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Evaluation of Lung Function by Spirometry in Textile Mill Workers

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ABSTRACT:
Background: In present scenario industrialization is growing at a faster rate throughout the world in developed as well as developing countries. Occupational lung disease is becoming one of the major problem in occupational health. Many environmental problems are associated with textile industry such as water pollution, noise pollution, soil pollution and air pollution. Out of these different pollutions air pollution resulting from cotton dust is the most important factor affecting health of the workers. Various studies in India and outside have been carried out in cotton mill workers with different results. So present study was planned to evaluate the lung function of cotton mill workers by spirometry in this part of country.
Material & methods: The study was carried out in 55 participants who were exposed to cotton dust directly. 55 controls were also selected from the workers of same mill but not exposed directly to cotton dust. Spirometry findings were compared between two groups.
Results: The values of most of the PFT parameters were significantly reduced in subject group compared to control group ($p<0.05$). However there was no any significant difference in the values of FEV1/FVC ratio between the groups ($p>0.05$).
Conclusion: From our study we conclude that workers in the cotton mills are exposed to cotton dust and various types of other air pollutants. And the chronic exposure results in decline in pulmonary function

Key words: Textile mill worker, Spirometry, Lung function

Introduction:

In present scenario industrialization is growing at a faster rate throughout the world in developed as well as developing countries (1). Occupational lung disease is becoming one of the major problem in occupational health (2, 3).Environmental pollution is one of the greatest problems the world is facing now. This is in turn causing grave and irreparable damage to the mother earth and to the livings on the earth. The health problems related to various occupations is being one of the biggest concern in public health (4). In developing countries workers are important part as important as machines in production industry & they are exposed to occupational hazards landing their health into risk (3).Many studies have documented health effects of lung function in the workers who been exposed to dust in small, medium and large industries (3). Many environmental problems are associated with textile industry such as water pollution, noise pollution, soil pollution and air pollution. Out of these different pollutions air pollution resulting from cotton dust is the most important factor affecting health of the workers (5). Cotton dust is generated during various stages of the cotton manufacturing process in a cotton mill. The processes that contribute to the cotton dust generation of include:

1) Opening and Cleaning: (Ginning):

Once the cotton bolls are picked, they are then delivered directly to the ginning factory by truck. Before the invention of the gin, the lint and seed were separated by hand, which was a slow process. Modern gins can separate and bale about 230,000 kilograms of cotton in one day (6).The cottonseed is removed from the cotton fiber by a machine called a gin. The gin separates the cottonseed from the fiber by using a series of blades and screens (7).

2) Cotton spinning:

The cotton yarn spinning process begins by harvesting the cotton plant. The cotton is then cleaned and sorted by size. The strands of cotton fibers are twisted together to form yarn. The yarn is placed on the rings of the spinning frame and is allowed to pass through several sets of rollers, which are rotating at a successively higher speed (8, 9).

The process of producing yarns from the extracted fibers is called spinning. The strands of cotton fibers are twisted together to form yarn. The yarn is placed on the rings of the spinning frame and is allowed to pass through several sets of rollers, which are rotating at a successively higher speed (9).

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A significant amounts of cotton dust is generated in all these processes that can pose a health risk to workers in the mill after prolonged exposure period. So effective dust control measures should be implemented in cotton mills and appropriate protective gears may be provided to workers for minimizing the exposure to cotton dust.Dust consists of solid particles ranging in size from less than 1 micron (µm) up to 100 µm.

The chances of these particles becoming airborne depend on their origin, physical characteristics and ambient conditions (10). During handling or processing of cotton, dust is produced which may contain substance mixture consisting of ground-up plant matter, bacteria, fungi, soil, pesticides, and other contaminants (11). The factors affecting inhalation of dust are size of particle, velocity of surrounding air and respiratory rate of a person. The dust particles with smaller size have greater chances of deep penetration into the respiratory passage. The dust particles having aerodynamic diameter <10µm easily reach the gaseous exchange areas of lung (10). In textile mills there are various weaving sections like ginning, carding and spinning operations where a large amount of dust is generated (12).

Patients who develop occupational diseases show pathological responses to their work environment (13). Among the occupational diseases pulmonary diseases are more common and more hazardous. Occupational lung diseases result from long or short repeated exposure to irritating or toxic substances. This exposure causes acute or chronic respiratory disease (14). Lungs are vulnerable sites for deposition of suspended particles in air. This is because of extensive surface area, high blood flow, thin alveolar walls & direct communication with environmental air (15). Cotton dust is an aerosol of heterogeneous solid particles originated from mechanical communication of a coarser material. Inhaled cotton dust particles up to 5
microns are retained in lung (16).

Exposure to cotton dust & products of several chemicals used in textile mill has been
associated with respiratory tract infection, bronchoconstriction, cough, excessive mucus, nasal stuffiness and nocturnal asthma **1.** (17). Chronic exposure causes severe respiratory dysfunction that may result development of chronic obstructive pulmonary disease (COPD) (18). Ultimately that can lead to chronic disabling disease the byssinosis. It has been defined as a respiratory disease associated with inhalation of cotton, flax and hemp. It is common in cotton processing countries. It is also called as cotton dust asthma by some. It is also called Brown Lung or Brown Lung Disease which is a type of Pneumoconiosis resulting from exposure to dust from cotton and other fibers. There is release of histamine due to inhaled dust resulting into constriction of air passages, causing breathing difficulty over a time. The accumulated dust in the lungs produces typical discoloration that gives the disease its common name. The manifestations occur after several years (19). The evidence of chronic lung disease resulting from occupational exposure to cotton dust has been demonstrated by various epidemiological studies of cotton mill workers (20).In initial stages symptoms include chest tightness, cough, wheezing and dyspnea in varying degrees. The characteristics symptoms of byssinosis are shortness of breath and tightness of the chest on returning to the work after a period of non-exposure (21).Usually on first day of work i.e. on Monday after week holiday these symptoms are observed in workers hence it is also called "Monday dyspnea". The effect on lung depends on the type of dust, duration of exposure, concentration of dust and the size of particle (22).

PFT is an accurate and reproducible assessment method for studying functional state of respiratory system. It is also possible to quantify the severity of the disease. The functions of respiratory system depends on the integrity of the airways, pulmonary vasculature, alveolar septa, respiratory muscles and respiratory control mechanisms (23).Various studies in India and outside have been carried out in cotton mill workers with different results. So present study was planned to evaluate the lung function of cotton mill workers by spirometry in this part of country.

Aims and objectives:

Aim:-To evaluate lung function of textile mill workers

Objectives:-

1) To carry out spirometry in textile mill workers and controls
2) To compare the findings among two groups
3) To find co-relation between severity of affection of lung function & duration of exposure.
4) To advise use of protective devices and regular health cheque up of workers

Materials and methods

Source of data:-The study was carried out in a spinning mill located in Western Maharashtra. A total 55 participants who were exposed to cotton dust directly were selected for study group and 55 controls were also selected from the workers of same mill but not exposed directly to cotton dust.Approval from Institutional Ethical Committee (IEC) for research project was taken in advance before beginning of the project. Subjects for the study were 55 workers in textile mill who are exposed to cotton dust. The sample size was decided by using following formula:

$$n = \frac{(SD1)^2 + (SD2)^2 \times 7.84}{(M1 - M2)^2}$$

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2) Inclusion criteria:-

- Workers in textile mill exposed to cotton dust (subjects)
- Apparently healthy workers non exposed to cotton dust (controls)

3) Exclusion criteria:-

Subjects with history of -

- Any major cardio respiratory disease
- Endocrine disorder
- Smoking

All the participants were called in office department of textile mill for carrying out lung function test. Informed written consent was obtained from all the participants.

4) Technical information about project instruments:-

- Proforma for recording medical history & clinical examination
- For weight recoding portable weighing machine wasused
- For measurement of standing height in cms a measuring tape was used
- For pulmonary function tests (PFTs) "MEDSPIROR" (RMS Chandigrah, India) computerized spirometer

5) Method of collection of data:-

Test was carried in morning hours between 10.00 am 12.30 pm. Before doing the PFT, a thorough history was recorded from participants of both the groups, which included personal history (Name, age, sex, address, habit of smoking) and medical history of any respiratory/cardiac disease. Anthropometric measurements like height and body weight were taken. General & systemic examination was carried out to exclude any major disease. The subjects were grouped into three groups depending on duration of exposure:

Group I- Exposure < 2 years
Group II- Exposure 2-5 years
Group III - Exposure > 5 years.

Pulmonary function tests were carried out by using computerized Spirometry- "MEDSPIROR" (RMS Chandigarh, India). All the guidelines suggested by American Thoracic Society (ATS) (24) were followed for spirometry tests. All the participant from both the groups were informed in detail about the test protocol & written informed consent was obtained from each of them. They were shown a demonstration of the test before carrying out test. A minimum of three readings were recorded of each test performed on every subject and the best of the three was selected as final reading, for having reproducibility and validity of the recorded parameters. The Pulmonary function parameters included were:

1) FVC (Forced Vital Capacity): This is the volume of air that is expired forcefully after maximum inspiration.
2) FEV1 (Forced Expiratory Volume in one second): It is the volume air that is expired forcefully in the 1st second after a maximal inspiration.
3) EFV1/FVC ratio: It is the percentage of FVC that is expired at the end of 1 st second.
4) PEFR (Peak Expiratory Flow Rate): It is the maximum rate achieved during forceful expiration after maximal inspiration.
5) FEF.2-1.2 (Forced expiratory flow between 0.2 to 1.2 L of expiration): It is the maximum rate achieved during forceful expiration between .2 L to 1.2 L of FVC.
6) MMFER (Maximum mid expiratory flow rate) or FEF25-75: It is the maximum rate achieved during middle 50% (From 25% to 75%) of FVC and
7) MVV (Maximum Voluntary Ventilation): It is maximum amount of air that can be inspired or expired in 1 min.

The actual values of all tests were taken.

6) Statistical analysis:-The data collected was summarized by computing mean and standard deviation (S.D.) of each study variable. Analysis was done by applying paired t test and one way ANOVA by using Instat 3 software. The difference was said to be significant if $p < 0.05$.

Observations and results:

From Table 1 it is seen that there was no significant difference in the values of anthropometric measurements in both groups ($p>0.05$)

From Table 2 it is observed that the values of most of the PFT parameters were significantly reduced in subject group compared to control group ($p<0.05$). However there was no any significant difference in the values of FEV1/FVC ratio between the groups ($p>0.05$).

From Table 3 it is observed that the values of FVC, FEV1 and MVV were significantly reduced in subjects from Group I compared to those of control group ($p<0.05$). But there was no difference in values of FEV1/FVC ratio between the groups. The vales of FEF25-75, FEF.2-1.2, PEFR and MVV were reduced in subjects from Group I compared to those of control group, however the difference was not statistically significant ($p>0.05$)

From Table 4 it is observed that the vales of FVC, FEV1, FEF25-75 and MVV were reduced in subjects from Group II compared to those of control group ($p<0.05$).The values of other parameters were also reduced in Group II but the difference was not statistically significant.

From Table 5 it is observed that the vales of FVC, FEV1 and MVV were reduced in subjects from Group III compared to

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those of control group ($p<0.05$). The values of FEF25-75, FEF.2-1.2 and PEFR were also reduced in Group III but the difference was not statistically significant.

From Table 6 it is observed that out of total 55 workers-39 (70.9%) had normal findings of spirometry parameters,5 (9%) had restrictive type of lung dysfunction,8 (14.54%) had obstructive type of lung dysfunction and3 (5.45%) had mixed type of lung dysfunction.

Discussion:

The cotton dust consists of a complex mixture of components that may include ground-up plant matter, cotton fiber, bacteria, fungi, soil, pesticides etc. It may also include other contaminants which might have accumulated during the growing, harvesting and processing or during storage of cotton. Cotton dust is the any dust that is present during handling and processing of cotton. Manufacturing process that uses new or waste cotton fibers or cotton fiber by-products in cotton mills can also produce cotton dust (25). There occurs a release of histamine from mast cells after inhalation of cotton dust. It acts on smooth muscles of bronchi producing the bronchoconstriction. There is excess secretion of mucus from mucus glands in the airways due to histamine. There is also direct action of histamine on vagal nerve endings causing smooth muscle contraction. This leads to diminished air entry in to the lungs (26). It has been reported that short term exposure to cotton dust can produce effects like; irritation of eyes on contact, inhalation of cotton dust can cause irritation of the upper respiratory tract and the lungs. Long term exposure effects include: after repeated exposure there can be serious, permanent lung damage (byssinosis) which can produce the symptoms like increase in chest tightness, difficulty in breathing, coughing and wheezing during working hours (27).

In the present study it is depicted from Table 1 that both the groups (subject & Control) were matched as there was no any significant difference in their age and anthropometric measurements ($p> 0.05$).The comparison of findings of spirometric PFT parameters between control group and subjects group (cotton mill workers) is depicted in Table 2.There was highly significant decrease in mean value of FVC in subject group as compared to control group ($p<0.0001$). This finding matches with the study of Dr. sujatatal koti et.al (28).

There was also highly significant decrease in mean value of FVC in subject group as compared to control group ($p<0.0001$). This finding matches with the study of Hamed O. Khalifa et.al (29),Sangeeta Vyas (30),Wang XR (31), GERALD DJ BECK (32),Glindmeyer HW (33), Ramaswamy, P (34), Mohammad Kh (35), Angeles Jaen(36),Larson R K, Barman (37), Bakirci N(38). We did not found any difference in mean values of FEV1/FVC ratio among two groups ($p>0.05$). We found highly significant decrease in PEFR of cotton mill workers compared to that of controls. This is consistent with the study of Saadat Ali Khan Aizasaadia (39).There was statistically significant decrease in mean values of FEF25-75 and FEF.2-1.2 in the cotton mill workers compared to those in controls. This finding is consistent with D. Choudat, F. Neukirch et al (40).There was also highly significant decrease in mean values of MVV in cotton mill workers compared to those in controls which might be due to highly significant decrease in FVC value of cotton mill workers.

After comparison of mean values of various parameters between controls and Group 1 cotton mill workers (Table 3) it was found that there was significant decrease in FVC, FEV1 and MVV ($p<0.05$) in cotton mill workers. The mean values of other parameters like FEF25-75, FEF.2-1.2 and PEFR were reduced in these group of cotton mill workers but the difference was not statistically significant ($p>0.05$). This might be due to short duration of exposure to cotton dust in these workers. The result of comparison of mean values of PFT parameters between controls and Group II cotton mill workers (Table 4) was a significant decrease in FVC, FEV1,FEF25-75 and MVV values in cotton mill workers($p<0.05$). The mean values FEF.2-1.2 and PEFR were also reduced in these workers compared to those of controls but not to statistically significant level ($p>0.05$). Whereas there was no difference in FEV1/FVC ratio values among controls and workers. After comparison of mean values of various parameters between controls and Group III cotton mill workers (Table 5) it was found that there was significant decrease in FVC, FEV1 and MVV($p<0.05$) in cotton mill workers. The mean values of other parameters like FEF25-75, FEF.2-1.2 and PEFR were reduced in these group of cotton mill workers but the difference was not statistically significant ($p>0.05$).

In the present study from the spirometry findings the lung function was found to be normal in 39(70.9%) workers, restrictive type of lung function was found in 8(14.54%), obstructive type of lung dysfunction was found in 5(9%) and 3(5.45%) workers had mixed type of lung dysfunction. Our results are parallel to earlier study done by Iwan Suryadi et al (41).

These results also were in agreement with the study results of Aminian et al (42). I their study there was normal pulmonary function in 77.66% and abnormal pattern in 22.34% of cotton exposed workers. There was co-relation found between severity of pulmonary dysfunction and duration of exposure in the present study. This finding is in agreement with the study of Ingale A.S. et al (43).

Conclusion:

From our study we conclude that workers in the cotton mills are exposed to cotton dust and various types of other air pollutants.

And the chronic exposure results in decline in pulmonary function. It is important to note that further analysis is needed to determine if the differences observed are statistically significant, and to take into account other factors such as age, smoking history, and other medical conditions that could affect pulmonary function. Overall, the results of the pulmonary function tests for the different groups indicate that there may be differences in respiratory health between the groups, and further analysis is needed to draw more definitive conclusions.

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Conflict of interest: The authors declare that there is no any conflict of interest.

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Table 1: Anthropometric measurements

Sr. No.	Parameter	Control group(n=55)	Subject group(n=55)	P value
1	Age(years)	40.21± 5.91	40.87± 6.91	0.5947*
2	Height(cms)	165.29 ± 7.3	166.45 ± 4.11	0.3055*
3	Weight(kg)	63.6 ± 11.68	63.36 ± 10.41	0.9110*

***statistically not significant**

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Table 2**:** PFT Parameters in control &subject group

Sr. No.	PFT parameter	Control (n=55) Mean ± SD	Subjects (n=55) Mean ± SD	P value
1	FVC (L)	3.08 ± 0.4	2.61 ± 0.36	<0.0001
2	FEV1(L)	2.79 ± 0.37	2.39 ± 0.35	<0.0001
3	FEV1/FVC (%)	90.75 ± 5.57	90.76 ± 6.04	0.9992
4	FEF25-75(L/S)	3.61 ± 0.84	3.22 ± 1.2	<0.05
5	FEF.2-1.2(L/s)	5.91 ± 1.54	5.33 ± 1.48	<0.0447
6	PEFR(L/s)	6.88 ± 1.61	6.72 ± 1.56	<0.0001
7	MVV(L/min)	118.81 ±± 25.89	98.03 ± 22.57	<0.0001

FVC (Forced Vital Capacity), FEV1 (Forced Expiratory Volume in First second of FVC), FEV1% (FEV1 as % of FVC), PEFR (Peak Expiratory Flow Rate in litres /sec), FEF25-75% (Forced Expiratory Flow Rate during 25 to 75 % of expiration), FEF 0.2-1.2 (Forced Expiratory Flow between 0.2 -1.2liters of expiration) and MVV (Maximum Voluntary Ventilation)

Table 3: PFT Parameters in Control & Group I

Sr. No.	PFT parameter	Control (n=55) Mean ± SD	Group I (n=19) Mean ± SD	P value
1	FVC (L)	3.08 ± 0.4	2.62 ± 0.33	<0.0001
2	FEV1(L)	2.79 ± 0.37	2.48 ± 0.4	0.0028
3	FEV1/FVC (%)	90.75 ± 5.57	90.80 ± 6.64	0.9755
4	FEF25-75(L/S)	3.61 ± 0.84	3.28 ± 1.27	0.2093

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5	FEF.2-1.2(L/s)	5.91 ± 1.54	5.33 ± 1.23	0.1432
6	PEFR(L/s)	6.88 ± 1.61	6.70 ± 1.26	0.6701
7	MVV(L/min)	118.81 ±25.89	97.33 ± 27.70	0.0026

Table 4: Parameters in Control & Group PFT II

Sr. No.	PFT parameter	Control (n=55) Mean ± SD	Group II (n=19) Mean ± SD	P value
1	FVC (L)	3.08 ± 0.4	2.66 ± 0.39	0.0002
2	FEV1(L)	2.79 ± 0.37	2.39 ± 0.33	<0.0001
3	FEV1/FVC (%)	90.75 ± 5.57	90.27 ± 5.36	0.7401
4	FEF25-75(L/S)	3.61 ± 0.84	3.07 ± 1.03	0.0275
5	FEF.2-1.2(L/s)	5.91 ± 1.54	5.42 ± 1.60	0.2367
6	PEFR(L/s)	6.88 ± 1.61	6.74 ± 1.88	0.7647
7	MVV(L/min)	118.81 ±25.89	102.52 ± 18.37	0.0137

Table 5: PFT Parameters in Control & Group III

Sr. No.	PFT parameter	Control (n=55) Mean ± SD	Group III (n=17) Mean ± SD	P value
1	FVC (L)	3.08 ± 0.4	2.54 ± 0.37	<0.0001

2	FEV1(L)	2.79 ± 0.37	2.31 ± 0.32	<0.0001
3	FEV1/FVC (%)	90.75 ± 5.57	91.25 ± 6.36	0.7571
4	FEF25-75(L/S)	3.61 ± 0.84	3.31 ± 1.33	0.2741
5	FEF.2-1.2(L/s)	5.91 ± 1.54	5.22 ± 1.66	0.1168
6	PEFR(L/s)	6.88 ± 1.61	6.71 ± 1.56	0.7066
7	MVV(L/min)	118.81 ±25.89	93.35 ± 25.68	0.0007

Table 6: The type of lung dysfunction in cotton mill workers

Sr. No.	Type of lung dysfunction	Number of workers	% of total
1	Normal	39	70.9
2	Restrictive	08	14.54
3	Obstructive	05	09
4	Mixed	03	5.45