

ORIGINAL ARTICLE

## Effects of Dyes on Pulmonary Functions in Male Spray Dye Workers in Dhaka, Bangladesh

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### ABSTRACT

There are many steel product manufacturing industries in Bangladesh where chemical dyes are used for coating the steel made product. The spray dye workers are continuously exposed to chemical dyes. Prolong exposure of these dyes can cause pulmonary disorders of the workers. This cross-sectional study was done to evaluate pulmonary functions of male dye workers. This study was carried out in the Department of Community Medicine in Dhaka National Medical College from September 2013 to September 2014. Out of 60 subjects, 30 apparently healthy male spray dye workers were taken from different steel manufacturing factories as study group and 30 apparently healthy male subjects who are not exposed to spray dye were taken as control. Sample was taken by convenient type of non-probability sampling. Auto spirometer (AS-507) was used to measure the lung functions of both groups. Forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), peak expiratory flow rate (PEFR) and FEV1/FVC% of all subjects were recorded by using a digital spirometer. Unpaired *t*-test were performed for analysis of data. The mean percentage of predicted value of FEV1, FVC and FEV1/FVC% were significantly lower ( $p < .001$ ) in spray dye workers than control group. From the result of this study it can be concluded that spray dye may have harmful effects on some pulmonary functions.

### INTRODUCTION

Poor health, safety and waste management with no control over the length and frequency of exposure may pose several health hazards to

textile workers. Occupation health authorities around the world have established safety regulations and /or guidelines to limit workers exposures through safe practices and personal protective equipment (PPE)<sup>1</sup>. An appropriate attitude towards the health risks associated with exposure to dyes, depends on knowledge about the danger and harmful effects of dyestuff. Millions of workers are exposed to dyes in different occupation but they have very little knowledge or no knowledge at all about the harmful effects of dyes. Hydrocarbon are organic compounds that are mainly derived from petroleum and used as solvent with different colour. These substances are volatile, serious toxicity and death can be associated with hydrocarbon exposure through inhalation and ingestion. Pulmonary toxicity is the most common health hazard. Hydrocarbon pneumonitis is caused by destruction of alveolar and capillary membranes as well as alteration of surfactant function and production, this eventually can lead to acute respiratory distress syndrome<sup>2</sup>.

Due to extensive surface area, high blood flow and free communication with external environment lungs are more susceptible to occupational pulmonary diseases. On prolonged exposure which may turn to lung fibrosis<sup>3</sup>. The pulmonary function test (PFT) have opened a new era towards scientific approach in diagnosis, prognosis and management of pulmonary disorders. The normal value ranges for pulmonary functions tests will be adjusted for the subjects age, height, sex and sometimes race. Research reports on the effects of spray dyestuff on pulmonary functions are very scarce. Different types of oxide colours like red oxide, blue oxide, silver oxide and hydrocarbon solvent were used in steel manufacturing factories. Those oxides contain free radicals and generally more reactive than non-radicals<sup>4</sup>. In this study, dye workers exposed to those oxides were included.

This study aims to investigate pulmonary function in workers dealing with dyestuff to observe the changes in lung function upon prolonged exposure.

## MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Community Medicine, Dhaka National Medical College from September 2013 to September 2014. This research work was approved by the Ethical Committee of Dhaka National Medical College. Total 30 apparently healthy male spray dye workers exposed to dyestuff for at least 6 months, age range 20 – 40 years were taken as study group. They were selected from different steel manufacturing and dyeing industries in old Dhaka City. Another 30 apparently healthy, age and socio-economically matched male non-spray dye workers were taken as control for comparison. A detailed medical and family history of all workers was recorded in a prefixed questionnaire. Those who had history of any respiratory or cardiac problem were excluded. Among 60 respondents 54 (90%) were smokers, 26 (48.15%) were belong to study group and 28 (51.85%) were control group. Dye worker but non-smoker was not available, that is why almost similar number of smoker control group was taken and mean value of their lung functions were compared. Smokers were defined as currently smoking at least one cigarette daily. Thorough clinical examination of each subject were done. Height, weight were measured to calculate BMI and for assessing lung function, FVC, FEV1, PEF and FEV1/FVC % were measured at normal room temperature by using a digital spirometer (AS-507). For statistical analysis, unpaired *t*-test was performed by using SPSS-20 version.

**RESULTS**

Mean age of study and control group were (24.40 ± 3.57) and (23.43 ± 3.41) respectively. Daily working hours of the study group and control group were mentioned in Table 1.

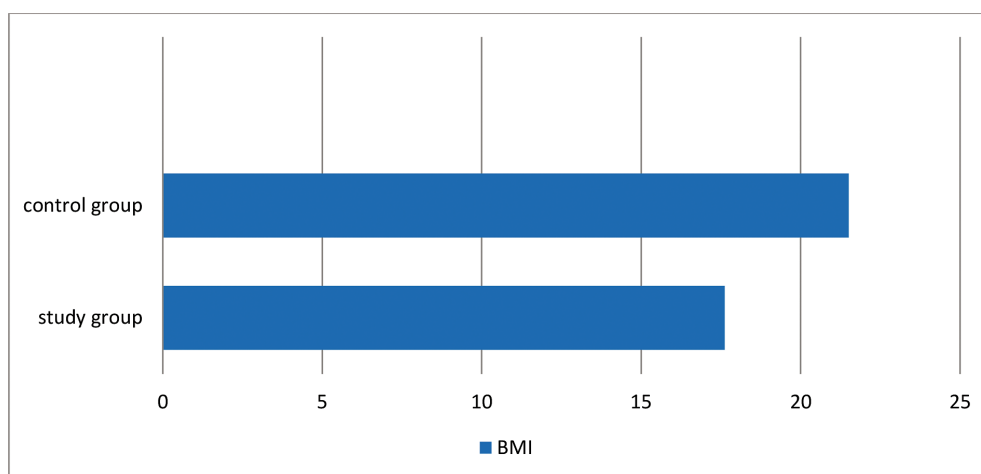
Among the study group, 13 (43.33%) workers worked for 8 – 10 hours per day, 9 (30%) worked for 10 – 12 hours per day and 8 (26.66%) worked for 6 – 8 hours per day. All subject of control group worked for 8 – 10 hours per day.

**Table 1** Working hours per day of study group (n = 30) and control group (n = 30)

	Working hours/ day	Frequency	Percentage
Study group	6 – 8	8	26.66%
	8 – 10	13	43.33%
	10 – 12	9	30.0%
Control group	8 – 10	30	100%

Data expressed daily working hours of study group and control group. Data are expressed as mean ± SD, n total number of subject, study group: workers exposed to dyestuff and control group: workers non-exposed to dyestuff.

BMI (body mass index) of study group and control group were (17.02 ± 1.64) and (21.51 ± 2.6) respectively (Figure 1).



**Figure 1** Mean BMI in study group and control group

The measured values of FVC, FEV1, PEFR and FEV1/FVC% were significantly lower in workers exposed to spray dyes than the control group (Table 2).

**Table 2** Percentage of predicted value of FVC, FEV1, PEFR, FEV1/FVC%

Parameter	Study group (n = 30)	Control group (n = 30)
FVC	63.70 ± 25.26***	100.63 ± 13.48
FEV1	58.03 ± 25.33***	106.60 ± 11.48
PEFR	45.70 ± 31.13***	93.07 ± 9.50
FEV1/FVC%	94.12 ± 21.40***	111.63 ± 7.45

\*\*\* =  $p < 0.001$

Data are expressed as mean ± SD, unpaired *t*-test was done, *n* = total number of subjects, study group: workers exposed to dyestuff and control group: workers not exposed to dyestuff.

## DISCUSSION

Hydrocarbon are used as thinner with different dyes in many steel manufacturing industries. The pulmonary system is most commonly affected by hydrocarbon through inhalation or aspiration.

Different types of oxides contain free radicals, which are more reactive than non-radicals<sup>4</sup>. A number of studies had demonstrated that free radicals are responsible for injurious and inflammatory response in the airways<sup>5</sup>. Exposure to the gases which contain free radicals at higher concentration causes characteristic lesions of the respiratory tract due to accumulation of macrophages in the alveoli and damage to the type-I alveolar epithelial cells which line the alveolar sacs<sup>6</sup>.

Hydrocarbon pneumonitis is caused by destruction of alveolar and capillary membranes as well as alteration of surfactant function and production, this eventually can lead to acute respiratory distress syndrome<sup>2</sup>. In this study lung function were measured in both control and study group.

Mean measured value of FVC, FEV1, PEFR and FEV1/FVC% were significantly lower in exposed group than control group. These findings are similar with those of other researchers<sup>3, 7, 8</sup>.

In a hot humid workplace, the dyes affect both allergens (e.g. reactive dyes) and irritants (e.g. H<sub>2</sub>S, SO<sub>2</sub> and nitrogen oxides) to increase in the respiratory system. Another study showed the frequency of acute and chronic respiratory symptoms was significantly higher among workers in the exposed group than in the control group. Means of FVC and FEV1 of pre-shift spirometry were lower than control ( $p < 0.001$ ). Across-shift spirometry showed significant reduction of FVC ( $p < 0.001$ ), FEV1 ( $p < 0.001$ ), FEF 25 – 75% ( $p = 0.05$ ) and FEF 25% ( $p = 0.007$ ) in dyeing workers compared to the control group<sup>9</sup>.

Eugenija Zuskin et al. found in their study that the prevalence of respiratory problems were more in case than control group. The spirometric parameters were found decreased in male after work shift and force expiratory flow (FEF) 25 – 75%, (FEF) 50% and (FEF) 25% were found significantly decrease in female workers<sup>10</sup>. Another study done in Turkey textile dyeing factories which comprised 106 exposed and unexposed workers which revealed that the mean expiratory flow rate (FEF) 25 – 75% of the exposed worker<sup>11</sup>. Various flow rates (FEF 25%, FEF 50% and FEF 75%) were found reduce in workers who working in carpet industries<sup>12</sup>.

## CONCLUSION

From the result of this study it can be concluded that spray dye may have harmful effects on some pulmonary functions.

## **CONFLICT OF INTEREST**

The authors declare that they have no competing interests in publishing this article.

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