parameter values in factory workers have a bad prognosis and must seek medical aid to protect themselves from morbidity and mortality.

Keywords: portable spirometre, vitalography, forced expiratory volume (FEV1), forced vital capacity (EVC), COPD, air pollution

Introduction

Occupation disease is caused by the constant exposure of workers to harmful occupational, physical, chemical, biological, ergonomic, and psychological factors [1].

In industries (factories), dust, cotton fibers, cement, and toxic materials used in industries are the main sources of air pollution [2]. Exposure to particulate materials that may lead to adverse respiratory effects like skin disease, lung function deterioration, sputum, coughing, wheezing, and an increased incidence of chronic obstructive pulmonary diseases have been reported globally [3].

In addition to this, the air pollution created by transport vehicles, including lorries, cars, and motor cycles, also aggravates the air pollution, which may lead to lung cancer or pulmonary tuberculosis. Occupation exposure to pollutants is a risk factor for 13 to 29% of patients. Several important occupational carcinogenic agents include arsenic, asbestos, beryllium, cadmium, chromium, nickel, silica, and particulate matter (in high concentrations). Volatile organic compounds are also harmful to the lungs, causing chronic obstructive pulmonary disease, which declines forced expiratory volume in one second (FEV1) associated with occupational exposure to dust, gases, and other pollutants [4]. Hence, a spirometry pulmonary function test was carried out to evaluate the respiratory function of laborers working in various industries exposed to harmful chemicals and dust.

Material and Method

100 (one hundred) adult patients referred to the physiology department of Swami Narayan Institute of Medical Sciences and Research Centre Kalol, Gujarat-382725, for pulmonary function tests were studied.

Inclusion Criteria: Patients above 20 years and below 60 years and exposed to dust in factories having difficulty breathing who gave written consent for study were selected for study.

Exclusion Criteria: Workers or labourers who recently joined (less than one year), had cardio-vascular illness in the present or past-existing kyphoscoliosis deformity. Those predisposed to allergic asthma were excluded from the study.

Method

100 (one hundred) adults working at factory exposed to dust pollution for more than one year are preferred; sixty (60) healthy volunteers were selected for comparison of pulmonary function tests. Everyone was subjected to a pulmonary function test.

Socio-demographic profile Performa was prepared to record age, sex, address, socio-economic status habits, smoking, consumption of alcohol, chewing tobacco, and any associated morbidities. Procedure for the pulmonary function test was explained to all workers and healthy volunteers.

The pulmonary function tests were performed using a portable PFT machine called a vitalograph. The best out of three readings were noted.

The spirometry functions were recorded using an electronic computerized portable spirometre (VITALOGRAPH) in the sitting posture following the American Thoracic Society recommendations [5]. To get the best results, each person did spirometry three times, and the best out of three was considered the pulmonary function test. The following parameters were investigated:

- Forced vital capacity
- Forced expiratory volume in 1s (FEV1)
- FEV1/FEV percent ratio

FVC percentage rates greater than or equal to 85% predicted was deemed normal, whereas values below 85% indicated bronchial obstruction. Based on the above parameters, the diagnosis was made for restrictive or obstructive pulmonary disorders. The association of pulmonary function tests with a habit of smoking among factory workers was also noted [6]. The duration of the study was from January 2023 to November 2023.

Statistical analysis: Comparison of FVC (1), FEV1 (1), FEV1/FVC% smokers and non-smokers factories were studied. Moreover, the pulmonary function test of labour factors and the healthy volunteer control group were also compared using the t test, and significant results were noted. The statistical analysis was carried out in SPSS software. The ratio of males and females was 2:1.

Observation and Results

Table 1: Comparative study of FVC (1), FEV1 (1), FEV1/FEVC%, and PFER among workers who are smokers and non-smokers.

- FVC (1) – 02 (± 0.32) in smokers and 4.32 (±0.42) in non-smokers; the t test was 17.16 and p<0.001.
- FEV1 (1) – 2.83 (± 0.28) in smokers and 3.90 (± 0.32) in non-smokers; the t test was 17.12 and p<0.001.
- FEV1 was 63.49 (± 6.48) in smokers and 77.72 (± 5.80) in non-smokers; the t test was 10.6 and p<0.001.
- PEFR (1/min): 378.06 (± 36.40) in smokers, 475.82 (± 35.30) in non-smokers; t test was 12.7 and p<0.001

Table 2: Comparison of FEV (1), FEV1 (1), FEV1/FVC (%), and PEFR (1/min) in labours and controlled group

- FVC (1) – 3.86 (± 0.76) in workers, 4.40 (± 0.32) in the controlled group; the t test was 6.47 and p<0.001.
- FEV1 (1) - 3.54 (± 0.60) in workers, 3.98 (± 0.36) in controlled; t test was 5.41 and p<0.001.
- FEV1/FWVC (%) - 72.10 (± 8.70) in worker, 88.19 (± 3.45) in controlled group; t test was 16.4 and p<0.001.
- PFER (1/min) - 445.96 (±58.26) in workers, 495.70 (± 30.26), t test: 7.09 and p<0.001

Table 1: Comparison of FVC (1), FEV1 (1), FEV1/FVC% and PEFR among smokers and non-smokers

Parameters	Factory workers (Mean ±SD)			
	Smokers	Non-smokers	t test	p value
FVC (1)	3.02 (± 0.32)	4.32 (±0.42)	17.16	P<0.001
FEV1 (1)	2.83 (± 0.28)	3.90 (±0.32)	17.12	P<0.001
FEV1	63.49 (±6.48)	77.72 (± 5.80)	10.6	P<0.001
PEFR(1/min/)	0	0	0	0

PVC – Forced Vital Capacity, FEV1- Forced expiry volume in 1s, PEFR – Peak expiration flow rate

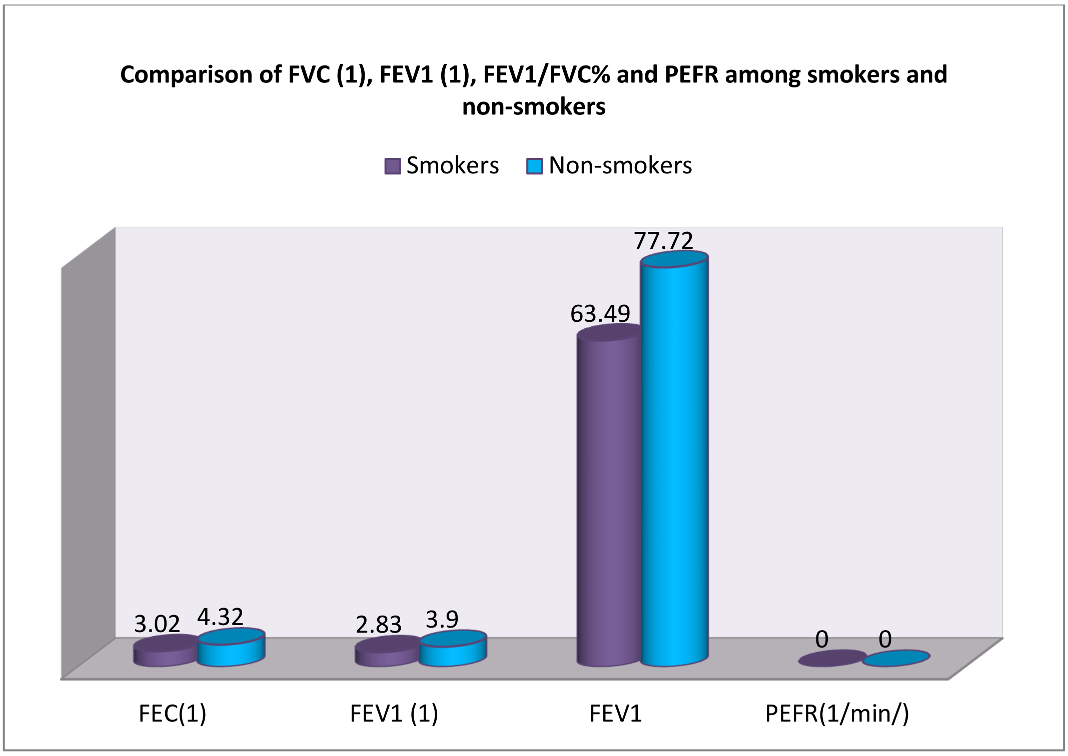

Figure 1: Comparison of FVC (1), FEV1 (1), FEV1/FVC% and PEFR among smokers and non-smokers

Table 2: Comparative study of FVC (1), FEV1 (1), FEV1/FVC (%) and PEFR (1/min)

Parameters	Factory workers (100)	Control group (60)	t test	p value
FVC (1)	3.86 (±0.76)	4.42 (±0.32)	6.47	P<0.001
FEV1 (1)	3.54 (±0.60)	3.98 (±0.36)	5.41	P<0.001
FEV1/FVC (%)	72.10 (±8.70)	88.19 (±3.45)	16.4	P<0.001
PEFR (1/min)	445.96 (±58.26)	495.70 (±30.26)	7.09	P<0.001

(p<0.001 – p value is highly significant)

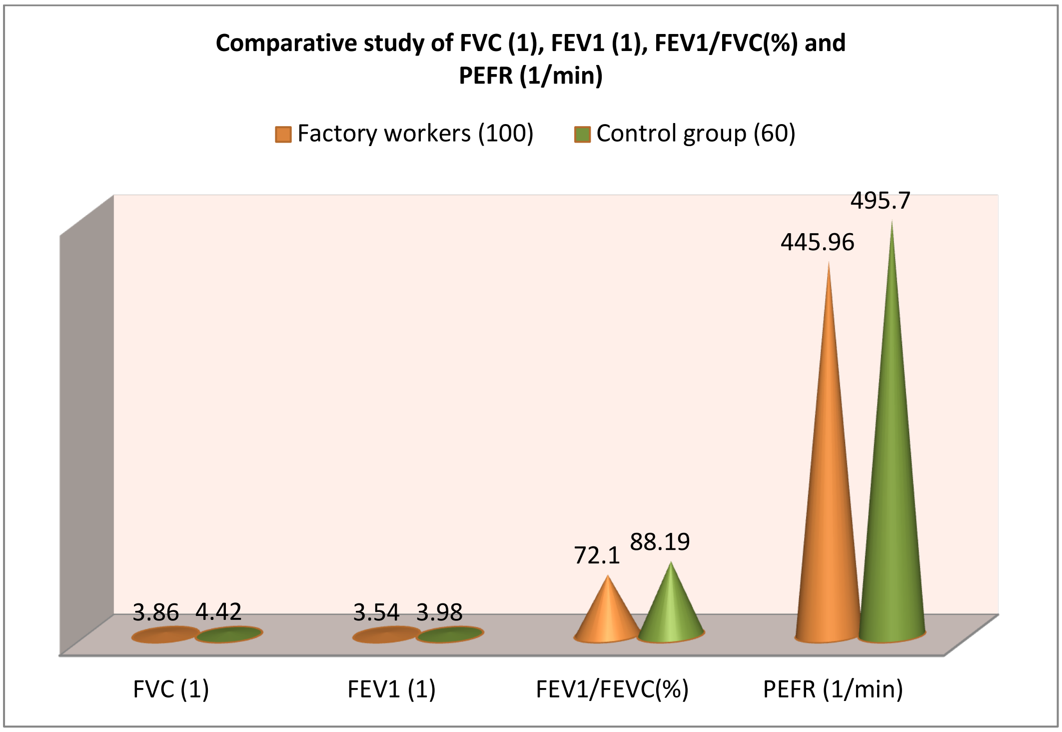

Figure 2: Comparative study of FVC (1), FEV1 (1), FEV1/FVC (%) and PEFR (1/min)

Discussion

Present study of pulmonary function test in factory workers of Gujarat population. In comparison of spirometric parameters in smokers and non-smokers among factory workers, FVC (1) was 3.02 (± 0.32) in smokers and 4.32 (± 0.42) in on-smokers; the t test was 17.16 and $p<0.001$. FEV1: 2.83 (± 0.28) in smokers and 3.90 (± 0.32) in non-smokers; the t test was 17.12 and $p<0.001$. FEV1 was 63.49 (± 6.48) in smokers and 77.72 (± 5.80) in non-smokers; the t test was 10.6 and $p<0.01$. PEFR: 378.06 (± 36.40) in smokers, 475.82 (± 35.30) in non-smokers; t test was 12.7 and $p<0.001$ (Table 1).

The spirometric parameters were compared between factory workers and healthy volunteers (controls). FVC (1): 3.86 (± 0.76) in workers, 4.42 (± 0.32) in controlled; the t test was 6.47 and $p<0.001$. FEV1 (1): 3.54 (± 0.60) in workers, 3.98 (± 0.36) in controls; t test: 5.41 and $p<0.001$. FEV1/FEVC (%): 72.10 (± 8.70) in workers, 88.19 (± 3.45) in controlled; t test was 16.4 and $p<0.001$. PEFR (1/min): 445.96 (± 58.26) in workers, 495.70 (± 70) in controls; t test was 7.09 and $p<0.001$. These results are more or less in agreement with previous studies [7,8,9].

Occupation disorders are seen in various proportions in different industrial or factory workers. Based on the duration of exposure, the organs affected also vary. Respiratory disorders constitute 60% of the total disorders globally, and 70% of morbidities are respiratory-related. The respiratory fatalities are due to 43.8% Metallic gases 47.2% due to fabrication dust, COPD (chronic obstructive pulmonary disease) may result from occupation exposure to mineral dusts, including metallic dusts, or a job involving workers of metal compounds, such as wielding metallic dust.

Deposition may give rise to pulmonary fibrosis and functional impairment, depending on the duration and fibrogenic potential of the agent and poorly understood host factors. Inhalation of iron compounds causes siderosis and pneumoconiosis with little or no fibrosis.

A possible mechanism could be the mobilization of neutrophils into the airways and the subsequent release of tissue-irritating substances either directly from neutrophils via platelets or by the secretion of prostaglandins from macrophages [10].

There is decreased diffusion capacity of the alveolar capillary membrane due to the destruction of alveoli, caused by inflammatory responses leading to decreased O2 saturation in the blood [11,12]. Hypoxia due to decreased O2 saturation leads to the release of leukotrienes and chemokines from eosinophils, resulting in broncho-constriction. Hypoxia, along with associated hyperpnea, gives rise to a decrease in PA CO2, resulting in further constriction of the bronchial muscles [13]. The lymphocytic infiltration caused by inflammatory responses may result in thickening of the walls of the bronchioles, resulting in obstruction of the lumen by granulation tissue [14].

The reduction in PEFR may involve the same mechanism for obstructive lesions. In addition, the inflammatory reaction releases proteins from eosinophils, which might be responsible for the hyper responsiveness of the airways.

Summary and Conclusion

Present study of pulmonary function tests in factory workers (industry) has decreased the parametric values of the spirometer, which leads to a bad prognostic value for respiratory diseases. Hence, medical check-ups must be made mandatory for such workers, and awareness of hazards due to exposure in industry must be created by medico-social workers. This study demands further immunological, nutritional, environmental, genetic, and pathophysiological studies because the exact pathogenesis of pulmonary diseases is still unclear.

Limitation of Study: Owing to the tertiary location of the research center, the small number of patients, and the lack of the latest technologies, we have limited findings and results.

This research work was approved by the Ethical Committee of the Swami Narayan Institute of Medical Sciences and Research Kalol, Gujarat (382725).

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