INCIDENCE OF BYSSINOSIS, EFFECTS OF INDOOR POLLUTANTS AND ASSOCIATED RISK FACTORS ON LUNG FUNCTIONS AMONG WOMEN WORKING IN COTTON MILLS

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Abstracts: **Background and objectives**: Byssinosis, best known to pulmonologist as "Brown lung disease" is a chronic occupational lung disease .Low socioeconomic women working in cotton mills, often neglect their health and thus this study aimed to find the prevalence of byssinosis, the associated respiratory symptoms, the severity of the disease between the women exposed to cotton dust alone or in combination with other indoor pollutants. **Methods:** A cross-sectional study was conducted on apparently healthy women (n= 315) working in cotton mills, Davangere, Karnataka, India. Pre-validated standard questionnaire were used. Byssinosis was graded as per Schilling's scale. Lung function tests were done by using computerized, MEDSPIROR. **Results:** The prevalence of byssinosis was 41%, majority (28%) of women were in grade ½. Significant association was found in the severity of disease between cotton dusts, other biomass users ($p<0.05$).**Interpretation & Conclusions**: The prevalence of byssinosis and other respiratory diseases is high. Exposure to cotton dust activates histamine releasing agents, disrupt mucociliary defences of lungs, and also domestic smoke emissions aggravates the airway reactivity and bronco constriction. Therefore, preventive measures like usage of masks, educational interventions to women are of utmost importance in reducing the risk.

Key Words: byssinosis, cotton dust, pollutants, women

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Introduction:

Byssinosis, best known to pulmonologist as "Brown lung disease" and "cotton worker's lung", is a chronic occupational lung disease. Industries associated with the processing of cotton, specifically yarn, thread and fabric mills are most associated with worker exposure to cotton dust[1,2] . Different steps of textile processing discharge a greater deal of dust in the air, and long-term exposure can leave mill workers with respiratory disorders[3]. Invisible small cotton dust particles enter into the alveoli of the lung through inhalation and accrue in the lymph causing damage to the alveoli, narrowing of the airways and thereby reducing the capacity to retain oxygen. As the cotton dust accumulates, the workers go through a feeling of chest tightness i.e byssinosis[4]

Also, symptoms of wheezing and coughing are seen due to smooth muscle contraction after histamine release, induced by the dust (pure cotton does not cause the disease) , which most likely contains bacterial endotoxins[5-7].

Worldwide, India is the second largest producer of textile goods, which account for 20% of the national industrial output and more so Davangere, once known as the Manchester of cotton industry. Byssinosis is a well-established disease occurring in cotton mill workers. Prevalence of byssinosis varies between 8 - 50% in various part of the continent highest being in India[1].Although causes and factors aggravating it are known to some extent, but not enough insight is available in women who are more prone for byssinosis in his part of peri-urban India; these women belong to low socioeconomic status, more exposed to additional allergens through domestic cooking fuels.

Modernization of the cotton industries in developed countries has led to better working environments. The disease shows a rapid decline in these countries. Preventive measures have also helped alleviate the prevalence of byssinosis. However, preventive measures in developing countries are far from adequate. Prevalence of byssinosis was reported as 30% in Indonesia, 37% in Sudan, 40% in Ethiopia, 46% in Turkey, and 50% in India[8-12,19].

Invisible small cotton dust particles enter into the alveoli of the lung through inhalation and accumulate in the lymph causing damage to the alveoli and reducing the capacity of retain oxygen. As the cotton dust accumulates, the worker develops a brown lung and suffers from byssinosis[14].

The development of the disease has been related to the dust level, but several observations suggest that the bacterial contamination of cotton is important. Other studies have shown that smoking and duration of employment influence the prevalence of byssinosis symptoms among exposed workers[15]. Byssinosis is basically a symptomatic disease; pretested questionnaires bases on symptoms are generally used to assess the prevalence of the disease. A study in South Africa detected byssinosis is mainly by performing a series of Pulmonary Function Tests and a questionnaire based on the standardized questionnaire made mandatory by the Occupational Safety and Health Association (OSHA) in 197813. A similar method was used in Ethopia[14] and lung Function tests were performed along with questionnaire based on the guidelines of the American Thoracic Society. Same was the case with Pondicherry and other studies conducted world wide[13-23].

In the cases related to women, apart from the exposure to dust, exposure to domestic smoke emissions especially in low socio-economic class women of India aggravates the airway reactivity and bronco constriction[24-25].

By this study we shall have the current scenario of the byssinosis of women in the cotton industry setup of Davangere and association of indoor pollutants along with cotton dust exposure on respiratory morbidity. This would help to create awareness among the workers so as to encourage usage of appropriate protective measures.

Material and Methods:

Study design

A cross-sectional study was undertaken to measure prevalence of byssinosis and other respiratory symptoms among workers in the cotton mills, Davangere. The study was performed during July to September 2013.

Subjects

The lung function tests and questionnaires for socio economic and respiratory morbidity were assessed in 315 women, aged 18-50 years. All the women were in good health, non-pregnant and non-lactating. None of them were hospitalized nor had donated blood for at least 6 months prior to start of the study. Written informed consent was obtained from all the women after they were given a full oral and written description on the aims and procedures of the study as well as the risks associated with it. Sufficient time was given to allow them to decide whether or not to participate in the study. For participants who were illiterate, thumb impressions were obtained. The experimental protocol was approved by the ethical committee of SS Institute of Medical Sciences & Research centre, Davangere, India.

Data collection

Socio-demographic data: Information on age, education, occupation, income, type of cooking, cooking oil used, and menstrual history was obtained using a close ended questionnaire.

Anthropometry: A digital balance (Salter's , UK) was used to record the weights of all women to the nearest 100 g. Weight was measured without shoes, jackets or cardigans, heavy jewels, loose chain or keys. They were asked to stand with their feet together in the centre and their heels against the back edge of the scale. They were asked to keep their arms hanging loosely and head facing forward. Measurements of height were made using a stadiometer to the nearest 0.1 cm. They were asked to remove their shoes and stand with their feet flat on the centre of the base plate, back straight, feet's together, heels against the rod straight and Frankfurt plane in a horizontal position (WHO 1995). BMI was calculated as weight in kg by the square of height in meters (kg/m2).

Lung Function test

Lung function tests (LFT) were conducted on the subjects based on the guidelines by American Thoracic Society.

The test procedure was carefully explained and demonstrated to the workers, each of whom was given a chance to practice. Worker was asked to sit in comfortable sitting position. She was asked to take a full, deep breath away from the Spiro meter and hold the mouthpiece between the lips to create a good seal. She was then asked to expire as fast and as hard as possible for as long as possible until no breath is lefts following which she was asked to inspire rapidly to maximum capacity. Changes in lung function were noted in term of FEV1 and FVC and forced expiratory volume in 1 sec to forced vital capacity ratio (FEV1/FVC) were measured.. The subjects performed at least three maximal forced expiratory manoeuvres' at each test period, and the largest FEV, and forced vital capacity (FVC) were selected for analysis regardless of the curve(s) on which they occurred. The tests were performed between 8 am and 10 am on the first day of the shift after the days off before entering the factory.

Administration of questionnaire

Questionnaire was prepared based on the symptoms of the disease on the guidelines of the American Thoracic Society. During a working day the workers were called one by one for a clinical examination and for general administration of questionnaire.

Data collection procedures

Questionnaires: A pretested questionnaire comprising of total 52 questions (28 close ended and 24 open ended) was made in English language (Translated in Kannada for the convenience of workers) and administered and filled as per the details told by workers.

Detailed questionnaires was formulated and information about work, job, duration, method of cooking, addiction and any other respiratory disabilities.

The byssinosis degrees of clinical symptoms suggested by Schilling's[26] (table 5) was used.

History of asthma and smoking was taken to exclude the confounders. Family history included allergic rhinitis and eczema to determine any atopy that the worker might have acquired. Information regarding working overtime and safety gadget usage was also documented.

Data Analysis (Statistical Analysis)

Continuous data were summarized as means (SD) and categorical data as numbers (%).Subjects that had missing data on any variable were not considered for the analysis involving that variable. Data analysis was performed using SPSS version 18.0. About 10% of the questionnaires were double entered to verify accuracy of data entry, and no discrepancies were noted. Prevalence was calculated for each respiratory symptom and for byssinosis. One way ANOVA was used to compare the means of pulmonary lung function tests of the observed value of FEV1 and FVC and the predicted FEV1 and FVC.

Pearson's correlation coefficient was calculated to test the correlation between the severity of byssinosis on cotton dust exposure alone or in combination with other indoor air pollutants during cooking.

Result:

Socio-demographic characteristics: The mean age of the study participants was 25 ±5.15 years, 22% were underweight and about 39% were 50 years or older. The majority (63%) were married. Quarter (23%) of them cannot read or write (Table 1-3). The mean duration of work in the cotton mill house was about 18 years. Most of the participants (95.3%) did not use protective devices at work.

Table 1: Age & anthropometry of the study population

Parameters	Mean ± SD
Age (y)	**25 ±5.15**
Anthropometry	
Weight (kg)	**49.2 ± 13.7**
Height (cm)	**154.2 ± 28.4**
BMI (kg/m2)	**20.99 ± 6.06**

Table 2: BMI Status of the study population

Particulars	N	%
Underweight	**70**	**22.29**
Normal	**194**	**61.90**
Overweight	**43**	**13.72**
Obese	**8**	**2.08**
Total	**315**	**100**

Prevalence of Byssinosis: The overall prevalence of byssinosis in the study population was 41% (table 4). It was higher among workers in the milling department (73%) than those in the other sections (27%). This pattern holds for each grade of byssinosis. A total of 27% workers had byssinosis-type respiratory symptoms (e.g., chest tightness, cough, breathlessness, and difficulty breathing) on day after the weekend break. Another 8 % workers had work-related symptoms on any day of the work week, not necessarily following the weekend break. These symptoms, although closely resembling those of byssinosis, are not typical of byssinosis, in which the symptoms start on the first day of the work week after a break.

Table 3: Socio-demographic data & clinical profile

Socio-Demographic Data		
Parameter		**Percentage (%)**
Marital Status	**Married**	**63**
	Unmarried	**37**
Education	**Primary School (1-5thstd)**	**25**
	Middle School (6-8thstd)	**18**
	High School (9-10th std)	**23**
	PUC/ Diploma	**10**
	Graduate	**0**
	Post Graduate	**0**
	Illiterate	**24**
House	**Pucca**	**20**
	Semi-Pucca	**72**
	Kuccha	**8**
Fuel Used	**Wood**	**37**
	Crop Residues	**0**
	Dung Cakes	**0**
	Coal/Coke/Lignit e	**0**
	Charcoal	**0**
	Kerosene	**15**
	LPG	**48**
Source of Lighting	**Electricity**	**94**
	Kerosene	**4**
	Gas	**2**
	Oil	**0**
Source of Drinking Water	**Piped Water**	**89**
	Ground Water	**5**
	Surface Water	**0**
	Well Water	**6**
Toilet Facility	**Flush Toilet**	**4**
	Pit Toilet	**73**
	None	**23**
Diet	**Veg.**	**14**
	Non-Veg	**84**
	Eggatarian	**2**
Occupation	**Unemployed**	**0**
	Unskilled Worker	**35**
	Skilled Worker	**60**
	Petty Business	**5**
	Secretarial Staff	**0**
	Semi-Professional	**0**
	Professional	**0**
Number of years employed	**<1 year**	**15**
	1-5 years	**33**
	5-10 years	**20**
	>10 years	**32**
Clinical Profile		
Menstrual History	**Normal**	**67**
	Irregular	**17**
	Absent	**16**
	Increased White Discharge	**6**
History of Asthma		**5**
Gastric Problems		**11**
Loss of Appetite		**8**
Irritation in the eye		**6**
Muscular Weakness		**69**
	Body Pain	**28**
	Leg Pain	**26**
	Back Pain	**26**
Other General Problems		**18**
Giddiness		**15**
Numbness		**2**
Grading of exposure	**Moderate (4-6 Hours)**	**2**
	Extreme (6+ Hours)	**98**

Table 4: Lung function tests

Parameter	Mean	Standard Deviation
FVC(Lts.)	1.86	0.45
FEV_1 (Lts.)	1.73	0.46
FEV_1/FVC %	93.46	11.50
PEFR (Lts)	3.51	1.11

Table 5: Prevalence of Byssinosis and grading according to Scilling's [26]

Grading	Symptoms	Number	Percentage
Grade 0	no symptoms of chest tightness or breathlessness on 1st day.	186	59
Grade ½	occasional chest tightness or breathing difficulty on the first day	88	28
Grade 1	chest tightness and/or breathlessness on 1st day only	35	11
Grade 2	chest tightness and/or breathlessness on 1st day along with other weekdays	6	2
Grade 3	Grade 2 symptoms + evidence of permanent impairment in capacity from reduced ventilator defect.	0	0

Table 6: Correlation between LFT and duration

PFT	Duration of work	Mean (lit)	SD	p
FVC	< 5 yrs 5 – 10 yrs > 10 yrs	3.28 2.64 2.46	0.67 0.84 1.14	< 0.001
FEV1	< 5 yrs 5 – 10 yrs > 10 yrs	1.98 2.1 1.69	0.95 0.63 0.68	0.035
FEV_1: FVC Ratio	< 5 yrs 5 – 10 yrs > 10 yrs	60.92 % 82.67 % 75.35 %	27.11 20.27 27.82	0.001
PEFR	< 5 yrs 5 – 10 yrs > 10 yrs	3.0 3.54 3.04	1.58 1.30 1.32	0.184

ANNOVA, p=<0.05

Prevalence of respiratory symptoms: The comparison of PEFR and FEV1/FVC% (table -5) was measured and showed variation among the study population. There was a strong correlation between duration of work, age & respiratory morbidity with lung function (table 6-8). The overall prevalence of respiratory symptoms (Fig 1) in the study participants were - cough (28%), chest tightness (17%) and dyspnoea (18%).The highest proportions of respiratory symptoms were found in

Table 7: Relationship between LFT & age A ANNOVA, p=<0.05

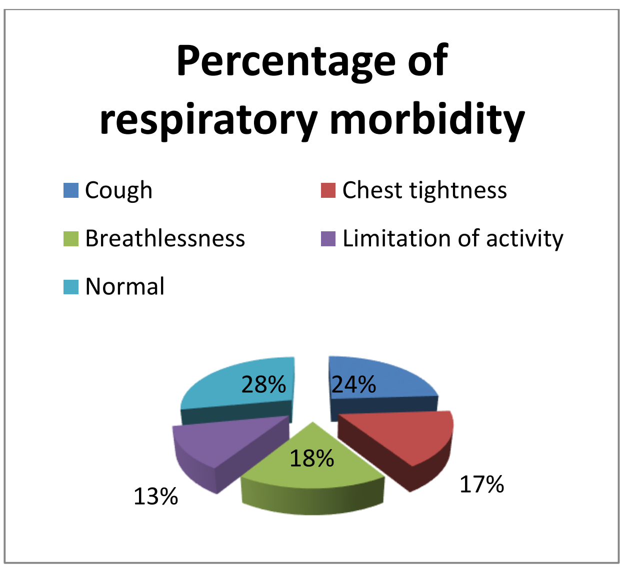
the milling section. After controlling for age, occupational history and using protective devices, workers in these sections were nearly 15 times likely to report phlegm and chest tightness, respectively, compared to those in the other sections.

Table 8: Relationship between duration of working and respiratory morbidity

Work duration	Abnormal Spirometry			Total
	Absent	Obstructive	Restrictive	
< 5 yrs	30 (19.86)	75 (49.66)	46 (30.46)	151 (100%)
5 – 10 yrs	17 (26.98)	28 (77.77)	18 (28.57)	63 (100%)
> 10 yrs	57 (56.43)	20 (19.80)	24 (23.76)	101 (100%)
Total	104 (33%)	123 (39%)	88 (28%)	315

n = 315, Chi sq= 9.02, p = 0.001

Figure 1: Clinical respiratory profile



We also found that that the usage of cooking fuels by these the women were different i.e biomass fuels users(52%) & gas users(38%) & mixed

	Age groups	Mean (lit)	SD	P
FVC	18 – 35 yrs 36 – 45 yrs > 45 yrs	3.12 2.51 2.01	0.72 1.30 0.63	< 0.001
FEV1	18 – 35 yrs 36 – 45 yrs > 45 yrs	2.17 1.64 1.30	0.63 0.54 0.43	< 0.001
FEV1:FVC Ratio	18 – 35 yrs 36 – 45 yrs > 45 yrs	72.82 % 63.0 % 68.14 %	20.52 25.62 20.89	0.89
PEFR	18 – 35 yrs 36 – 45 yrs > 45 yrs	2.61 2.53 2.80	1.11 1.10 1.35	0.10

users(10%). PEFR distribution of these 315 subjects showed that a significant association in the severity of disease between cotton dusts, biomass users ($p<0.05$). Also exposure to cotton dust is associated with statistically significant fall in FVC, FEVl and PEFR

Discussion:

The term Byssinosis is generally applied to one or more acute respiratory symptoms associated with the cotton dust, flax, and hemp dust in the workplace[18]. Though cotton dust has been established as the causative agent for byssinosis, it was important to determine the other risk factors associated with the occurrence of the disease in women who are also exposed to biomass fuel gases while cooking so as to implement comprehensive preventive measures.

This study firstly says that that there is 41% prevalence of byssinosis in women working in cotton mill in south India. It is in concordance to the other studies showing a prevalence rate of 8 - 50% in various part of the continent. Next, there was a strong association of abnormal PEFR and indoor air pollution caused due to domestic cooking fuels. Associated risk factors like In a study from Kanpur, only dustiness and length of exposure were important contributory factors to the occurrence of byssinosis[22]. The risk of byssinosis among workers in the card room, blow room and waste plant sections and those who had an exposure of >5 years was nearly 3 times higher compared to workers in other sections of the mill and/or those with <5 years of exposure[26-29].

Few studies in women working in ginning factory have shown, pulmonary abnormalities as well as respiratory symptoms are high in women. Here both acute and chronic abnormalities were reported which shows both the long term and the short term effects of cotton dust on lungs.

The type of cooking device used also is significant as far as indoor air pollution is concerned. Commonly, four types of cooking devices are available throughout this country[30]. These include (1) kerosene stove (wick type or pressure type); (2) coal-lighted "angithi;" (3) gas stove operated by liquified petroleum gas (LPG); and (4) "chulla" in which biomass fuels (dried dung, crop residues, and agricultural wastes) are used. The amount of indoor air pollution or morbidity and mortality produced by these fuels has been documented [31]. It is well established that all types of cooking fuels produce respiratory irritants such as oxides of nitrogen, sulphur dioxide, and unburnt hydrocarbons. These soot particles that are generated more with fire wood cooking Chula are probably more hazardous in causing changes of chronic bronchitis as well as airways obstruction. Studies in India have reported varied frequencies of 2 -50 % of chronic bronchitis in the rural non smoking women[32-34]. These studies have not paid attention if these were only because of indoor pollutants or is any influence of other dust particles Our present study shows an high prevalence of byssinosis in women who are exposed to the combination of pollutants. Cough, has been associated with the respiratory impairments.

Pollution and cotton dust exposure presents the possibility of serious misclassification of exposure, and very little information is available to quantify the relationships between exposure level and risk. Though this study shows some association, measurement of pollutant index is very crucial. This has important implications for assessing the health impact of exposure levels in various populations, as well as in estimating the potential health gains that might result from reducing exposure by different amounts

Conclusion: Byssinosis continues to be prevalent in women working in cotton mills who work without any masks. Exposure to domestic cooking fuels produced a significant amount of respiratory morbidity. Use of smokeless devices, provision of adequate ventilation, masks to prevent inhalation of dust might be helpful to prevent some of these effects.

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