Effect of car painting vapours on pulmonary and liver function of Automobile painting worker within Baghdad governorate area

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Abstract

Background: Automobile spray painting is considered an occupation with a high risk of respiratory impairment and asthma. Exposure to organic solvents used for spraying might be of high risk for development of dysfunction in other organs.

Objective: The study was designed to evaluate the pulmonary and hepatic toxicity due to exposure of automobile painters to organic solvents in work places within the Baghdad governorate area.

Methods: Thirty cross sectional selected male workers employed in automobile body paint shops in two industrial areas within Baghdad city (Al-Sheikh Omar and Al-Rasheed camp regions) were recruited to the study during the period from March to May 2012. Thirty non-exposed students and employees in the college of pharmacy-University of Baghdad, age matched with workers, were included as control group. Pulmonary function test (PFT) was performed for all subjects using flow spirometry and blood samples were obtained for evaluation of serum transaminases (AST and ALT), in addition to serum levels of total bilirubin and albumin. The results were correlated with age of workers and duration of exposure.

Results: 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. Correlation of the PFT markers with age and duration of exposure reveals non significant values.

Conclusion: Spray painting is an occupation which involves the risk of respiratory impairment and also confirms the need of regular medical examinations and implementation of appropriate measures to prevent adverse respiratory effects of workplace exposure in automobile spray painters.

Keywords: respiratory function, automobile painting, occupational hazards

Running title: Occupational hazards of automobile painting

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Introduction

There is evidence of work place related asthma among spray painters using isocyanate-based aerosol paint. According to the European Community Respiratory Health Survey (ECRHS) classification, spray painting is considered an occupation with a high risk of respiratory impairment and asthma (occupational set "spray painters") [(1)]. Diisocyanates are compounds with low molecular weight and high reactivity, that have an N=C=O group. The most commonly applied isocyanides are toluene diisocyanates (TDI), 4,4-diphenyl methane diisocyanates (MDI) and 1,6-hexamethylene diisocyanate (HDI). They are used in the production of polyurethane foam, elastomers, adhesives, paints, and surface coatings [(2)]. They are common in workshops with a small number of workers such as automobile body paint workshops, which use a lot of paint, primer, and coatings containing HDI [(3)]. The most common routes of diisocyanates exposure are the respiratory tract and skin [(4)]. These compounds take form of the mist, vapor, or aerosol, depending on the type. Skin contact can occur via contaminated surfaces [(5)]. Diisocyanates and polyisocyanates affect the respiratory system in a number of ways including irritation, asthma, hypersensitivity pneumonitis, and asymptomatic acceleration with decreased lung function [(6)]. Various studies have indicated that exposure to relatively low concentrations of isocyanides is related to impaired lung function [(7)]. Monitoring exposure to these chemicals in car body paint shops presents a number of difficulties because each shop employs a small number of workers, work practices are inconsistent, and exposure is irregular [(2)]. In addition, medical surveillance and occupational hygiene programs for these workers are usually inadequate [(8)]. Small factory workers exposed to isocyanides seem to have significantly higher prevalence of respiratory symptoms than controls [(9)]. Car painters are exposed to a mixture of organic solvents (mostly toluene, but also xylene, isopropanol, and other constituents), some of which are considered potentially hepatotoxic [(10)]. Routine monitoring of the activities of liver enzymes has been recommended, and also applied [(11)], for the periodic examination of workers exposed to organic solvents. This recommendation is based mainly on the assumption that organic solvents (a heterogeneous group) may be hepatotoxic in concentrations found in the air at worksites. The present study was designed to evaluate the pulmonary and

hepatic toxicity due to exposure of automobile painters to organic solvents in work places within the Baghdad governorate area.

Materials, Subjects and Methods

The exposed population included 30 cross section selected male workers employed in automobile body paint shops in two industrial areas within Baghdad city (Al-Sheikh Omar and Al-Rasheed camp regions) during the period from March to May 2012. Their mean age was (37.9±8.89) years (range: 22 to 53 years), and work experience (13.39±6.85) years (range: 10 to 40 years). Each worker was interviewed using a questionnaire, which included personal data, respiratory signs and symptoms, duration of exposure and the whole time they spend in this profession. This questionnaire was specifically designed for this study. Exclusion criteria were respiratory disorders including asthma, cigarette smoking, and use of respiratory drugs. All subjects were apparently healthy on enrolment. Thirty non-exposed students and employees in the college of pharmacy-University of Baghdad, age matched with workers, were included as control group. Each subject signed informed consent before enrollment and the study protocol was approved by the local ethics committee of the College of Pharmacy, University of Baghdad.

***Peak flowmetry*:**

All workers and control group subjects took peak flowmetry [(2)] tests with the portable spirometer (Spirobank G, MIR Co., Italy) two times a day during 3 consecutive days and the mean of these measurements are used for calculations. Changes in peak flowmetry were calculated for each worker. The recorded value was the maximum of three attempts during each test. During peak flowmetry, the Forced Vital Capacity (FVC), the Forced Expiratory Volume in one second (FEV1), the Peak Expiratory Flow (PEF) and the ratio FEV1/FVC were estimated automatically by the spirometer. According to the American Thoracic Society (ATS), a decrease of more than 20% suggests respiratory impairment [(12)].

***Estimation of Liver Function*:**

Venous blood samples (10 ml) were obtained by vein puncture from the workers and control group subjects in a plain tube; after clot formation the samples were centrifuged at 3000 rpm for 15 min to get the serum. The separated serum was utilized for estimation of liver enzymes, AST, ALT, and serum levels of total bilirubin and albumin using ready made analytical commercial kits (Randox Laboratories, UK).

***Statistical Analysis*:**

All values were expressed as mean±S.D; statistical analysis was performed using unpaired Student's *t*-test. *P* values less than 0.05 indicated significant differences.

Results

In table 1, the results of peak flowmetry showed that all the pulmonary function parameters (FVC, FEV1, FEV1/FVC and PEF) were significantly difference ($P<0.05$) in the worker group (20.7%, 37.87%, 23.3% and 28.0%, respectively) compared with that reported in the control group. In table 2, the data showed that two of the liver function markers were significantly differ in workers compared to controls; total serum albumin was significantly increased by 62%, while the serum GPT activity was significantly increased by 64.3%. Meanwhile, other markers (GOT activity and serum albumin level) were not significantly changed ($P>0.05$). The relationship between duration of exposure (years) and lung function was evaluated; figures 1-4 demonstrated that all components of lung function were poorly correlated with the duration of exposure, where low and non-significant r values were reported in this respect. Figures 5 and 6 clearly showed that no significant relation between the age of workers and the lung function test markers.

Discussion

In the present study, the pulmonary function markers of the automobile painting workers showed significant decreases compared with non-workers control group, indicating the expected respiratory of exposure to the organic solvents used in this provision. These changes in pulmonary function may be attributed to the ignorance of workers to comply with standard protection measures that should be followed in this situation. It is also important to point to the fact that such respiratory effect resulted from both the direct inhalation as well as the systemic blood born toxic effects of those chemicals, and the possible effects of other inhalational pollutants in the busy working environment in those industrial districts of Baghdad may have an added impact on the results of the pulmonary function test (PFT). Many previous studies shed a light on the occupational exposure to automobile painting solvents, and reveal significant level of correlation

between duration of exposure and the change in PFT [13,14]; other results suggested that the decrease in FVC might serve as a guide to identify car painters at risk of a further decrement in lung function [15]. The deterioration in lung function reported in the present study might be explained better according to the type of solvents used at the work places, which is unfortunately not estimated due to technical limitations. In this respect, many researchers indicated that exposure to low toluene disocyanate concentrations is associated with minimal but detectable changes in airway calibre and in epithelial barrier permeability causing some changes in the pulmonary function [16], and nearly 36.4% of the automobile garage workers had some form of pulmonary function impairment; obstructive and/or restrictive [17,18]. In spite of the importance of exposure time in the quantitative aspect of lung function, the present study failed to identify significant correlation between the duration of exposure and the deterioration in lung function; this might be attributed to the limitation of small sample size or inconsistence in continuity of daily exposure per week or year of work; the differences in types of solvents used during the work may play significant role in this respect. Wink *et al* showed that mean peak flow in workers decreased on the day of exposure and increased on days when the workers were away from work [19]. In contrast to that, other study reported a significant correlation between changes in peak flow on the day of painting and age and between changes in peak flow and work experience [20]. Although age of workers and LFT markers are not well correlated in the present study, other study of worker exposure in a cleaning agent manufacturer observed that variations in the peak flow were directly related to age [21]. Moreover, automobile spray painters using organic solvents-containing aerosol paints in our study were employed in more than one auto body repair shops different in the size of business and premises. In fact, every auto body repair shop is unique environment [22] that differs from others in work practices, workload, and the level of coating, and no two shops are the same. Literature describes different types of WRA in subjects employed in car repair industry [23]. In the present study, the overall liver activities didn't show a great changes similar to that reported with the pulmonary function, remembering that in the liver its only the systemic blood born toxicity that matters but not the direct exposure as with the respiratory system. The level of serum albumin was not significantly decreased, remembering that albumin was synthesized in the liver and affected only by extensive liver damage and poor nutrition. The AST activity in the serum also not significantly increased, supporting the possibility of existence of only mild liver toxicity. Regarding the significant increase in ALT activity and elevated serum bilirubin compared controls is a weak indicator to the existence of some degree of liver damage that may be due the organic solvent exposure but not severe enough to reveal significant liver function impairment. The controversial data existing in relation to toxicity of organic solvents might be explained as a consequence of difference in exposure pattern, acute or chronic exposure, or other factors that contribute to changes in liver function tests [24]. In most workers, the liver seems to remain largely undamaged from inhalation exposure to a commonly used mixture of solvents. In many workers this seems to be true even for high exposures for limited periods [25]; other reports showed that exposure to non-permissible levels of a mixture of solvents can only cause mild cholestatic hepatic dysfunction [26]. In conclusion, the present findings confirm that spray painting is an occupation which involves the risk of respiratory impairment and, and also confirm the need of regular medical examinations and implementation of appropriate measures to prevent adverse respiratory effects of workplace exposure in automobile spray painters.

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Table 1. Effect of exposure to painting solvents vapors on pulmonary function in automobile painting workers within Baghdad area.

Pulmonary Function Markers	**Exposed workers** n = 30	**Control group** n = 30	**% Changes**
FVC (L/min)	70.0±4.34 *	88.6±2.18	↓ 20.7

FEV1 (L/min)	50.4±5.18 *	81.2±2.70	↓ 37.9
FEV1/FVC %	72.8±6.82 *	95.0±1.98	↓ 23.3
PEF (L/min)	62.8±3.91*	87.2±2.01	↓ 28.0

Values represent mean±S.D; n= number of subjects; * significantly different compared to control group ($P<$ 0.05). FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume in one second; PEF: Peak Expiratory Flow. % change: percent of results from deducting control group form exposed workers.

Table 2. Effect of exposure to painting solvents vapors on the markers of liver function in automobile painting workers within Baghdad area.

Liver Function Markers	**Exposed workers** n=30	**Control group** n=30	**% changes**
Total Serum Bilirubin (mg/dl)	0.94±0.4*	0.58±0.2	↑62.0
Serum AST (GOT) (U/L)	13.8±4.2	12.4±3.2	↑11.3
Serum ALT (GPT) (U/L)	18.4±6.4*	11.2±5.1	↑64.3
Serum Albumin (g/L)	43.4±3.2	44.8±2.2	↓3.1

Values represent mean±S.D; n= number of subjects; * significantly different compared to control group ($P<$ 0.05). AST: Aspartate aminotransferase; ALT: Alanine aminotransferase. % change: percent of results from deducting control group form exposed workers.

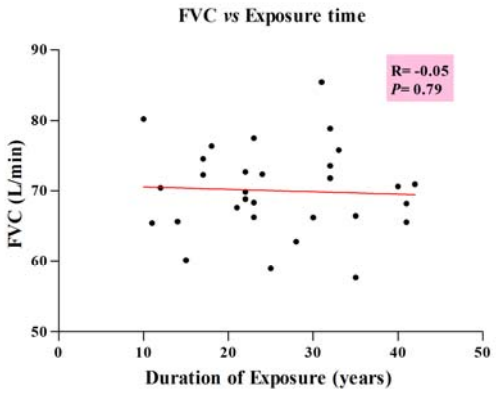

Figure 1. Correlation between duration of exposure (years) to painting solvents and the change in Forced Vital Capacity (FVC) in lungs of automobile painting workers.

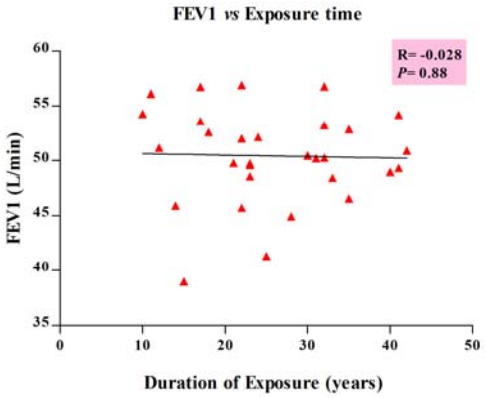

Figure 2. Correlation between duration of exposure (years) to painting solvents and the change in Forced Expiratory Volume in one second (FEV1) in lungs of automobile painting workers.

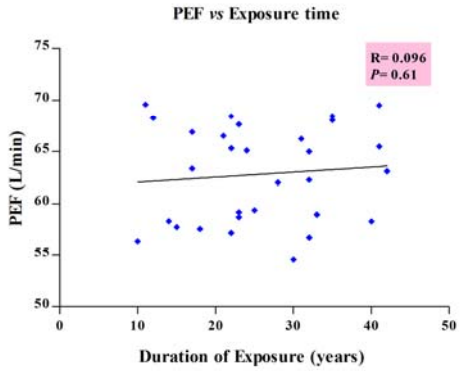

Figure 3. Correlation between duration of exposure (years) to painting solvents and the change in Peak Expiratory Flow (PEF) in lungs of automobile painting workers.

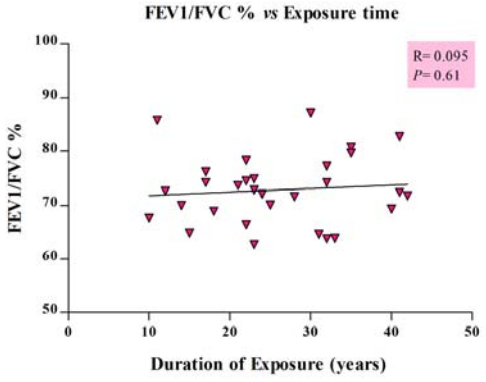

Figure 4. Correlation between duration of exposure (years) to painting solvents and the change in FEV1/FVC ratio (%) in lungs of automobile painting workers.

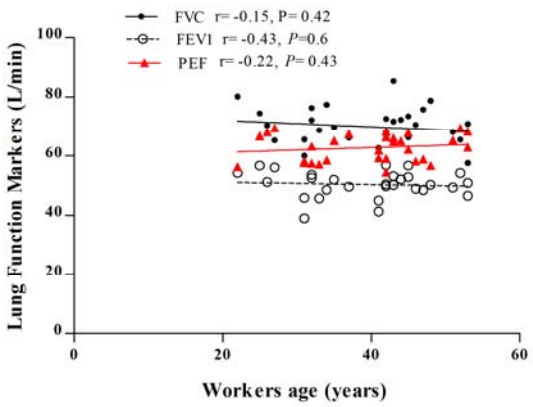

Figure 5. Correlation between lung function test markers and the age of automobile painting workers.

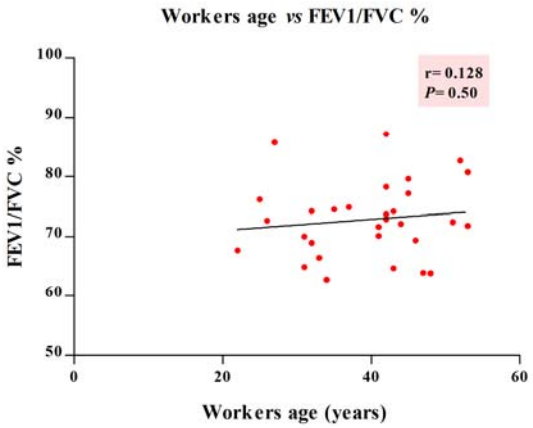

Figure 6. Correlation between FEV1/FVC ratio and the age of automobile painting workers.

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