

Research Article (Open access)

Evaluation of Pulmonary Function in Car Spray Paint Sprayers

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ABSTRACT- Background: Pulmonary function tests have added in the early detection of pulmonary dysfunction in patients considered to be normal on the basis of clinical and radiological examination. The present study was designed to evaluate pulmonary functions in car paint sprayers.

Methods: Sixty subjects in the age group 18 to 45 year were divided into two groups (each group having thirty subjects). Group A consisted of healthy controls. Group B consist of healthy, car paint sprayers. Car paint sprayers had employment duration of 5 to 12 years. Anthropometric and respiratory parameters using MEBISOFT were performed. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS-17).

Results: The results of present study suggested that the values of FVC, FEV1, FEV1/FVC and PEFR were significantly lower in subjects who were in Group B exposed to organic solvents (used for spraying car painting) when compared with Group A subjects.

Conclusion: The present study results strongly recommend for following appropriate safety measure while spraying car painting using organic solvents irrespective of their smoking status and age.

Key-words: Pulmonary function, Car spray painters, SPSS-17, Anthropometry, BSA, FVC

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INTRODUCTION

Pulmonary function tests have added in the early detection of pulmonary dysfunction in patients considered to be normal on the basis of clinical and radiological examination. Car paint sprayers are exposed to iso-cyanates¹ which are a group of low molecular weight aromatic and aliphatic compounds containing the highly reactive isocyanate group (-NCO)². The most commonly used isocyanates include toluene di isocyanate (TDI), diphenyl methane di isocyanate (MDI), hexamethylene di isocyanate (HDI), and biuret modified HDI (HDI-BT)³. Most of the isocyanate compounds are colorless, yellow, or brown liquids with sharp pungent odours. Inhalation and dermal exposure can occur during the manufacture and use of these compounds.

Isocyanates are used as cross-linking agents in polyurethane products such as foams, varnishes, and paints. Therefore, workers and individuals in close proximity to spray application of polyurethane are very likely to be exposed⁴.

Chronic inhalation can cause immune disorders as well as nasal and lung lesions. Chronic inhalational exposure to isocyanates in plant workers has been linked to pulmonary effects that are characterized by dyspnoea, wheezing and bronchial constriction⁵. Detailed medical and occupational history should be obtained to investigate the relationship between asthmatics symptoms and workplace exposure⁶.

In addition, different types of pulmonary function and inhalation challenge tests are used to confirm diagnosis of Occupational asthma. However, since repeated pulmonary function testing is not sufficient to diagnose and evaluate pulmonary damage induced by car paint sprays³, low molecular weight proteins were introduced as interesting peripheral biomarkers.⁶⁻¹¹

MATERIALS AND METHODS

Sixty subjects in the age group 18 to 45 year were divided into two groups (each group having thirty subjects). Group A consisted of healthy controls. Group B consist of healthy, car paint sprayers. Car paint sprayers had

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employment duration of 5 to 12 years.

The study was conducted in Department of Physiology, Santosh Medical College, Ghaziabad, India & Sudhanshu Automobile Company in Delhi, India. A written consent was taken from them. Subjects with FEV1% value less than 60% of predicted value was excluded from the study. The subjects of both group had no present or past history of recurrent respiratory infection, cough or dyspnea. They were non-smokers. There was no clinical evidence of malnutrition, heart disease or any other physical ailment. The following measurement was carried out on each subject:

Anthropometry: Height and weight was measured. Body surface Area (BSA): in square meters was calculated from the height and weight of the subject using Du-Bois normogram.

Respiratory parameters: Respiratory parameters by spirometry. At least three acceptable and reproducible Maximal Expiratory Flow volume (MEFV) Curves were obtained after explaining the procedure. They were monitored on the computer screen. In the present study all the parameters were studied by using MEBISOFT. The highest FEV1 from the best three curves were selected for assessment and following parameters were computed FVC (Forced Vital Capacity), FEV1 (Forced Expiratory Volume in First Second), FEV1/FVC, FEF25_75 (Forced Expiratory Flow at 25% - 75%), PEFR (Peak Expiratory Flow Rate), FEF50 (Forced Expiratory Flow at 50% of FVC), MVV (Maximum Voluntary Ventilation), FRC (Functional Residual Capacity), RV (Residual Volume), TLC (Total Lung Capacity), DLCO (Carbon Monoxide Diffusion Capacity)

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS-17). The results were expressed as mean ± standard deviation (SD). Independent t-test was applied to study the PFTs in smokers and non-smokers and also for worker with symptoms suggestive of Occupational Asthma and without Occupational Asthma. Relationship between duration of exposure and respiratory morbidity state was studied by correlation test. P < 0.05 was considered significant.

RESULTS

Comparison of anthropometric parameters (Body surface area [BSA], weight and height) among Group A and Group B subjects is shown in Table 1.

There was no statistical difference in body surface area and height between Group A and Group B subjects. The mean weight of subjects of Group B group (63 Kg) was less than the subjects of Group A groups (72 Kg) with mean difference of 9 kg. Overall, the anthropometric parameters were similar in both the groups.

Table 1: Comparison of anthropometric parameters among Group A and Group B subjects

Parameter	Group A N = 30	Group B N = 30	
Body surface area	1.76±0.14	1.64±0.09	NS
Height	1.56±0.11	1.54 ±0.07	NS
Weight	71.74±9.97	63.20±6.73	NS

Values are expressed as Mean ±SD
 N: Number of subject in each group
 NS: Not Significant
 Group A: Unexposed Worker
 Group B: Exposed Worker

Table 2: Comparison of Pulmonary Function parameters among Group A and Group B subjects

	Group A N = 30 Mean ±SD	Group B N = 30 Mean±SD	P-value
Forced Vital Capacity (L)	2.99±0.14	2.36±0.30	P< 0.001
Forced Expiratory Volume in FIRST second (L/sec)	2.84±0.15	1.75±0.31	P< 0.001
Ratio of FEV1 to FVC	95.08±2.17	74.48±12.65	P< 0.001
Forced Expiratory Flow over 25% to 75% of FVC	3.34 ± 0.19	2.21±0.43	P< 0.001
Peak Expiratory Flow Rate (L/sec)	7.86±2.08	4.55±0.40	P< 0.001
Forced Expiratory Flow at 50% of FVC (L/sec)	4.55±0.19	3.24±0.82	P< 0.001
Maximum Voluntary Ventilation (L/min)	107.63±5.43	85.62±19.93	P< 0.001
Residual volume (L)	1.63±0.19	1.16± 0.40	P< 0.001
Total lung capacity (L)	4.74±0.51	3.14± 1.11	P< 0.001
Carbon Monoxide Diffusion Capacity	28.10±0.57	23.20±4.27	P< 0.001

Values are expressed as Mean (±SD)
 N= Number of subject in each group
 Group a: Unexposed Worker
 Group b: Exposed Worker P< 0.001

The results of present study suggested that the values of FVC, FEV1, FEV1/FVC and PEF were significantly lower in subjects who were in Group B to organic solvents (used for spraying car painting) when compared with Group A subjects (Table 1). The difference in PFT markers between both Group B and Group A was statistically significant.

The other pulmonary impairment parameters included forced expiratory flow over 25% to 75% of FVC, forced expiratory flow at 50% of FVC, maximum voluntary ventilation and residual volume. In addition, total lung capacity (L) and carbon monoxide diffusion capacity significantly decreased in Group B subject than Group A subjects. There was statistical significant difference in all pulmonary function parameters compared between Group B and Group A subjects. These results suggest that the changes in pulmonary function in Group B subject were due to organic solvent which is used for spraying car painting.

DISCUSSION

In the present study, the pulmonary function markers of subjects who were exposed to car painting vapors significantly decreased compared with unexposed subject, indicating that the pulmonary function impairment in exposed subject was due to organic solvent which was used for spraying car painting.

The present study, all the key pulmonary function parameters including total lung capacity and carbon monoxide diffusion capacity were significantly lower in exposed subject than unexposed subjects.

Wink¹² showed that mean peak flow in workers decreased significantly on the day of exposure and increased on days when the workers were stayed away from work.

In other study, significantly lower FVC, FEV1 and FEV1/FVC values were recorded in both higher and lower age group smokers and non-smokers paint workers in comparison to control group except FEV1% and PEF values of higher age group paint workers, where it showed significantly lower values than control group workers.¹³

Again, Saad¹⁴ studied on tannery workers exposed to benzene and formaldehyde and found that the values of pulmonary function parameters (FVC, FEV1) were significantly lower in the exposed workers.

Metwally¹³ explained these findings by longer duration of exposure and older age with high solvent exposed group of workers resulting in further deterioration in lung function parameters. These results corroborated with the study of Schweigert.¹⁴ who studied car paint sprayers exposed to solvent. They found that there was progressive decline in percentage of predicted FEV1 with increasing intensity of solvent exposure.

Chattopadhyay Parkar¹⁵ and Cullen¹⁶ pointed out that obstructive impairment was more frequent in smoker workers but increased frequency of restrictive impairment was not statistically significant with smoking which corroborated with our findings.

Metwally¹³ and Dement¹⁷ demonstrated increased risk of COPD among paint workers exposed to solvent, which was in accordance with our findings where prevalence of chest tightness, chronic Bronchitis and Bronchial asthma was high among high Volatile organic compounds exposed paint workers in comparison to low VOC exposed group. These respiratory effects were probably due to Volatile organic compounds, and Xylene induced oxidative stress.¹⁸ Other results suggested that the decrease in forced vital capacity might serve as a guide to identify car painters at risk of a further decrement in lung function.¹⁹ In this respect, many researchers indicated that exposure to low toluene diisocyanate concentrations was associated with minimal but detectable changes in airway caliber and in epithelial barrier permeability causing some changes in the pulmonary function,²⁰ and nearly 36.4% of the car paint sprayers had some form of pulmonary function impairment; obstructive and/or restrictive²¹⁻²².

In our study, the correlation between pulmonary function parameters with duration of exposure to painting solvents and age of car paint sprayers (years) was negative except for forced expiratory flow at 50% of FVC and carbon monoxide diffusion capacity.

It has been reported that the car painters who smoke less are less likely to use respiratory protection in highly exposed situations and therefore show a greater decline in lung function.

CONCLUSIONS

The present study results recommends for following appropriate safety measure while spraying car painting using organic solvents irrespective of their smoking status and age; however it is highly recommended to the subjects who are chronic smokers. The smoking populations of workers who ignore to follow standard protection measures during car painting are at very high risk of developing pulmonary impairment. Exposure to paints leads to an obstructive pattern of impairment of pulmonary function.

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