

Research Article

Forced vital capacity, forced expiratory volume in 1st second and forced expiratory ratio in automobile spray paint workers

Geetika Gupta^{1*}, Sabita Yograj¹, Anil K. Gupta², Bhavna Langer³, Mumtaz Goni¹

¹Department of Physiology, ASCOMS, Jammu, Jammu and Kashmir, India

²Department of Medicine, ASCOMS, Jammu, Jammu and Kashmir, India

³Department of Community Medicine, GMC, Jammu, Jammu and Kashmir, India

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*Correspondence:

Dr. Geetika Gupta,

E-mail: drgeetikamahajan@gmail.com

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ABSTRACT

Background: Automobile industry is a place where workers are exposed to harmful chemicals and toxic substances. Workers engaged in automobile spray painting are at a risk of developing respiratory problems. This is due to exposure to low molecular weight compounds (isocyanates) in spray paints.

Methods: The present study was conducted on 100 male subjects comprising of the study group (n=50) and the control group (n=50), 18-35 years of age, non-smoker and with no pre occupational respiratory illness. The study group included workers working for 6-8 hours a day and exposed to spray paints for ≤5 years and the controls were age and BSA matched healthy office workers of the same locality. A preformed questionnaire was given to subjects and pulmonary functions parameters (forced vital capacity (FVC), forced expiratory volume in 1st second (FEV1), forced expiratory ratio (FEV1/FVC)) were recorded by computerised spirometer (Medspiror).

Results: The two groups did not differ significantly on physical parameters. The pulmonary function parameters of the study group (FVC p=0.036, FEV1/FVC p=0.000) were found to be significantly different when compared to that of controls. As the age, weight, height and BSA increases there was a significant decrease in FEV1 in study group. Duration of exposure (<3 and more than equal to 3) had no statistically significant impact on pulmonary function tests (FVC p=0.139, FEV1 p=0.339, FEV1/FVC p=0.158) in the study group.

Conclusions: Exposure to automobile spray paint impairs lung functions.

Keywords: Forced vital capacity, Forced expiratory volume in 1st second, Forced expiratory ratio

INTRODUCTION

Pulmonary function tests are a major step forward in assessing the functional status of lungs and includes group of tests that measure the functions of lungs and are widely used in diagnosis evaluation and management of patients with disorders of respiration.¹ Most of the lung diseases result from interaction between the various agents inhaled from the environment and tissues of airways and lungs.² India's auto motive industry is growing rapidly and is expected to be the third largest

market in the world. Numbers of workers are engaged in automobile spray painting and their health concern is of important because of rapidly expanding use of coating materials.^{3,4} These spray paints create a fine mist or droplets that may remain suspended in the air for short period of time thereby increasing the risk of inhalation as well as eye and skin irritation.⁵ Isocyanates and similar low molecular weight compounds are used as cross linking agents in polyurethane products like foams, paints, insulating materials, varnishes and rubber modifiers.⁶ These compounds are known to be toxic, and are characterized by highly reactive NCO groups and are

one of the most commonly identified causes of occupational asthma. Besides allergic asthma, they may also result in hypersensitivity pneumonitis and possibly accelerated decline in lung function.⁷ Other signs and symptoms include allergic cough, sore throat, itching, burning sensation of eyes, nose, dermatitis and eczema. Pulmonary effects can be dyspnoea, wheezing, bronchoconstriction etc.⁸ Fuchs and Valade were the first to recognize that spray paint exposure can cause respiratory diseases.⁹ It was more frequently observed in workers who had been working for longer duration as compared to workers with shorter duration.¹⁰ Medical surveillance of workers potentially exposed to respiratory hazards may be a valuable tool in early recognition and prevention of occupational lung disease. As in early lung disease physiological reversibility is almost a certain possibility if not further exposed to the toxic chemicals and dust.¹¹

Despite the extensive use of spray paints in automobile industry, very few studies have been conducted in India, (as compared to western countries) to see the effects of these paints on pulmonary function parameters i.e., FVC, FEV1 and FEV1/FVC when exposed for ≤ 5 years.

METHODS

A cross-sectional study was conducted on 100 subjects of 18-35 years of age. Out of these, study group (cases) included 50 male subjects, non-smokers, working as automobile spray painters for 6-8 hours a day, with employment duration ≤ 5 years. For comparison, 50 age and BSA matched apparently healthy controls who were not exposed to automobile spray paint, non-smokers were taken (office workers of same area). After selecting the subjects, the purpose of the study was explained to each subject and written consent was taken. All those fulfilling the inclusion criteria and willing to participate were included in the study. Face to face interview was conducted using pre-structured questionnaire and the data was collected.

Exclusion criteria

Subjects with history of any pre-occupational respiratory diseases like asthma, bronchitis, allergies, abdominal and chest surgery, and smoking were excluded from the study.

Pulmonary function tests

PFT's were performed on all the subjects with the help of Medspiror (records and medicare Chandigarh). Tests were done on subjects in the sitting position. The subjects were thoroughly familiarized with the apparatus and demonstration was given to the subjects to how to perform the tests. The subjects were asked to take maximal inspiration and then blow into mouth piece as rapidly, forcefully and completely as possible with maximal effort. A nose clip was applied during the

maneuver. The parameters studied in detail were FVC, FEV1, and FEV1/FVC.

Table 1: Interpretation of values.¹²

Parameters	Restrictive	Obstructive
FVC	<80% of predicted	Normal or <80% of predicted
FEV ₁	Normal or <80% of predicted	<80% of predicted
FEV ₁ /FVC	\geq Predicted	< Predicted

Normal values are based upon the age, weight, height, BSA. It gives predicted value, actual value and % of predicted value. A value is considered abnormal if its <80% of predicted value.

Statistical analysis

Analysis was performed using computer software SPSS (20.0). Descriptive statistics were used for the demographic and outcome data and summarized as mean \pm standard deviation (SD). Independent sample t-test was applied to find the significance of difference between the two group means. The correlation between various independent variables and PFT's in controls and the study group was assessed using the Pearson correlation test. A P-value of less than 0.05 ($p < 0.05$) was considered statistically significant.

RESULTS

A total of 50 subjects of study group and 50 controls were included in this study. The results of the study are showed in the below given tables. Anthropometric parameters of controls and the study group i.e. age, height, weight, BSA are shown in Table 2. Comparison of mean values of parameters did not reveal any statistically significant difference between the two groups.

Table 2: Comparison of mean values of anthropometric measurements between controls and the study group.

Parameters	Controls	Study group	P-value
Age (Years)	28.20 \pm 4.35	27.34 \pm 3.68	0.280
Height (cms)	165.92 \pm 7.08	166.86 \pm 6.99	0.506
Weight (kg)	59.4 \pm 11.78	60.28 \pm 8.90	0.587
BSA(kg/m ²)	1.64 \pm 0.17	1.69 \pm 0.14	0.119

Data presented as mean \pm standard deviation

$P < 0.05$ significant

Table 3 shows the comparison of pulmonary function parameters between controls and the study group. FVC and FEV1/FVC were significantly higher in controls as compared to study group. The mean FVC of the study group was lower, 3.38 \pm 0.803 when compared with that of

the control (3.71±0.70) and was found to be statistically significant (p=0.036). The study group also showed a decrease level of FEV1 but the difference was not statistically significant (p=0.374). Ratio of FEV1/FVC in the two groups was found to be statistically significant (p=0.000).

Table 3: Comparison of mean values of pulmonary function tests between controls and the study group.

Parameters	Controls	Study group	P-value
FVC	3.71±0.71	3.38±0.803	0.036*
FEV1	3.17±0.67	3.05±0.70	0.374
FEV1/FVC	85.01±7.6	90.81±6.36	0.000**

Data presented as mean±standard deviation

P value <0.05 *statistically significant.

Table 4(a) and 4(b) depict the correlation between various independent variables and pulmonary function tests in cases and controls. Correlation is significant at 0.05 level. There was a significant negative correlation between age and FVC and age and FEV1.

Further a significant positive correlation was seen between BSA and FVC in control group. In the study group there was no significant correlation between various parameters and FEV1/FVC. FVC and FEV1 showed a highly significant negative correlation with age. The age, weight, height and BSA increase there is a significant decrease in FEV1 in study group. There was no statistically significant difference between pulmonary function tests and duration of exposure (<3 and more than equal to 3) among study group (Table 5).

Table 4(a): Correlation between various independent variables and PFT's in controls.

Parameters (Controls)	FVC		FEV ₁		FEV ₁ /FVC	
	Correl ⁿ	Significance	Correl ⁿ	Significance	Correl ⁿ	Significance
Age	-0.447**	0.001	-0.463**	0.001	-0.071	0.624
Weight	0.140	0.332	0.050	0.729	-0.223	0.120
Height	0.238	0.097	0.257	0.071	0.096	0.508
BSA	0.357	0.011	0.273	0.055	-0.202	0.160

Significant* < 0.05

Highly significant** < 0.01

Table 4(b): Correlation between various independent variables and PFT's in the study group.

Parameters (study gp)	FVC		FEV ₁		FEV ₁ /FVC	
	Correl ⁿ	Significance	Correl ⁿ	Significance	Correl ⁿ	Significance
Age	-0.526**	0.000	-0.549**	0.000	-0.215	0.134
Weight	0.423**	0.002	-0.377**	0.007	-0.033	0.819
Height	0.646**	0.000	-0.631**	0.000	0.149	0.301
BSA	0.383**	0.006	-0.344**	0.015	-0.029	0.843

Significant* < 0.05

Highly significant** < 0.01

Table 5: Relationship between duration of exposure (<3 and more than equal to 3) with PFT using independent sample t-test in study group.

Parameters	t-values	p-values
FVC	1.50	0.139
FEV ₁	0.966	0.339
FEV ₁ /FVC	-1.43	0.158

DISCUSSION

Pulmonary function tests are non-invasive diagnostic tests that provide measurable feedback about the functions of the lungs. Single indices are of value in screening tests for detection of early abnormality and for follow up of subjects in whom diagnosis has already been made. A group of indices provides a multi-dimensional picture of the function of the lung. In public health and in

industrial field, the application of tests of lung function to workers in industry provides biological indices which are of value in defining safe conditions and in assessing the effects of exposure to known hazards.¹³ The present study was undertaken to evaluate the effects of spray paint exposure on dynamic pulmonary functions parameters.

All subjects in our study were asymptomatic. There is statistically significant reduction in the FVC among the study group and FEV1/FVC ratio was also increased significantly. The findings are suggestive of restrictive type. This could be attributed to the ignorance of workers to comply with standard protective measures. The present study is in harmony with previous studies by Dahlqvist V et al, Baur X et al.^{14,15} The changes in the parameters may be due to diffuse, predominantly mononuclear inflammation of the lung parenchyma particularly the terminal bronchioles, interstitium and alveoli. This

inflammation organises into granulomas and may progress to fibrosis. Aggarwal et al stated that a true restrictive defect in total lung capacity could be diagnosed only when there was reduction in total lung capacity (TLC).¹⁶ Mapp CE et al and many other studies have also reported asthma like symptoms and obstructive pattern of disease, this indicates that nature of pulmonary damage in exposed subjects can be of mixed pattern.¹⁷⁻¹⁹ Chattopadhyay O et al also observed that 83 workers had obstructive impairment and 21.19% had restrictive impairment.^{20,25} No significant relation was found when parameters were studied for duration of exposure. The study is in agreement with Revathi M et al.²¹ On the contrary Siddanagoudra et al reported strong correlation between duration of exposure and pulmonary functions.²² Further studies with history of long duration of exposure to these compounds can be done for better results.

CONCLUSION

The present findings revealed that spray painting is an occupation which involves the risk of respiratory involvement. Education of workers, use of personal protective measures and regular medical check-up are recommended.

Only those workers who were exposed to spray painting were included in the study, there is a further need to include those exposed for more than 5 years to verify the effect of duration of exposure, if any. Previous data on Pulmonary function tests of these workers was not available, the workers should be followed up periodically and results be compared to further corroborate the findings.

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