

Study of pulmonary function tests in car spray painters of age group 20-40years, exposed more than 5years

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Abstract

Background: Automobile spray painting is an occupation where painters are exposed to organic solvent containing isocyanates. This exposure is associated with high risk of respiratory disorders like asthma and chronic bronchitis. **Objective:** The aim of this study is to evaluate the effect of paints that contain Isocyanates like hexamethylenediisocyanate (HDI) and biuret modified (HDI-BT) on lung functions of car spray painters in terms of obstructive and restrictive pattern. **Material and methods:** This study included 30 mild-moderate painters from various automobile service centres of Hubballi, involved in car spray painting for more than 5yrs. Pulmonary function test was carried out, parameters like FEV₁, FVC, FEV₁/FVC, PEFR, FEF_{25-75%}, were measured using NDD Medizintechnik AG, easy on PC USB spirometer. **Result:** The result of present study showed very high significant decrease in FVC, FEV₁, FEV₁/FVC, PEFR and FEF_{25-75%}, with P value <0.0001 in subjects who were exposed to organic solvent (car spray paints) compared to the subjects who are unexposed. **Conclusion:** The results suggest that the decrease in FEV₁ and FVC in painters shows that they are at risk of obstructive lung function.

Keywords: Isocyanates, FEV₁, FVC, FEV₁/FVC, PEFR, FEF₂₅₋₇₅, occupational exposure, spray painting.

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Introduction

Humans are exposed to various pollutants. The association of respiratory problems with chemical emission from common indoor materials has been studied but specific effect of car spray paint has not been widely investigated in India. Car painters are exposed to various toxic chemicals like isocyanates especially hexamethylene diisocyanate(HDI) and biuret modified(HDI-BT) which are irritants to the airway and may cause sensitisation. Isocyanates are a group of highly reactive, containing functional group $-N=C=O$, and are classified as aliphatic and aromatic, common forms include the aromatic methylene bisphenyl di-isocyanate(MDI) and toluene di-isocyanate (TDI) and aliphatic hexamethylene di-isocyanate(HDI). Isocyanates are used in number of products including paints, coatings and polyurethane products, adhesive across variety of industries[1]. These isocyanate compounds are colourless, yellow or brown liquids with sharp pungent odours. As spray painting creates fine mists that may suspend in air for a short period of time the painters are directly exposed to isocyanate fumes, inducing acute and chronic airflow obstructive diseases[2].

Spirometer: Spirometry is a standard test used to measure the lung functioning. The Spirometer is a device that works by measuring airflow into and out of the lungs and the speed of the breath. The parameters measured are FVC, FEV₁, FEV₁/FVC, FEF_{25-75%}, MVV, PEFR. As Hubballi is known for its automobile industries and car showrooms, our study population and samples from the same as been taken for the study of pulmonary function test in car spray painters.

Method of collection of data: The current study is a statistical analytical study including 30 workers. The written informed consent

was obtained from the subjects. General physical examination was done to know the health status and to rule out any deformity in the subjects.

Anthropometric measurements were recorded. PFT parameters were recorded by, NDD Medizintechnik AG, Switzerland, easy on PC USB spirometer, in the Department of physiology, KIMS Hubballi during the period June to July 2016-17 in both the groups. The parameters obtained are:

Forced Vital Capacity (FVC), Forced Expiratory Volume in First second (FEV₁), FEV₁/FVC (FEV₁%), Peak Expiratory Flow Rate (PEFR), Forced Expiratory Flow during 25-75% expiration (FEF_{25-75%}).

Recording of lung volumes

All the subjects were thoroughly acquainted with the apparatus. Details about the procedure were explained in their vernacular language. The tests were carried out in sitting posture. The test was repeated at least 3 times before recording the value. Values for PEFR, FEV₁, FEV₁/FVC, FEF_{25-75%}, are obtained at the same time. Group A: car spray painters exposed more than 5years. Group B: control group not exposed to spray paints. Subjects were selected based on inclusion and exclusion criteria.

Inclusion Criteria

Workers aged 20-40 year, Non smokers and exposed to car spray paints for more than 5years

Exclusion Criteria

Workers with respiratory disorders: H/O tuberculosis, respiratory tract infection, asthma and bronchitis, Smoking and alcohol consumption and any history of syncope association with forced exhalation. The results were expressed as mean \pm standard deviation (SD). Unpaired *t* test was applied to study the PFTs in car spray painters and controls. Relationship between duration of exposure and respiratory morbidity state was studied by correlation test.

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Anthropometric measurements were recorded and Mean and SD of age, height, weight and BMI were calculated.

- A probability P value of < 0.05 is considered as significant (S).
- A probability P value of < 0.001 is considered as highly significant (HS).

- A probability P value of < 0.0001 is considered as very highly significant (VHS).

Results

The result of present study showed very high significant decrease in FVC, FEV₁, FEV₁/FVC, PEFR and FEF_{25-75%}, with P value < 0.0001 in subjects who were exposed to organic solvent (car spray paints) compared to the subjects who are unexposed.

Table 1: Anthropometric parameters of the car painters and controls

Anthropometric variables	Group A (painters)	Group B (controls)	P Value	Significance
Age(yrs)	28.8 ±4.63	28.63±4.66	0.887	NS
Height (cm)	160.7±5.47	161.36±6.55	0.686	NS
Weight (kg)	60.66±6.40	63.1±8.13	0.202	NS
BMI (kg/m ²)	23.38±2.47	24.24±2.66	0.199	NS

Table 1 shows anthropometric details of two groups. From the above table it is evident that the two groups were well matched with respect to age, height, weight, BMI respectively.

Table 2: Comparison of the study variables in car painters and controls

Parameters	Painters	Controls	P value	Significant
FVC(L)	2.94±0.78	4.03±0.65	0.0001	VHS
FEV ₁ (L)	2.07±0.56	3.30±0.47	0.0001	VHS
FEV ₁ /FVC (%)	70.60±13.15	80.05±7.70	0.001	HS
PEFR(L/S)	4.35±1.54	11.71±2.22	0.0001	VHS
FEF _{(25-75%)(L/S)}	2.45±1.29	3.94±0.65	0.0001	VHS

Discussion

Occupational asthma is defined as reversible airways obstruction caused by specific agents in the work place. The airway obstruction in the obstructive lung diseases where the airway lumen may be partially obstructed by excessive secretion (chronic bronchitis) or oedema fluid. The airway wall smooth muscles may be contracted (asthma) or thickened because of inflammation and oedema or mucous glands may be hyper-trophied[3]. In the current study a total of 30 car spray painters exposed more than 5years and 30 controls who are unexposed to paints were evaluated for the effects of car spray paints on pulmonary function tests using computerized spirometer. The pulmonary function test (FVC, FEV₁, FEV₁/FVC, PEFR, FEF 25-75%) of each subjects were recorded. The results were tabulated and statistically analysed. Table 1 shows the comparison of anthropometric parameters of all the car painters and controls. It can be observed that there is no significant P value with respect to all the parameters studied. Table 2, Car spray painters showed statistically a very high significant decrease in FVC, FEV₁, PEFR and FEF(25-75%) with $p < 0.0001$ where as in controls that were unexposed had no change in FVC, FEV₁, PEFR and FEF(25-75%) .A similar study was conducted by Randolph BW *et al.*, the mean cross-shift decrease in forced expiratory volume in 1 second (FEV₁) (P = 0.0002). The lung function data indicated that of the 40 spray-painters examined, (25%) showed clinically significant cross-shift decreases in FEV₁[4]. A similar study was conducted by Schwartz DA *et al.*, 10 men showed a decline in FVC within the week. A significant correlation was found between the change in FVC within the week and the long term (six year) change in FVC[5]. Similar observations were made by White MC1 *et al.*, longer employment as a painter was associated with increased prevalence of chronic obstructive disease. Multiple regression analysis showed a significant association between years worked as a painter and a decrement in FEV₁ equal to about 11 ml for each year worked. The prevalence of chronic bronchitis was significantly associated with increased use of spray application methods [6]. A similar study by Minov J1 *et al.*, they underwent serial peak expiratory flow rate (PEFR) measurement and bronchoprovocation testing. Significant work-related changes in PEFR diurnal variations and in non-specific bronchial hyperresponsiveness (NSBH) were observed in one patient, suggesting allergic occupational asthma (OA). Their data confirm that spray painting is an occupation with increased risk of respiratory impairment and asthma[7].

A similar study was conducted by Kumar H P Arun *et al.*, they observed decline in FVC was moderately significant with P value 0.02, while decline in FEV₁, FEV₁/FVC ratio, FEF 25-75 and PEFR values were strongly significant P value < 0.001 in spray painters when compared to no painters[8]. A similar study was conducted by Ahmad Tarik Numan, Thirty cross sectional selected male workers employed in automobile body paint shops in two industrial areas. The results indicated significant decrease in PFT markers (FVC, FEV₁, FEV₁/FVC and PEF) compared to control group, while liver function did not significantly affected[9]. A similar study was conducted by Savitri P Siddanagoudra *et al.*, study revealed that nine spray painters showed $< 70%$ FEV₁/FVC suggestive of early obstructive lung disease when compared to their % predicted. PEFR and FEF_{25-75%} were also declined but not statistically significant suggesting smaller airway obstruction. All the nine workers had typical symptoms of OA. This could be attributed to long duration of exposure to isocyanate[10]. A similar study by Sumit Arora1 *et al.*, suggested that the values of FVC, FEV₁, FEV₁/FVC and PEFR were significantly lower in workers exposed to organic solvents (used for spraying car painting) when compared with controls[11]. A study conducted by Kaukiainen A, Riala R, Martikainen RKaukiainen A, Riala R, Martikainen R, on painters reported more asthma-like, rhinitis, laryngeal and eye symptoms than the carpenters [odds ratio (OR) 1.4-1.8]. the painters with 1-10 years of painting experience had a threefold risk of asthma compared with the carpenters. Chronic bronchitis was linked to painting occupation[12]. A study conducted by C T Leffler and D K Milton, On 23-year-old spray painter who developed contact dermatitis and respiratory difficulty characterized by small airways obstruction shortly after the polyfunctional aziridine cross-linker CX-100 began to be used in his workplace as a paint activator. This case illustrates the importance of using appropriate work practices and personal protective equipment to minimize exposure. Occupational asthma is diagnosed by a history of work-related symptoms and exposure to known causative agents[13]. A similar study was conducted by Ott MG, early studies from the 1960s and 1970s provided evidence of transient or fixed lung function loss (measured as a decline in forced expiratory volume in one second [FEV₁]) during periods of ongoing exposure among employees experiencing high rates of work-related symptoms of OA[14]. A similar study was conducted by Ucgun II, Ozdemir N, Metintaş M, Metintaş S, Erginel S, Kolsuz M, Of these subjects, 190 (61%) were furniture painters and 122 (39%) automobile

painters. In the first phase of the study, a modified questionnaire and pulmonary function test (PFT) were done. During the second phase, peak expiratory flow rate (PEFR) was monitored, in the third phase, nonspecific bronchial provocation tests (NSBPT) with histamine were done on 23 of the PEFR-monitored workers. Finally, through questionnaire, typical history, PFT, PEFR monitoring, and NSBPT, 30 workers (9.6%) were diagnosed as having OA. Smoking habits and atopy in the OA-diagnosed workers were found to be statistically significantly high in comparison to the other workers[15].

Conclusion

The current study was undertaken to study the effect of paints on pulmonary functions of car spray painters exposed more than 5 years and on controls unexposed to paints. PFT parameters like FVC, FEV₁, FEV₁/FVC, PEFR and FEF_{25-75%} were measured. The data was tabulated, analyzed statistically and discussed.

It was found that

- Car spray painters showed very high significant decrease in pulmonary function parameters like FVC, FEV₁, PEFR and FEF_{25-75%}.
- Based on the clinical finding and years of exposure to isocyanate there is decline in lung functions
- Exposure to paints leads to an obstructive pattern of pulmonary disease.

The study recommend the painters to follow all the safety measures while performing car spray painting using organic solvent. Regular medical examination and PFT should be done once in a year.

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