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Research Article

Impact of paints exposure on pulmonary function tests of male workers in Basrah City ,South of Iraq

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ABSRACT

Background: House paint workers are highly exposed to a mixture of substances as components of paints such as organic solvents ,pigments and other additives. Inhalation of these materials during continues exposure may create serious health problems including respiratory disorders due to the toxic effect of paints materials. This study aimed to investigate the impact of house paint exposure on pulmonary function tests FVC,FEV1,FEV1%,FEV1/FVC%,PEF and ELA of male painters during different duration of exposure in Basrah City, South of Iraq.

Materials and method: Spirometery method was used to measure PFT of all individuals in the study who were divided within three groups depending on the duration of exposure to house paints: Group 1: 29 home paint workers who exposed to paints for more than 5 years. Group 2 consisted of 47 home paint workers who exposed to paint for less than 5 years. Group 3 is the control includes subjects who never expsed to paints.

Results: Data analysis revealed that there were significant differences in PFT among the three groups($p<0.05$).Group 1 showed high significant decline $p<0.0001$ in the PFT, the result was attributed to the increased duration of paint exposure. Estimated lung age was significantly higher than real age in group 1 and 2,while there was no significant change in group 3.Several factors could work together ,beside the toxic effect of chemical martials of paint to deteriorate PFT .In conclusion house paint exposure could result in respiratory impairment by affection on PFT. This impairment got worse by increasing duration of exposure. Spreading awareness and following occupational instructions to reduce duration of exposure and use suitable protective equipments are recommended to reduce the toxic effect of paints.

Keywords: pulmonary function tests, house paints exposure

INTRODUCTION

Exposure to paints and paints removal materials was found to be of a great role in the incidence of several health problems and particularly respiratory diseases(1, 2)

Chemistry of the paints has changed over time but in general, paint is a generic nomenclature of a mixture of substances and chemical materials such as organic solvents, pigments, and other additives like resin, binder, and dryer (3, 4). Benzene and toluene are the most chemical compounds used in the formulation of paints. The exposure to these compounds may result in a deleterious effect on the individual's health by affecting the skin, eye, nose, throat, and respiratory system(5, 6). Acute exposure to high concentrations of these materials can cause coma and death (7). Other components of paints such as isocyanate dimethylethanolamine are capable to induce airways narrowing (8). Paints might cause harmful effects wether they were powder, liquid, or spray (9). House paints workers have exposed to a combination of several materials including aerosols from spray paint, powder, and volatile organic compounds (10). continuous and long term exposure to these compounds makes paint workers at risk of respiratory impairment (9). Several previous studies have revealed that organic solvents in spray paint could result in different health problems in spray paint workers (4, 11, 12).). Chronic inhalation of the vapors emitted from paint materials could induce respiratory symptoms such as nasal irritation, cough, wheezing, and bronchi (4, 13). as well might lead to more serious problems like asthma, pneumonitis and other respiratory disorders (3, 8). The occupational exposure to paints materials and solvents has been widely studied especially in industrial countries (14). According to the European Community Respiratory Health Survey (ECRHS), occupational asthma results from spray paint exposure(9). However, the most common cause of occupational asthma in paint workers worldwide is isocyanate and other paint products(4, 11, 12). The sever exposure of paint workers to isocyanate may develop to different pulmonary lesions and respiratory disorders (8, 15).Pulmonary function tests are reliable

detectable tests used to compare lung function with known standards to show how well the lungs should be working. They detect the narrowing in the airways, identify early changes in lung function, and show to which extent the exposure to paint components could hurt the lung. This study was conducted to reveal the impact of paint exposure in paint workers during different durations on pulmonary function tests such as FVC, FEV1, FEV1/FVC %, and estimated lung age.

MATERIALS AND METHODS

This study was conducted in Basra city, south of Iraq during the period from June 2019 to April 2020. The study was approved by the local scientific and ethical committees. The purpose of the study was explained to all the participants and they were asked to sign an informed consent before enrollments.

Patients: The population in the study consisted of 101 male subjects aged between 25 to 55 years. This population was divided into three groups depending on the duration of exposure to the paints. the type of paints studied was home paints. Group 1: 29 home paint workers who exposed to paints for more than 5 years. Group 2 consisted of 47 home paint workers who exposed to paint for less than 5 years. Group 3 is the control of the non exposed group. It included 25 healthy individuals; they were randomly selected, age-matched subjects, and never exposed to paint throughout their life. The population study was matched for age, height, and weight by using frequency-matching techniques.

Besides smoking habits, many cases were excluded from the study e.g. patients with comorbidities such as diabetes mellitus and hypertension, patients with cardiovascular and chronic renal disorders, individuals with respiratory diseases, and who kept on bronchodilator or respiratory drugs.

The required information of all subjects was obtained by filling out a form of a questionnaire which included; medical history, occupational history, and duration of exposure to paints (years of works), lifestyle such as smoking habit beside heath status if ever suffered from respiratory symptoms like runny nose cough, itching, sore throat, and eye irritation.

Method: Pulmonary function tests: Forced vital capacity (FVC), forced expiratory volume at the first seconds of expiration (FEV1), FEV1/FVC ratio, peak expiratory flow (PEF)and estimated lung age(ELA) were measured for all workers and control groups subjects by using a spirometer (spirolab III MIR. Medical International Research; Italy). The spirometry method applied to all participants in a sitting position. The subjects were instructed to exhale in the mouthpiece of the instrument rapidly and forcefully as much as possible with a continuous manner for full expiration. The procedure was repeated three times for each participant to record the best result(16). FVC function was chosen to get and record the required spirometric parameters and diagnosis, as well as height, weight, age, and other characteristics such as the races or are required to calculate the percentage of predicted values. According to the American Thoracic Society (ATS), the normal pulmonary function tests are when the values of FVC and FEV1 normal. A decrease in them or even one may result in pulmonary dysfunction. Obstructive lung disorders were considered when FVC% is normal (80%) and FEV1/FVC< 70%, restrictive lung disorder is considered when FVC<80% and combined (restrictive and obstructive) lung disease were diagnosed when both (FVC and FEV1/FVC) are reduced(13, 16, 17).

Statistical analysis

Data statistically analyzed by using Statistical Package for the Social Sciences (SPSS) Statistical Software for Windows, Version 25.0 IBM (SPSS Inc, IL, USA). Means value ±standard deviation (SD)represented the data. A least significant difference(LSD) of one-way analysis of variance (ANOVA)was used to test the differences among the groups. Qualitative data were tabulated as (%) tested using the Pearson Chi-square test. The correlation between the parameters was found using Pearson's correlation test. The result was considered significant at $p<0.05$.

RESULTS

As seen in Table 1, the total number of the participants in this study was 101 subjects divided into three groups. Totally, the means of (age, weight, height, and BMI) are (38.47±7.83, 84.45±5.55, 174.87±5.90, 27.67±1.75) respectively. which are important characteristic parameters specifically in the study and measuring pulmonary function tests, There were no significant differences ($P<0.05$), in all these parameters among the three groups studied, as seen in the table, which revealed the characteristic details of the groups. Comparing of pulmonary function tests among the groups in the study revealed that the measured FVC was significantly lower in paint workers **group1 (3.5672 ± 0.44)**, who exposed to paint for more than 5 years **than group2 (3.9260± 0.56) and group3 (4.0312±0.37), p<0.05, While there was no significant difference between group 2**

and group 3, p< 0.05 as seen in table 2. On the other hand, the measured FEV1 showed significant changes among the three groups: a significant difference between group 1 and group 2 (2.54±0.47 vs 2.96±0.71), p<0.05, a highly significant difference between group1 and group 3 (2.54±0.47 vs 3.51±0.37) and even a highly significant difference between group 2 and group 3 (2.96±0.71 vs 3.51±0.37), p<0.001. As well as, the results showed significant changes among the groups in the percentage of the predicted value as clarified in Table 2. The same table showed, there were significant differences in FEV1/FVC% between-group 1and group 3 (71.28±10.4 vs 87.04±4.64), p< 0.05, but we observed there was no significant change between group 1 and group 2, p> 0.05. However, the changes included another parameter such as PEF, which showed significantly less value 6.24±0.97 in group1, p <0.05 than both group2 (7.88±1.3) and group3 (8.36±0.74), while no significant difference was observed between group 2 and group3.

Finally, ELA, the parameter that reflects whether pulmonary function tests were normal or abnormal as well as it may give a clear view of the efficiency of the lung to work normally. This was confirmed by the significant negative correlation between ELA each of FVC, FEV1and FEV1/FVC%.(P<0.05), as seen in (table5,figure1,2,3). It is obvious that group1 had a higher value of ELA (50±6.622) than other groups 2, 3 (39.47± 7.49 and 36.08±6.84) respectively, p< 0.05. However, there was no significant difference between group 2 and group3, as clarified in Table 2.

Regarding the results of pulmonary function tests of the three groups, the percentage of diagnosed cases was distributed as seen in table 3:group1:10 obstructive (34.5%) out of 29 which represented the highest percentage compared to the other cases. While the normal case in group 1 was 7(24.1%).The normal case was the highest in number among both groups 2and 3.

In group 2 there were 25(53.2%) normal subjects out of 47. In general, the abnormal diagnostic cases showed the highest percentage among group 1 :(34.5% 0bstrective, 24.1% restrictive, and 17.2% combined cases) compared to the other groups as clarified in Table 3. Therefore, It is obvious that there were significant changes(p<0.05) among the three groups in the percentage of the diagnosed cases, as seen in table 3, even though the difference between group 1 and 2 was less significant (p= 0.039) compared to the highly significant difference that was found between group 1 and 3 as well as between group 2 and 3 (p <0.001). When comparing the real age and ELA of all subjects in the three groups, we found significant differences between these parameters in group1 and group 2 (p <0.05).On the other hand, there was an insignificant difference (p>0.05) in group 3 who never exposed to paints.

Table 1:General characteristics of the groups

Groups / Parameter	Paint workers (exposure > 5 years) (N=29)	Paint workers (exposure < 5 years) (N=47)	Control Group (N=25)	Total (N=101)	**P-value
Age	40.93±6.28	37.96±6.95	37.68±6.51	38.47±7.83	0.115
weight	84.86±5.58	83.53±5.01	85.68±6.35	84.45±5.55	0.265
height	175.38±6.07	175.13±6.16	173.80±5.29	174.87±5.90	0.575
BMI	27.97±1.53	27.28±1.87	28.03±1.69	27.67±1.75	0.125

N: Numbers of subjects; BMI: Body Mass Index; * The data were expressed by mean ±SD; **The difference is significant when p<0.05

Table 2: Comparison of Pulmonary function test parameters (FVC, FVC percentage, FEV1, FEV1percentage, FEV1/FVC percentage, PEF, and ELA) among the three groups.

group / Parameter	Exposure > 5 years group 1 N=29	P-value Difference Between-group 1 &(2, 3)	Exposure < 5 years N=47	P-value Difference Between-group 2 & 3	Control N=25	Total N=101
FVC, L	3.5672 ± 0.44	0.002* 0.001*	3.9260± 0.56	0.382	4.0312±0.37	3.849±.0.51
FVC%	81.04 ± 7.41	0.205 <0.001**	83.05±7.01	<0.001**	89.198±4.92	84±7.3
FEV1, L	2.54±0.47	0.03* <0.001**	2.96±0.71	<0.001**	3.51±0.37	2.97±0.67
FEV1%	74.71±10.64	0.024*	83.22±8.77		91.24±2.6	82.76±10.7

		<0.001**		<0.001**		2
FEV1/FVC%	71.28±10.4	0.127 <0.001**	74.73±10.73	<0.001**	87.04±4.64*	76.8±11.2
PEF	6.24±0.97	<0.001** <0.001**	7.88±1.3	0.080	8.36±0.74	7.53±0.74
ELA	50±6.622	<0.001** <0.001**	39.47± 7.49	0.057	36.08±6.84	41.65±8.92

FVC forced vital capacity; FEV1 forced expiratory volume in the first seconds; PEF: peak expiratory flow, ELA: estimated lung age

* statistically significant as p<0.05.

** Statistically highly significant as p < 0.001

Table 3: The percentage of diagnosed cases in the three groups: paints workers group 1,2and the control group 3

Diagnosis	Paint worker exposure > 5 years Group(1)	P-value Between-group 1&(2,3)	Paint workers exposure < 5 years Group(2)	P-value Between Group 2&3	Control Group (3)	Total
Normal	7 (24.1%)	0.039*	25 (53.2%)	<0.001***	21 (84%)	53 (52.48%)
Obstructive	10 (34.5%)		14 (29.8%)		2 (8%)	26 (25.74%)
Restrictive	7 (24.1%)		6 (12.8%)		2% (8%)	15 (14.9%)
Combined	5 (17.2%)	<0.001**	2 (4.3%)		0 (0%)	7 (6.9%)
Total	29		47		25	101

Data were represented as No. (%), Chi-square test used to test the difference between the groups.

P* value significant difference between worker exposure>5 years and worker exposure < 5 years

P** value highly significant difference (<0.001) between worker exposure>5 and control

P*** value highly significant difference (<0.001) between worker exposure < 5 years and control group

Table 4: Comparison between the real age and ELA in the three groups.

Parameter / Group	Age (years) Mean ± SD	ELA (years) Mean ± SD	P-value
Paint Exposed>5	40.93±6.28	50.±6.622	0.013
Paint Exposed<5	37.96±6.95	39.47± 7.49	0.02
control	37.68±6.51	36.08±6.84	0.076

Table5: Correlation between ELA and pulmonary function tests parameters

		FVC	FEV1	FEV1/FVC%
ELA	r	-0..450	-0533	-0.439
	p	<0.001	<0.001	<0.000

ELA, Estimated lung age; r-= correlation coefficient; Pearson's Correlation is significant at the 0.01 level

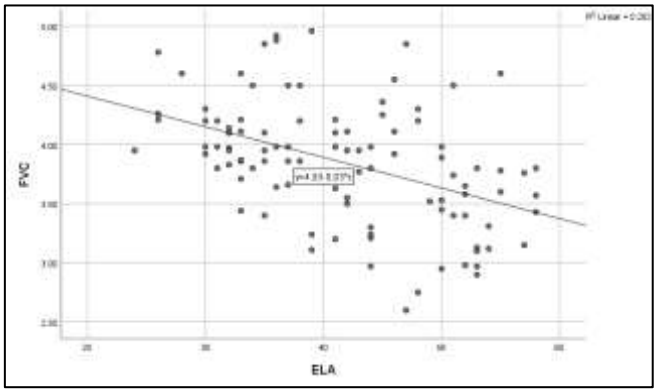

Fig.1: Correlation between ELA and FVC

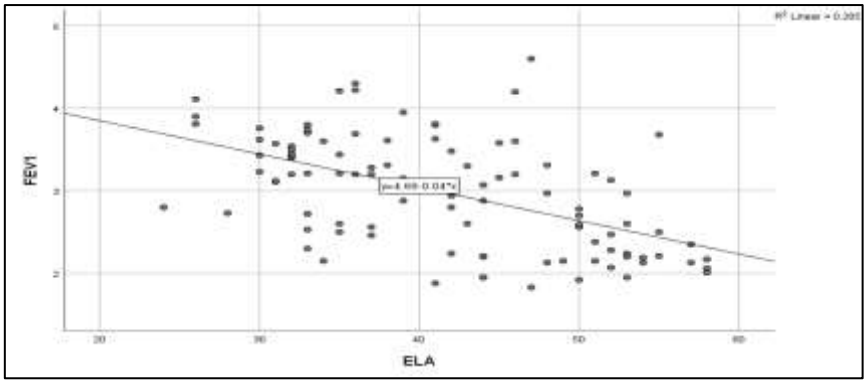

Fig.2: Correlation between ELA and FEV1.

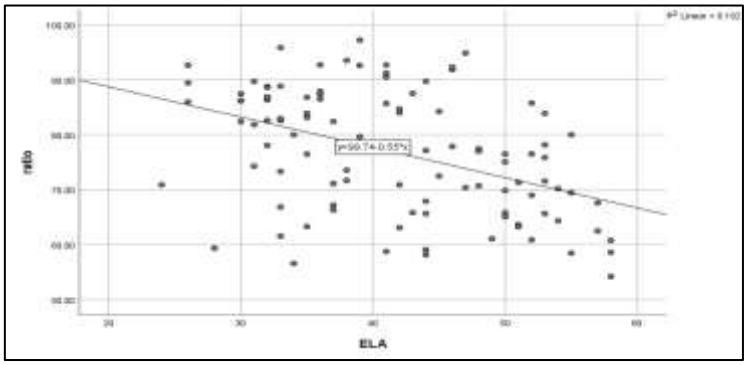

Fig.3: Correlation between ELA and FEV1%.

DISCUSSION

The study included 101 male individuals distributed in three groups according to their exposure to the house paints. Despite the number of individuals in these three groups was not identical the other parameters such as age, weight, high, BMI, and general health status were matching and didn't show significant difference $p<0.05$ as seen in table 1. On the other hand, when comparing the pulmonary function tests FVC, FEV1, and PEF among these three groups, they revealed significant changes ($p<0.05$). The difference between group 1 and group 2 was significant and the difference between groups 1 and 3 was highly significant ($p<0.001$), as clarified in the results (Table 2). This significant decline in the pulmonary function tests in house paint workers could reflect the serious impact of paint exposure on respiratory function. Many previous studies (18, 19)(20) have approved the role of paint exposure in causing different health problems and particularly respiratory diseases symptoms such as cough, nasal and throat irritation .This study extended deeply to reveal the effect on lower respiratory tract even when the individual looked apparently healthy or complained of very light symptoms such as temporary irritation. House paints exposure could result in a clear decline in the pulmonary function tests for many reasons. It has been found that house paints are a mixture of spray paints which were well known of its toxic effect due to containing volatile organic compounds; powder materials which contain different chemical compounds and this paint had a deleterious effect on respiratory function and they could elevate the incidence of pulmonary dysfunction that might develop to chronic obstructive pulmonary diseases (21). These painters were exposed to different chemicals which are toxic components and capable to induce hyperreactivity narrowing and obstruct the respiratory passages such as isocyanates and dimethyl ethanol amines , besides the exposure to the solvents materials and aerosols which contain chemically active materials (22, 23).

One of the ways that could result in such a toxic effect is the continuous inhalation of these materials. The continuous inhalation may lead to different upper and lower respiratory tract lesions depending on the concentration of the active materials and duration of exposure (6, 24). However, this inhalation has been found highly associated with dyspnea, wheezing, and bronchial obstruction(8). As a consequence, the exposure to house paints for more than 5 years could highly affect the pulmonary function tests of the workers in group 1 and increase the percentage of COPD and CRPD among them comparing to the other groups as seen in table 3.

The results of the present study were in agreement with what was concluded by another study (15),

which stated that the significant reduction in PFT was due to paint exposure. However, our findings could reveal a highly significant decline in PFT in group 1 for several factors that work together to exacerbate the effect of house paint exposure. Some factors were related to work conditions for example the paint workers did not follow the full instructions of safety and protection procedures of work such as using protective equipment (masks, gloves, and glasses). This equipments could give suitable protection and reduce the harmful effect of paint exposure significantly as was approved by(25), which concluded the non-significant changes in the Spirometric results of the painters were due to commitment to using protective equipment. Wearing fit and suitable equipment made the employees less likelihood to be at risk of direct exposure(26). It seems to us that the lack of using protective equipment is due to decreased awareness and perception of how much that paint exposure might harm system functions particularly the respiratory system because most of these workers were with limited education. Another factor that might increase the risk of respiratory airways diseases is the components and quality of the paint. It has been found that low-cost paints were used to be widely used. These paints contain a mixture of different chemicals with potential effects to increase respiratory diseases (26). The continuous and unlimited duration that workers exposed to paints during work time without enough break might be another factor that exacerbated respiratory dysfunction and even made the individuals of group 2 with reduced PFT and increased percentage of COPD and CRPD compared to group 3. However, group 1 showed more deterioration in PFT due to the long paint exposure for more than 5 years. This result was in agreement with the finding of a previous study (15), which supposed that a decrease in PFT was inversely related to the duration of exposure.

Another factor that could work with paint exposure to increase the impairment of PFT was related to environmental factors such as temperature. This study was carried out in Basra City, south of Iraq which is characterized by high temperatures during the summer. The high temperature could increase the rate of evaporation of chemicals which increasing the toxic effect of these chemicals (27, 28). Several studies in a different areas of the world were done to investigate the role of paint exposure on the respiratory system.(10, 18, 25, 29), despite the harmful effect of paint was approved these studies could find different results which might be attributed to the diversity of the environmental factors besides what mentioned previously the chemical composition and work conditions. Hence all these factors could work together to reduce PFT significantly and increase the percentage of COPD among group1 as the highest rate of the diagnostic cases (34%), which was the same finding of the result of Dibakar, et al (30). We also found restrictive cases, the finding that came in matching to what other study found: both COPD and CRPD among individuals who exposed to paint for several years. That is why group 1 showed significantly higher ELA than other groups and for those reasons that ELA of groups 1 and 2 was significantly different from the real age (table 4).ELA should be the same age when the respiratory function is normal (5). the deterioration in PFT was inversely correlated to ELA which means that ELA got elevated as the PFT became decreased.

In conclusion, house paint workers showed a significant decline in pulmonary function tests.This decline showed more significant among the workers who exposed to paints for more than 5 years, indicating the significant role of duration of exposure. Many factors could work together besides the toxic effect of the chemical components of the paint to exacerbate the impairment in the pulmonary function tests. Spreading awareness about the harmful and toxic effect of paint exposure as well as using suitable protective equipment are important to reduce the toxic effect.

Data Availability: The data used to support the findings of this study are included in the article.

Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this paper.

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