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Comparative Study of Pulmonary Functions in Industrial Workers of North India with Long Term Exposure to Cotton Dust.

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ABSTRACT

Background: The pollution and other occupational hazards because of biological and chemical dust are causes of the biggest pulmonary disability in industrial workers of the world. The incidence of respiratory disorders has increased many folds in the last 4-5 decades due to environmental and industrial pollutants. Objective: Purpose of this study was to find out the changes in the ventilatory functions following exposure to the cotton dust and to assess the damage to the pulmonary tissue as the number of years of such exposure. Second purpose was to ensure safety of workers by apprising the employers and at the same time increasing the productivity. **Methods:** Study done on one hundred cotton industry workers of age between 20-60 years. Comparison was drawn with less and more than 10 years of exposure. Same number of age, height and weight matched normal control subjects were also taken. All were nonsmoker, previously not suffering from any chronic lung disease and their Pulmonary Function tests, in terms of F.V.C., FEV in 0.5, 1st & 3rd second ($FEV_{0.5}$, FEV_1, FEV_3, $FEF_{25-75\%}$, P.E.F.R., M.V.V., F.E.V. $FEF_{0.5}$ / F.V.C.%, F.E.V. 1/ F.V.C.%, F.E.V. 3/ F.V.C.% were done, analysed and compared. **Results:** Highly significant in FVC, FVC0.5, FEV1, FEV3 and MVV, significant in $FEF_{25-75\%}$, $FEF_{25\%}$, FEF $FEF_{50\%}$, FEF $FEF_{75\%}$, and non-significant in FEV0.5/FVC %FEV_1/FVC%, FEV_3/FVC% ratio. Results were non-significant in all parameters when 6 year and 10 years of exposure were compared. This may be due to the fact that once the exposure occurs for some years then further exposure does not create any more damage to the respiratory functions. **Conclusion:** There is highly significantly decline in pulmonary functions in cotton industry units when compared to normal population of same area taken as control subjects. But more number of years of exposure to cotton dust causes non-significant additional damage.

Keywords: Cotton dust, occupational lung disease, Byssinosis, Forced Vital capacity, lung functions tests.

INTRODUCTION

The pollution is one of the dangerous occupational hazards because of biological and chemical dust in the working place area. These become cause of the biggest disability of pulmonary functions in industrial workers of the world. The incidence of respiratory illnesses has increased many folds in the last 4-5 decades due to environmental and industrial pollutants.

Byssinosis is the disabling occupational disease caused by cotton dust. The worldwide incidence of Byssinosis among workers in the dusty sections of textile mills is nearly 40%. Over the years, byssinosis has been referred to as cotton worker's lung, Brown lung disease, Monday fever, and mill fever.[1,2]

Ramazzini in 1713[3] recorded for the first time the incidence of breathlessness among handlers of food grain was by and since then he is considered as father of occupational medicine. Harmful effects of mining also dates back to pre-history when man first started to dig underground for flints to make arrowheads and axes.

Presently the incidence of respiratory illnesses has increased many folds in the last 4-5 decades leading to reduction of lung functions. Asbestos and quarts exposure; is the causative factor for pulmonary fibrosis and pulmonary oedema and bronchiolitis from toxic gas inhalation and allergic responses from organic dust exposure like cotton, hemp, jute and grain dust.[4]

In the past 40 years lung functions tests are being used for diagnosis, assessment and clinical management of breathlessness. Epidemiological and research tools in this regard are formulated in industrial preventive medicine. Spirometery is one of very simple non-invasive method of accessing lung functions. It is an invaluable screening test to identify patients with obvious and underlying lung disorders.

Cotton dust is also associated with cancer mortality, especially gastrointestinal cancer, and endotoxin may play a causative role. Findings also indirectly support a protective effect of endotoxin on lung cancer.[5] However a higher incidence of chronic non-specific broncho-pulmonary disease is reported

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among industrial workers with the reduction in ventilator capacity suggesting that these workers develop acute and chronic respiratory symptoms.[6]

Workers exposed to cotton dust generally complain of cough, phlegm production, rhinitis, wheezing, chest pain, and breathlessness. Unexposed worker has a significant lower frequency ($P < 0.001$) of symptoms as well as higher ($P < 0.001$) forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and peak expiratory flow rate (PEFR) than exposed workers.[7]

This has been found that pulmonary function tests in terms of Vital capacity, FEV_1 and $FEV_{25-75\%}$ in slate pencil industry, wool carpet industry and diamond cutting and polishing industry workers are significantly lower than in normal subjects8. All this is because of exposure to chemical, mechanical and biological effects of dust exposure in the industrial units.

Present study has been done on computerized spirometer examining the workers in their working place in textile industry of Amritsar district and then comparing the results with equal number of healthy controls of same area. Purpose of this study was to find out the changes in the ventilatory functions following exposure to the cotton dust and to assess the damage to the pulmonary tissue due to industrial pollution. Another purpose was to ensure health and safety of workers by explaining the employers during testing period and at the same time putting the study before environmentalists and general public at large.

MATERIALS AND METHODS

Present study has been conducted in the department of Physiology, Government Medical College, Amritsar, Punjab. In this study one hundred textile workers of age between 20-60 years were taken. They were non-smoker, without history of any chronic lung disease before working in the textile industry. Pulmonary Function tests were performed and results recorded, called here in Experimental Group (E). In addition same number in the same age group, non-smoker, non-exposed subjects were taken from nearby residents of the particular industrial unit. They served as Control Group (C).

In all subjects a detailed personal and family history was taken for any history of smoking or exposure to household fumes and such subjects were excluded from study. General physical examination was done and height weight was measured and matched. Other exclusion criteria was no history of any cardio-pulmonary disorder, exertional dyspnoea, obesity, and any chest deformity.

Persons having history of Asthma, Chronic Infection of Lung, Tuberculosis, Bronchial allergy, were also excluded.

Following parameters were studied and recorded. Parameters and their respective abbreviations are as under

1. Body Surface Area (B.S.A.)
2. Forced Vital Capacity (F.V.C.)
3. Forced Expiratory Volume in 0.5, 1st & 3rd second ($FEV_{0.5}$, FEV_1, FEV_3)
4. Maximum Mid Expiratory Flow Rate ($FEF_{25-75\%}$)
5. Peak Expiratory Flow Rate (P.E.F.R.)
6. Maximum Voluntary Ventilation (M.V.V.)
7. Forced Expiratory Volume, Forced Vital Capacity Ratio expressed as percentage ($F.E.V._{.0.5}$/ F.V.C.%, $F.E.V._{.1}$/ F.V.C.%, $F.E.V._{.3}$/ F.V.C.%)

Above tests were done on computerized spirometer (MEDSPIROR) under good daylight conditions in both experimental and Control groups and reading were recorded and data analysed and results were compared in both of groups and were compared with the previous studies done by other researchers.

RESULTS

The study showed that as shown in Table I there was highly significant decline in Forced Vital Capacity (F.V.C.) Forced Expiratory Volume in 0.5, 1st & 3rd second ($FEV_{0.5}$, FEV_1, FEV_3) Maximum Mid Expiratory Flow Rate ($FEF_{25-75\%}$) Peak Expiratory Flow Rate (P.E.F.R.) Maximum Voluntary Ventilation (M.V.V.) Forced Expiratory Volume, Forced Vital Capacity Ratio expressed as percentage ($F.E.V._{.0.5}$/ F.V.C.%, $F.E.V._{.1}$/ F.V.C.%, $F.E.V._{.3}$/ F.V.C.%) in textile workers with over 10 years for exposure to cotton dust when compared with same number of normal controls.

As shown in Table II results were highly significant fall in FVC, $FVC_{0.5}$, FEV_1, FEV_3 and MVV, FEF_{25-75}, $FEF_{25\%}$, $FEF_{50\%}$ $FEF_{75\%}$ and significant in FEF_{25-75}, FEF_{2-12}, FEF_{25-75}, $FEF_{25\%}$, $FEF_{50\%}$ and FEV3 / FVC%, non-significant in PEFR, $FEV_{0.5}$/FVC %, ratio with 6 years of exposure to cotton dust.

[Table 3] concluded that results were non-significant in all parameters when years of exposure at 6 year and more than 10 years were compared with.

Table 1: Showing Mean, Standard deviation, t values with statistical significance of 14 respiratory parameters between cotton industry workers and control group with 10 years of exposure

Parameter	Control Group		Cotton Industry Workers		t value	P value	Significance
	Mean	S.D.	Mean	S.D.			
FVC	2.57	0.62	1.98	0.60	6.83	<0.001	HS
FEV0.5	1.42	0.69	0.70	0.38	9.14	<0.001	HS
FEV1	2.14	0.64	1.31	0.52	10.06	<0.001	HS
FEV3	2.57	0.62	1.88	0.57	8.19	<0.001	HS
PEFR	3.30	1.78	2.62	1.12	3.23	<0.01	HS

FEF25-75	2.42	1.16	1.90	0.81	3.67	<0.001	HS
FEF2-12	2.71	1.52	2.12	0.86	3.37	<0.01	HS
FEF25%	3.08	1.66	2.38	1.04	3.57	<0.001	HS
FEF50%	2.77	1.37	2.07	0.96	4.18	<0.001	HS
FEF75%	2.12	1.10	1.43	0.70	5.29	<0.001	HS
FEV0.5/FVC%	54.78	20.90	37.35	20.41	5.96	<0.001	HS
FEV1 / FVC%	82.80	13.15	68.62	22.99	5.35	<0.001	HS
FEV3 / FVC%	100		96.02	11.86	3.35	<0.01	HS
MVV L/min	83.75	26.10	42.35	13.25	14.14	<0.001	HS

HS: Highly Significant P<0.001 or <0.01 S: Significant P<0.05 NS: non-Significant P>0.05

Table 2: Showing Mean, Standard deviation, t values and P value with statistical significance of 14 respiratory parameters between Control Group and Cotton Industry workers with 6-10 years of exposure

Parameter	Control Group n=100		Cotton Industry Workers 6-10 years. n=31		t value	P value	Significance
	Mean	S.D.	Mean	S.D.			
FVC	2.57	0.62	2.01	0.58	4.53	<0.001	HS
FEV0.5	1.42	0.69	0.71	0.39	6.16	<0.001	HS
FEV1	2.14	0.64	1.36	0.67	5.79	<0.001	HS
FEV3	2.57	0.62	1.93	0.55	5.31	<0.001	HS
PEFR	3.30	1.78	2.72	1.34	1.79	>0.05	NS
FEF25-75	2.42	1.16	1.92	0.01	2.23	<0.05	S
FEF2-12	2.71	1.52	1.17	0.99	2.04	<0.05	S
FEF25%	3.08	1.66	2.44	1.22	2.13	<0.05	S
FEF50%	2.77	1.37	2.11	1.12	2.56	<0.05	S
FEF75%	2.12	1.10	1.43	0.71	3.62	<0.01	HS
FEV0.5/FVC%	54.78	20.90	36.82	19.84	4.28	<0.001	HS
FEV1 / FVC%	82.80	13.15	68.05	25.04	3.58	<0.01	HS
FEV3 / FVC%	100		96.92	10.36	2.04	<0.05	S
MVV L/min	83.75	26.10	42.58	16.33	9.19	<0.001	HS

HS: Highly Significant P<0.001 or <0.01 S: Significant P<0.05 NS: non-Significant P>0.05

Table 3: Showing Mean, Standard deviation, t values and P value with statistical significance of 14 respiratory parameters between Cotton Industry workers with 6-10 years and with more than 10 years of exposure

Parameter	Cotton Industry workers 6-10 years n=31		Cotton Industry Workers more than 10 years. n=45		t value	P value	Significance
	Mean	S.D.	Mean	S.D.			
FVC	2.01	0.58	1.89	0.39	1.04	>0.05	NS
FEV0.5	0.71	0.39	0.66	0.33	0.59	>0.05	NS
FEV1	1.36	0.67	1.22	0.37	1.10	>0.05	NS
FEV3	1.93	0.55	1.76	0.40	1.51	>0.05	NS
PEFR	2.72	1.34	2.46	0.94	0.96	>0.05	NS
FEF25-75	1.92	1.01	1.89	0.61	0.15	>0.05	NS
FEF2-12	1.17	0.99	2.04	0.79	0.62	>0.05	NS
FEF25%	2.44	1.22	2.31	0.92	0.51	>0.05	NS
FEF50%	2.11	1.12	1.97	0.84	0.60	>0.05	NS
FEF75%	1.43	0.71	1.42	0.67	0.60	>0.05	NS
FEV0.5/FVC%	36.82	19.84	36.23	17.60	0.13	>0.05	NS
FEV1 / FVC%	68.05	25.04	66.89	20.90	0.21	>0.05	NS
FEV3 / FVC%	96.92	10.36	94.30	14.30	0.89	>0.05	NS
MVV L/min	42.58	16.33	40.58	9.51	0.66	>0.05	NS

HS: Highly Significant P<0.001 or <0.01 S: Significant P<0.05 NS: non-Significant P>0.05

DISCUSSION

The lung tissue is constantly under threat from environmental and industrial pollutants. Textile industries are one of the major industrial pollutant units. By determining the vital capacity (FVC), Timed Vital Capacity ($FEV_{0.5}$, FEV_1, FEV_3), Maximum Voluntary Ventilation (MVV) and Maximum Mid expiratory flow rate, it is possible to accurately detect and evaluate the underlying patho-physiology. Proinflammatory constituents of organic dust are considered a possible cause of compromised respiratory health. They found that exposure to cotton dust deteriorates ventilatory functions and elevates proinflammatory cytokine levels. Analysis of the release of cytokines can be used to evaluate the immune responses to organic dust-induced airway inflammation.[9]

With same aim present study was undertaken. Other aim was to collect more data in industrial workers and to draw conclusive evidence as to how industrial work has on pulmonary functions in long term exposure (more than 10 years) on pulmonary functions. And whether with number of years of exposure does increase the damage with further deterioration of pulmonary functions.

Our data has shown that there is highly significantly decline in pulmonary functions in textile industry workers when compared with normal controls expressed here in terms of Forced Vital Capacity

(F.V.C.) Forced Expiratory Volume in 0.5, 1st & 3rd second ($FEV_{0.5}$, FEV_1, FEV_3) Maximum Mid Expiratory Flow Rate ($FEF_{25-75\%}$) Peak Expiratory Flow Rate (P.E.F.R.) Maximum Voluntary Ventilation (M.V.V.) Forced Expiratory Volume, Forced Vital Capacity Ratio expressed as percentage ($F.E.V._{0.5}$/ F.V.C.%, $F.E.V._1$/ F.V.C.%, $F.E.V._3$/ F.V.C.%).

Next there were highly significant fall in FVC, $FVC_{0.5}$, FEV_1, FEV_3 and MVV, FEF_{25-75}, $FEF_{25\%}$, $FEF_{50\%}$ $FEF_{75\%}$ and significant in FEF_{25-75}, FEF_{2-12}, FEF_{25-75}, $FEF_{25\%}$, $FEF_{50\%}$ and FEV3 / FVC%, non-significant in PEFR, $FEV_{0.5}$/FVC %, ratio with 6 years of exposure to cotton dust. But when number of years of exposure of 10 and more than 10 year were compared with 6 years of exposure the results were non-significant. This shows that the initial damage caused by dust exposure for first 6 years was sustained and not further damage and decline in respiratory functions were observed.

Similar study was done by X-R Wang et al,[10] who did follow up study of long term exposure to cotton dust. Who observed that chronic exposure to cotton dust is related to both work specific and non-specific respiratory symptoms. Byssinosis is more strongly associated with exposure to endotoxin than to dust. Cessation of exposure may improve the respiratory health of cotton textile workers; the improvement appears to increase with time since last exposure. high proportion of symptoms was found to be intermittent, rather than persistent. These results are consistent with results obtained in number of other earlier studies. Nagoda M et al,[7] did a cross sectional study and compared two hundred male workers exposed to raw cotton dust in a Textile Company with 200 unexposed workers. Their forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and peak expiratory flow rate (PEFR) were determined with a flow-sensing spirometer and Wright's peak flow meter.

These findings are also concurrent with Kumar et al (1992),[11] Christiani et al (1994),[12] and Fishwick et al (1996).[13]

But our focus was to access the damage to the lung tissue with increasing number years of exposure to the cotton dust. We found no evidence of additional damage.

The significant reduction in percentage predicted values of FEV_1 (82 vs 59), FVC (79 vs 63) and MVV (77 vs 64) were observed by Purohit R, Lata H, Walia L, Whig J. in 2014,[14] in workers as compared to healthy controls indicates obstructive pattern of respiratory abnormality.

CONCLUSION

There is highly significantly decline in pulmonary functions in cotton industry units when compared to normal population of same area taken as control subjects. Chronic exposure to cotton dust is causes specific and non-specific respiratory symptoms. But more number of years of exposure to cotton dust causes non-significant additional damage. Byssinosis is more strongly associated with exposure to endotoxins than to dust. Cessation of exposure or prevention of exposure by wearing masks during working hours may improve the respiratory health of cotton textile workers.

Abbreviations

B.S.A.- Body Surface Area, F.V.C.- Forced Vital Capacity, $FEV_{0.5}$, FEV_1, FEV_3 - Forced Expiratory Volume in 0.5, 1st & 3rd second, $FEF_{25-75\%}$- Maximum Mid Expiratory Flow Rate, P.E.F. R.- Peak Expiratory Flow Rate, M.V.V.)- Maximum Voluntary Ventilation, $F.E.V._{0.5}$, / F.V.C.%, $F.E.V_1$./F.V.C.%, $F.E.V_3$./F.V.C.% - Forced Expiratory Volume, Forced Vital Capacity Ratio expressed as percentage

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