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ORIGINAL ARTICLE

Spirometric Assessment of Lung Function in Garment Workers in Bangladesh: A Cross Sectional Study

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Abstract:

Background: *Exports of textiles and garments are the principal source of foreign exchange earnings in Bangladesh. Exports of textiles, clothing, and ready-made garments (RMG) account for 85% of Bangladesh's total merchandise exports and provide employment to around 5 million workers. Workers of garment factories are susceptible to various respiratory morbid conditions, by virtue of workplace and working conditions and are at risk of suffering from various chronic respiratory illnesses. Early studies in textile workers throughout the world have focused on the relationship between hemp or cotton dust exposure and the development of a syndrome termed Byssinosis. Even though quite a few studies have been conducted in among garment workers in Bangladesh enough emphasis has not been given on the epidemiological aspects of chronic respiratory illnesses affecting pulmonary functions among the workers in these mills.*

Objective: *The purpose of the study is to observe pulmonary function among garment workers in Bangladesh and compare it with unexposed population.*

Methods: *This cross sectional observational study was conducted at cotton mill in Gazipur, Dhaka,Bangladesh. A control group was taken from BSMMU for the purpose of comparison. A modified questionnaire was used to inquire about socio demographic characteristics, socioeconomic history, complete occupational history, potential confounding factors, physical parameters and spirometry was done among workers.*

Results: *There was significant association of pulmonary function FEV1, FVC, PEF with cotton dust exposure and a significant reduction of both FEV1 predicted 2.92±0.38 and observed 2.47±0.67 p<0.001 (paired t test) and PEF predicted 7.3%±1.10, observed 5.34±1.67, p<.001 (paired t test) was found among garment workers in comparison to non-exposed population group. Also female workers are more affected than male workers. No significant association of pulmonary function was found with the duration of exposure and distribution.*

Conclusion: *We conclude that there is a significant association of pulmonary function in both long term and short term cotton exposed workers in comparison to non-exposed control group. There is a significant association of pulmonary function parameters (FEV1 and PEF) among female workers. It is justified to tell that cotton dust exposure has an effect on pulmonary function impairment.*

Keywords: *Cotton dust, Garment workers, Pulmonary Function*

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Introduction:

Since the dawn of civilization, occupation related respiratory diseases have always been a matter of grave concern for respiratory health. Its prominence reached the peak during the timeframe of industrial revolution. There is growing interest in the contribution of workplace exposures to obstructive lung disease, given that 25-45% of patients with chronic obstructive pulmonary disease (COPD) worldwide have never smoked[1]. While a number of non-tobacco related environmental exposures may cause COPD, including biomass fuel, early childhood infections, and pulmonary tuberculosis, occupational exposure to dusts are a major contributor, with one U.S. based study citing a population attributable risk of 9%[2].

Early stage byssinosis in many respects fulfills the criteria for the diagnosis of asthma: reversible airflow obstruction and airway hyper-responsiveness. (National Heart, Lung, and Blood Institute, 2007) Large changes in FEV1 before and after a work-shift (cross-shift drop in FEV1) has been noted in a number of different studies.[3]

Most studies in cotton and hemp workers report an increased incidence of chronic and progressive dyspnea, cough, and sputum production characteristic of symptoms seen in COPD[4]

Pathologic studies in garment workers have been conflicting, reporting variable associations between cotton dust and emphysema but confirming the presence of airways disease[5]; all of these studies have been limited by lack of quantitative exposure assessment to cotton dust and tobacco.

The pulmonary function test (PFT) become an important modality in this new era in diagnosis, prognosis and management of pulmonary disorders[6].

Parameters seen in spirometry:

a) FVC: FVC is the maximum volume of gas that can be expired when the patient exhales as forcefully and rapidly as possible after a maximal inspiration. It is the primary indicator of the presence of possible restrictive impairment.[7] The FVC is reduced or restrictive when the compliance of the lung is decreased or when the chest wall expansion or neuromuscular function are limited.

b) FEV1: FEV1 measures the volume expired over the first second of an FVC maneuver. FEV1 is reported as a volume, although it measured flow over a specific interval.[8] It is the most widely used spirometric parameter, particularly for the assessment of airway obstruction.[9]

c) FEV1/ FVC ratio: Disproportionate reduction in the FEV1 as compared to the FVC is reflected in the FEV1/FVC ratio and is the hallmark of obstructive lung disease.[10]

Forced expiratory volume over 1 second (FEV1) is a dynamic measure of flow used in formal spirometry. It represents a truer indication of airway obstruction than does PEFR.[11] Although PEFR usually correlates well with FEV1, this correlation decreases in patients with asthma as airflow diminishes. Interpretation of spirometry results should begin with an assessment of test quality.[12] Failure to meet performance standards can result in unreliable test results.

As in Bangladesh there is scarcity of research, so this study would be beneficial for the health of the workers.

To assess the effect of exposure to cotton dust on the health of garment workers, this study was initiated and conducted in a Bangladeshi garment industry company. The purpose of this review was to observe the pulmonary function among garment workers and to compare it with a matched non-exposed control group.

Methodology

Place of study

Our study has two parts. 100 male and female workers from a garment factory in Konabari, Gazipur were interviewed and spirometry was done. Same number of people that belong to the control group were interviewed and spirometry was done at BSMMU.

Study period

One Year after clearance from IRB.

Type of study

Cross sectional, Observational study.

Data collection procedure

100 exposed persons with at least 2 years employment at the factory as a study subject and

100 matched persons from BSMMU as a control group were selected. All subjects were first interviewed by a modified standardized questionnaire[13]. Personal information including name, age, and history of smoking and tobacco chewing were covered. Work history including questions covering all the details of present and past employment, history of job-related occupational exposure, job responsibilities, working time, working area, duration of employment, and the use of protective equipment during work were taken meticulously. Physical measurements including weight, Height and BMI of each subject were noted. Clinical examination of chest was done. Spirometric pulmonary function test was aimed at calculating forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio using the spirometry system according to the guidelines of American Thoracic Society. For spirometry, MIR spirolab 4 (made in Italy) was used.

Estimation of air quality in working sections

Ai quality was measured by respiratory dust sampler (temptop air quality detector) in blow section, ring and packaging section. It measured suspended particulate matter PM 2.5 and PM 10 (microgram/cubic meter). The highest recorded value was taken among all the readings displayed in the monitor.

Criteria for selection of workers

Inclusion criteria:

1) All workers of 18 years and above (male and female) willing to participate having at least 2 years of experience in the production chain were included in the exposed population.
2) The population exposed to cotton dusts having at least 2 years of job activities.
3) Willing to participate

Exclusion criteria:

1) Previous exposure to other occupational dust such as Silica, Coal dust, silk.
2) Those with history of smoking.
3) Those diagnosed with tuberculosis, asthma or COPD.
4) Subjects with neuromuscular disease, with gross clinical abnormalities in thoracic cage and vertebral column.
5) Unable to perform spirometric procedure

Data collection

All data were checked after collection. Then the data were entered in to computer and statistical analysis of the results were obtained by using windows based computer software devised with Statistical Packages for Social Science (SPSS-23), (SPSS Inc, Chicago, IL, USA).The variables were expressed as mean, frequency and standard deviation. The qualitative data were analyzed by chi--square test and quantitative data were analyzed by paired t-test, unpaired t test and Bonferroni test. Multiple comparison test were analyzed by one way ANOVA test. P value of less than 0.05 was considered statistically significant. p-value less than .001 was considered highly significant.

Observations and Results:

This study included 100 (one hundred) subjects who were working in the cotton spinning mill in Gazipur, Dhaka. These workers were working in different sections of the spinning mill like blow room, ring room, and packaging. Air quality was measured Both PM2.5 and PM 10. The main objective of the study was the observation of pulmonary function among cotton mill workers.

Frequency of demographic variables

Table-I

Demographic profile (age) of the study subjects (n=100)

Age (years)	Frequency (n)	Percentage (%)
18-20	46	46.0
21-25	20	20.0
26-30	17	17.0
>30	17	17.0

Among 100 workers the age of workers were 18 years and above. All workers came under almost the same economic category since all of them were interviewed of their actual assets. This table] showing range of age was 18-50 years. The mean + SD of age (in years) was found as 25.0 + 8.2. The age group with the largest number of exposed workers was less than 20 years and the frequency was 46%.

Table-II

Demographic profile (age) of the control group (n=100)

Age (years)	Frequency (n)	Percentage (%)
18-20	46	46.0
21-25	20	20.0
26-30	17	17.0
>30	17	17.0

Among 100 people of the control group, the age of people were 18 years and above. This table showing range of age was 18-50 years. The mean + SD of age (in years) was found as 25.0 + 8.2.

Table-III

Demographic profile (gender) of the study subjects (n=100)

Gender	Frequency (n)	Percentage (%)
Male	44	44.0
Female	56	56.0

Regarding gender, the male frequency was 44% and female was 56%. So the proportion of female workers were high.

Table-IV

Demographic profile (gender) of the control group (n=100)

Gender	Frequency (n)	Percentage (%)
Male	44	44.0
Female	56	56.0

Regarding gender of the control group, the male frequency was 44% and female was 56%. So the proportion of female subjects were high in here also.

Table-V

Distribution of the study subjects according to the working section (n=100)

Section	Frequency (n)	Percentage (%)
Blow	30	30.0
Ring	40	40.0
Packaging	30	30.0

In this present study, pulmonary function was assessed by spirometry. Pulmonary functions of cotton mill workers in different sections of the factory were recorded. Spirometric parameters that were used FEV1, FVC, FEV1/FVC, and PEFR.

Table-VI

PM level at working area (n=100)

Section	PM 2.5
Blow	125.0
Ring	19.0
Packaging	25.5

Here in this table it is showing PM 2.5 level was the highest in blow room that is 125.0 which is regarded as unhealthy among other sections. PM 2.5 is the microdust which causes damage to the gas exchange part of lung. So, this particle was measured considering as important independent variable to cause pulmonary function impairment.

Table-VII

Distribution of confounding factors among the study subjects (n=100)

	Frequency (n)	Percentage (%)
Use of Biomass fuel	5	5.0
Passive smoker	25	25.0

Passive smoking and biomass fuel using were confounding factors which were found 25% and 5% respectively.

Table-VIII

Distribution of confounding factors among the control group (n=100)

	Frequency (n)	Percentage (%)
Use of Biomass fuel	0	0.0
Passive smoker	30	25.0

Passive smoking and biomass fuel using were confounding factors which were found 30% and 0% respectively.

Table-IX

Distribution of work-related variables among the study subjects (n=100)

	Frequency (n)	Percentage (%)
Use mask during work	47	47.0
Duration of work (years)	5.2 ± 3.1 (2-14)	

Several other variables were selected in this study which included mask use, duration of work in years. Among 100 workers the mean SD of duration of work exposure (in year) was found as 5.33.1. The range of work exposure was 2 to 14 years. During work, mask users were 47%. So it implies the rest of the workers were not using respiratory masks as protective devices during work shift.

Table-X

Distribution of work-related variables among the control group (n=100)

	Frequency (n)	Percentage (%)
Use mask during work	51	51.0
Duration of work (years)	6.24.1 (2-14)	

Several other variables were selected in this study which included mask use, duration of work in years. Among 100 people, the mean SD of duration of work exposure (in year) was found as 6.24.1. The range of work exposure was 2 to 14 years. During work, mask users were 51%. So it implies that mask usage among control group was higher than garment factory workers.

Table-XI

Spirometry findings of the study subjects (n=100)

	Predicted	Observed	p-value
FEV1	2.92 0.38	2.47 0.67	<0.001*
FVC	3.34 0.43	2.86 1.19	<0.001*
FEV1/FVC	87.43 4.78	86.36 14.62	0.027
PEF	7.03 1.10	5.34 1.67	<0.001*

Paired t-test was done to measure the level significance

In table VIII showing there was a high significant decrease in the observed value of FEV1, FVC and PEF among 100 workers in comparison with respective predicated value.

Table-XII

Spirometry findings of the control group (n=100)

	Predicted	Observed	p-value
FEV1	2.96 0.38	2.93 0.67	>0.05
FVC	3.34 0.43	3.32 1.19	>0.05
FEV1/FVC	88.62 4.78	88.25 14.62	>0.05
PEF	8.15 1.01	8.14 1.27	>0.05

Paired t-test was done to measure the level significance

In table XIII showing there was no significant decrease in the observed value of FEV1, FVC and PEF among the control group in comparison with respective study subjects.

Here mean value of FEV1, FVC, FEV1/FVC and PEF were compared among three different sections of spinning mill and high significant reduction of FEV1 was found in blow room. (p value <0.001) and PEF was also significantly reduced.

Table XII is showing there was statistical significance of pulmonary function among genders. FEVI and PEF showed statistical significant that is high is high significant reduction of FEVI and PEF among female exposed Workers.

Table XVIII is showing there was no statistical significance of pulmonary function among genders of the control group.

Table-XIII

Spirometry findings of the study subjects working at different section (n=100)

	Blow	Ring	Packaging	p-value
FEV1	2.08 0.68	2.42 0.57	2.92 0.53	<0.001*
FVC	2.76 1.10	2.83 1.13	2.98 1.37	0.766
FEV1/FVC	86.19 20.85	92.94 7.28	89.17 14.01	0.156
PEF	4.99 1.84	5.11 1.50	6.02 1.56	0.028*

ANOVA test was done among the groups.

*p <0.001 is highly significant

*P <0.05 is significant

*p >0.05 is non-significant

Table-XIV

Pulmonary function in male and female of the study subjects (n=100)

	Male	Female	P-Value
FEV 1	2.95	2.09 0.49	<0.001*
FVC	2.96 1.09	2.77 1.27	0.429
FEV1/FVC	89.93 16.41	89.66 13.19	0.927
PEF	6.511.52	4.43 1.12	<0.001*

An unpaired t-test was done to measure the level of significance.

Table-XV

Pulmonary function in male and female of the control group (n=100)

	Male	Female	P-Value
FEV 1	2.99	2.92 0.49	>0.05
FVC	3.36 1.09	3.32 1.27	>0.05
FEV1/FVC	88.98 16.41	87.95 13.19	>0.05
PEF	6.511.52	6.43 1.12	>0.05

An unpaired t-test was done to measure the level of significance.

Discussion:

Sociodemographic data of the study population were evaluated in this study. Among 100 workers pulmonary functions were observed by using spirometry. Among them 44 were male and 56 were female with the age of 18 years and above. The mean + SD of age (in years) was found as 25.08.2. The age group with the largest number of exposed workers was less than 20 years and the frequency was 46%. Among 100 workers the mean+ SD of work exposure (in years). was 5.343.1. During work, mask users were 47%. So it implies the rest of the workers were not using respiratory masks as protective devices during work shift. Passive smoking was another confounding factor that was found at 25%.

Garment workers group showed significant (P<0.001) decrease in forced expiratory volume in 1 s (FEV1), ratio of FEV1 and forced vital capacity (FVC) and peak expiratory flow rate, and no significant difference of FVC between groups. Garment workers showed a significant decrease in spirometric parameters as the duration of exposure and symptoms increased, spirometric abnormality increased[14]. This study also showed a statistically significant decrease in the observed value of FEV1, FVC, and PEF among 100 workers in comparison with the respective predicted value in comparison to the control group. A study[15] shows that respiratory morbidity was higher in cotton textile mill workers compared to unexposed comparison group. They found that age >30 years, dust exposure, duration of exposure >10 years, and smoking were significant risk factors for respiratory morbidity. In this study, the mean age frequency was 25 years (SD=8.2). The age group with the largest number of exposed workers was less than 20 years and the frequency was 46%. Among 100 workers work exposure was 5.3years (SD=3.1). During work, mask users were 47%. So it implies the rest of the workers were not using respiratory masks as protective devices during work shift. Passive smoking was another confounding factor that was found at 25%. So it implies that in this study workers had a low duration of exposure, smokers were not included in the study only passive smokers[16]. Hence this study did not show the changes in pulmonary function parameters as other studies. Another study was conducted in flour mills and it also showed the duration of employment more than 10 years causes a significant reduction of pulmonary function parameters.[17]

The differences in PEFR mean were highly significantly reduced in symptomatic workers than asymptomatic. There is a study which was done in Bangladesh mentioning about non-significance of duration of exposure and symptoms and lung function[18] .The lower lung function indices in cigarette smokers and occupational substance exposure have been supported by various studies.[19] In our study particulate matter was measured in different sections. In the blow room, FEV1 was significantly reduced than FVC, PEF, and FEVI/ FVC. A significant difference between the mean percentages in the predicted value of PEFR, FVC, and FEV1 of nonsmokers and smokers in the exposed and control groups were found. But our study excluded smokers. So the significant change of pulmonary function is solely due to dust exposure. Considering other biomass (5%) or passive smoking (25%) which were included in our study the percentage was so low that it was not considered as a culprit agent for such reduction.

Also, the results of this study were in agreement with the results of another study which revealed that the FEV1% was significantly lower among exposed workers than control[20]. Also, the same results were found in another study where 198 textile workers and 50 subjects were taken as control and found that FEV1 was significantly lower in the exposed group as compared to control[21]. In this study, about 47% of the workers used a protective mask during their work. It was a reusable cotton cloth mask. Statistical analysis showed no statistical significance of pulmonary function parameters. It somehow correlates with the study[22] which showed that in spite of using face mask lung function changes were there. Hence at the end of the discussion, it has been revealed that there was a significant reduction of FEV1, FVC and PEF in cotton mill workers with a wide range of exposure was observed. As there were different study which showed both short term and long term exposure can cause pulmonary function change. Cotton dust exposure was solely the culprit agent as nonsmoker was included in this study. Our limitation of the study was no endotoxin level was measured and the control group was not included. In most of the studies, smokers were included and lung function impairment was found in association with cotton dust exposure. Some studies showed the changes in pulmonary function with endotoxin levels. Few percentage of workers were exposed to biogas and passive smoking which were not being considered as culprit for pulmonary function changes in our study. Regarding gender female workers showed a significant reduction of pulmonary function FEV1 and PEF which also agreed with some studies.

Conclusion:

It was found that there was a significant reduction of FEV1, FVC and PEF among garment factory workers in comparison to the control group. Female workers were predominantly affected as there were significant reduction of FEV1 and PEF. No significant relation was found with duration of exposure. As there was high concentration of PM 2.5 in blow room and significant reduction of FEV1 was found in this section. So it could be told that there may be presence of possible association between cotton dust exposure and impaired lung function. Hence the most important finding of this study is the higher the exposure of cotton dust the more significant association of pulmonary function (significant reduction of FEV1).

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