Pulmonary function of jute mill workers from West Bengal, India

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ABSTRACT

Background: Jute industry workers constantly exposed themselves to jute dust and are at risk of impairment of lung function. Investigation on various studies revealed the effects of exposure to jute dust but limited studies so far undertaken regarding its bearing on pulmonary function of jute workers of West Bengal,India.

Purpose: To evaluate the respiratory status of jute mill workers of West Bengal exposed to occupational hazards.

Materials and Methods: This cross sectional study was conducted on 203 male jute mill workers of age range 18 – 60 yrs. from West Bengal and a control group of 141 men of similar age .Dynamic pulmonary function parameters were carried out including physical parameters, respiratory abnormalities, year of exposure and smoking history.

Results: FVC, FEV_1, $FEF_{200-1200}$ and PEFR values of higher age group non smoker of low dust zone were significantly higher in comparison to the non smoker of high dust zone. The prevalence of chest tightness was 33.49% and liver dysfunction was 41.9% in dusty zone workers of jute mill in comparison to less dusty zone. Again, incidence of chest tightness and cough was highest (35.44%) in higher age group workers and prevalence of byssinosis like symptoms and chronic bronchitis was 30- 37% after 10 – 30years of exposure. But occurrence of bronchial asthma was 11.9% in workers of greater than 20 years of exposure. Prevalence of all the above respiratory abnormalities was higher among smokers than non-smokers.

Conclusions: Concentration of jute dust exposure had been associated with decrease in FVC, FEV_1, and PEFR with a higher risk of developing chronic bronchitis, bronchial asthma, byssinosis and other respiratory symptoms. This indicated high occupational health hazards which would create an alarming situation, if remained unchecked.

Key words: Pulmonary function, jute workers, restrictive/obstructive, respiratory symptoms, odds ratio

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INTRODUCTION

Occupational health hazards have been a cause of concern for the workers engaged in industries. It is a fact that industrial dusts are known to cause an increased morbidity and mortality among exposed population all over the world [1]. Increased risk of chronic non-specific disease including asthma has been found in a number of occupations. The relative risk of chronic non-specific lung disease incidence from the Zutphen (Holland) study [2] indicates a higher value of relative risk factor in textiles and tailors, including Jute, hemp, etc. West Bengal is a major Jute producing state and jute industries present in this state form a vital part in its developmental work. As such a segment of population of West Bengal who are engaged in this industry renders real benefit by their continuous top performance thereupon. This entails the necessity of maintaining a favourable health conditions of workers for the prospect of such industry. Inhalation of jute dust and fibres and deposition of it in the alveoli can cause respiratory impairment after a long period of exposure. The symptoms are shortness of breath, chest pain, later bronchitis with increased sputum. Occurrence of respiratory disease increased significantly in developed countries; it is still present in developing ones [3]. In West Bengal, attempts have been made to study the manifestation of byssinosis [4].Here the occupational lung disease caused by jute, cotton dust in inadequately ventilated working environment among jute workers has created major problems, particularly in respect of health hazards of the workers. This problem requires to be looked into for combating the related diseases and consequent remedies there upon. The present study has, therefore, been conducted to evaluate the risk factors enjoined in such occupation, to investigate the magnitude of pulmonary function of jute mill workers and finally to suggest the betterment of health and efficiency of such workers.

MATERIALS AND METHODS

Subjects

The Jute workers (n=203) were divided into two age groups-18-35 yrs. and 36- 60 yrs. Year of Jute fibre exposure, smoking habit, duration of smoking, gross income, family history of respiratory diseases were also recorded before starting experiment. The control group of subjects (n=129) were selected from office workers, school and college employees, having no respiratory diseases. Age was recorded from their office register, smoking habits and year of smoking were recorded by questionnaire. Before starting any experiment individual consent was taken from each subject and approval from employer was also taken. The research design was approved by Institutional Ethical Committee of our Institute.

This cross-sectional study was conducted during June-August, 2009 in a jute mill located at Budgbudge area of West Bengal. Myself and a group of experienced research scholars conducted this study and collected data. The subjects were taken from their departments with the help of the management, and study was conducted in their medical room within the factory premises. The study population consisted of 203 men workers selected randomly from a total of 800 workers concerned with dusty and non-dusty sections in the Batching, Carding, Spinning, Weaving, Packing, Cleaning, etc.

Pulmonary Function Tests

Forced vital capacity (FVC) and Forced Expiratory Volume in 1 sec (FEV_1), FEV_1%, Forced Expiratory Flow in 200-1200ml, $FEF_{25-75\%}$, $FEF_{75-85\%}$, were measured by Spirometer (Spirovit SP1 model) in the daytime between 11 A.M and 5 PM. Data regarding the participant(e.g age and height) were fed into the machine. The machine had a built-in formula to calculate the normal values of FEV_1 and FVC as per details entered into it according to Indian standard formulae for men. The participant was taught how to perform the test and then asked to perform it thrice. The maximum of the three tests was used to obtain the final evaluation of the participants' lung function. After calculation, the machine in the form of printed graphs – normal, obstructive, restrictive and combined, provided any 4 patterns. The calculated value was then converted into BTPS by multiplying this value into BTPS factor. Peak Expiratory Flow Rate (PEFR) was measured by Wright's Peak Flow Meter. All the measurements were taken on the subject in standing upright position with the nose clip [5]. Three respiratory efforts were recorded, and the highest value was used as lung function parameters. A modified questionnaire [6] was used for the respiratory symptoms by interview method. Emphasis was given on enquiry regarding occurrence of chest tightness, wheezing, cough and phlegm appearing in them and the frequency of occurrence; day of occurrence, duration and relationship with work were recorded. Age was recorded from factory record. Besides, body mass was recorded by standard weighing machine without shoes, body height was recorded by standard procedure without shoes, and BMI was calculated from body mass/(height in m)^2. Chest Tightness- tightness or constriction of the chest appeared at any time during the work shift and on any workday, specifically on the first day of the working

Table 1.Air-borne concentration of Jute dust in the work-environment of the Jute factory

Serial No	Location/Operation	Measured Concentration of Jute dust mg/m^3	Permissible limit mg/m^3 International National(Chen etal,1997 and ACGIH,2008)
1	Selection and Spreading Department (Batching)	5.1	10
2	Softner (Batching)	0.6	10
3	Breaker Card (Batching)	1.3	10
4	Wrap Winding (Spinning)	2.4	10
5	Twisting	0.5	10
6	Beaming	0.7	10
7	Weaving	0.2	10

week (byssinosis) Chronic bronchitis- sputum production occurred at least 5 days a week for a minimum of three months a year for at least two consecutive years. Chronic cough- cough without sputum occurred at least five days a week for a minimum of three months a year. Obstructive ventilatory defect was indicated if -[{ for at least two consecutive years. Restrictive ventilatory defect was indicated if [{FVC /predicted FVC}X100%] was smaller than 80%.FEV_1/FVC)}X100%] was smaller than 70%. If both the above conditions were satisfied it was called Combined ventilatory defect.

Environmental Study

The concentration of airborne respirable Jute dust of different sections of the mill was taken from a recent environmental pollution report (2008) of the industry (Table 1), and it was found that all the departments had airborne dust concentration within a permissible limits which was10mg/m^3 [7]

Statistical analysis

Mean, standard deviation and Pearson's product-moment correlation between parameters were analysed. Student '*t*' tests were performed to compare the mean between groups after performing the normality test by histogram, b1, b2 method and Q-Q Plot method. Odds ratio (OR) and 95% confidence intervals were calculated for prevalence of respiratory diseases (dependant variable) among smoker/ non smoker and OR compared the odds of exposure to jute dust of different level of the year of exposure(<10 years/10-19 yrs/>20 years) [8].

RESULTS

Table 1 represented the total dust concentration in different sections of jute mill. It was 5.1mg/m3 in batching whereas spinning, twisting, beaming and weaving was in between 2.4-0.7mg/m^3. Except batching (high dust zone), all other departments were considered as low dust zone. This study was undertaken in June –July 2009.The pollution report was followed as per International standard [7] but at present recent Central Pollution Control Board's (CPCB) recommendation for permissible limit of jute dust in our country is 100µg/m^3(0.1mg/m^3) [9]. Among 203 jute workers, 62.06% were from high dust departments, and 38% were from low dust departments. Out of the dusty or hazardous departments workers 25.39% were smoker, and the same was 25.97% in non-hazardous department's workers. Besides the above, there were 203 workers of which 121 were of higher age group, and 82 were of lower age group. Table 2 represented mean ± SD values of Pulmonary functions of jute mill workers as well as control group. All the pulmonary function values of jute workers were significantly ($p<0.05$-0.001) lower than control group.

Table 2. Mean ± SD values of different physical parameters and pulmonary functions of Jute workers and control group.

	JUTE MILL						CONTROL					
	Lower Age Group			Higher Age Group			Lower Age Group			Higher Age Group		
	(All) (n=82)	S (n=10)	NS (n=72)	(All) (n=121)	S (n=42)	NS (n=79)	All (n=60)	S (n=21)	NS (n=39)	All (n=81)	S (n=26)	NS (n=55)
Age (yr)	27.39 ±4.85 ***	26.4 ±5.6	27.53 ±4.76	47.96 ±7.02	48.0 ±5.41	47.94 ±7.77	24.9 ±6.06	26.76 ±6.36	23.90 ±5.72	47.83 ±7.30	47.73 ±7.76	47.87 ±7.14
Height (cm)	162.88 ±5.94 ****	163.76 ±5.28 *	162.75 ±6.06	161.11 ±15.61 ***	164.18 ± 6.19	159.48 ±18.63 **	168.43 ±5.95	168.40 ±5.97	168.46 ±6.02	166.40 ±7.35	166.50 ±6.89	166.33 ± 7.62
Bodymass (kg)	57.98 ±9.46 ***	58.6 ±8.04	57.90 ±9.69	60.83 ±10.13 ****	60.19 ±9.72 ***	61.16 ±10.38 ***	62.70 ±10.76	63.80 ±12.17	62.13 ±10.03	67.10 ±10.58	67.60 ±11.23	66.90 ±10.35
BMI (kg/m^2)	21.85 ±3.39	21.9 ±3.22	21.84 ±3.44	23.05 ±4.22	22.37 ±3.52	23.43 ±4.54	22.10 ±3.65	22.48 ±4.06	21.89 ±3.44	24.21 ±3.18	24.29 ±2.9	24.17 ±3.33
FVC (L)	3.12 ±0.59 ****	3.17 ±0.48 ****	3.12 ±0.60	3.11 ±0.83 ****	3.03 ±0.63 ****	3.15 ±0.92	4.30 ±0.61	4.19 ±0.45	4.35 ±0.67	3.69 ±0.61	3.70 ±0.61	3.68 ±0.62
FEV_1 (L)	2.68 ±0.62 ****	2.79 ±0.46	2.67 ±0.64 ****	2.58 ±0.67 ****	2.52 ±0.61 ****	2.61 ±0.70 ****	3.91 ±0.64	3.82 ±0.53	3.96 ±0.70	3.17 ±0.56	3.12 ±0.58	3.20± 0.56
FEV_1%	85.76 ±10.9 ***	87.95 ±6.04	85.46 ±11.45 ***	83.20 ±10.98 *	82.81 ±10.21	83.40 ±11.43 *	90.98 ±6.31	90.96 ±5.45	90.99 ±6.8	86.09 ±6.93	84.33 ±7.8	86.92 ±6.39
$FEF_{200-1200}$ (L/min)	4.62 ±1.61 ****	5.20 ±1.20	4.54 ±1.65 ****	4.69 ±1.94 ****	4.36 ±1.90 ****	4.87 ±1.96 ****	7.44 ±1.98	7.44 ±1.84	7.45 ±2.08	6.94 ±1.89	6.65 ±1.94	7.09 ±1.87
$FEF_{25-75\%}$ (L/min)	3.15 ±1.19 ****	3.23 ±0.93	3.13 ±1.22 ****	2.89 ±1.20 ****	2.78 ±1.19 **	2.95 ±1.20 ****	5.04 ±1.34	4.92 ±1.2	5.11 ±1.42	3.80 ±1.27	3.54 ±1.16	3.93 ±1.31
$FEF_{75-85\%}$ (L/min)	1.47 ±0.72 ****	1.41 ±0.50	1.48 ±0.75 ****	1.10 ±0.50 ***	1.07 ±0.51	1.12 ±0.50 ***	2.34 ±0.98	2.16 ±1.04	2.43 ±0.95	1.33 ±0.62	1.20 ±0.48	1.39 ±0.67
PEFR (L/min)	442.80 ±96.30 ****	465.00 ±47.90	439.72 ±101.0 ****	432.89 ±94.53 ****	425.95 ±97.56 ****	436.58 ±93.30 ****	530.50 ±59.96	533.33 ±57.13	528.97 ±62.10	517.04 ±59.13	511.15 ±54.14	519.82 ±61.63

*p<0.05,**p<0.02,***p<0.01,****p<0.001 S= smoker, NS= non-smoker

Table 3 represents comparison of pulmonary functions of high and low dust exposure of lower and higher age group jute workers. It was found that in lower age group workers FVC, $FEV_{1,}$ $FEF_{200-1200}$,$FEF_{25-75\%}$ and PEFR values of high dust zone were significantly (p<0.001) lower in comparison to low dust exposed group. But in case of smoker lower age group workers only FVC and FEV_1 values of high dust zone was significantly (P<0.05-0.02) lower than low dust zone but FVC ,FEV_1, $FEF_{200-1200}$, FEF_{25-75}, FEF_{75-85} and PEFR values of high dust exposed non-smoker workers of lower age group were significantly (p<0.05- 0.001) lower than low dust exposed non-smoker workers. In case of higher age group workers except $FEV_{1\%,}$ all the pulmonary function values were significantly (p<0.01-0.001) higher in low dust exposure than high dust exposed group. All the pulmonary function values except $FEV_{1\%}$ and $F_{75-85\%}$ of smoker higher age group workers of high dust zone were significantly (p<0.01-0.001) lower than smokers of low dust zone. Only FVC,FEV_1,$FEF_{200-1200}$ and PEFR values of higher age group non-smoker of lower dust zone were significantly (p<0.01-0.001) higher in comparison to the non-smoker of high dust zone.

Table 3. Mean ± SD values of different physical parameters and pulmonary functions of Jute Mill workers of Low and High dust exposure.

	Lower age group						**Higher age group**					
	High Dust			**Low Dust**			**High Dust**			**Low Dust**		
	All (n=49)	S (n=5)	NS (n=44)	All (n=33)	S (n=5)	NS (n=28)	All (n=77)	S (n=27)	NS (n=50)	All (n=44)	S (n=15)	NS (n=29)
Age (yr)	27.57 ±4.77	26.60 ±7.54	27.68 ±4.47	27.12 ±5.03	26.20 ±3.70	27.29 ±5.27	46.45 ±7.08 ***	47.41 ±5.20	45.94 ±7.89 ***	50.59 ±6.15	49.07 ±5.80	51.38 ±6.27
Body mass (kg)	57.59 ±9.49	60.70 ±9.58	57.24 ±9.53	58.56 ±9.53	56.50 ±6.55	58.93 ±10.02	60.78 ±9.84	60.18 ±9.42	61.10 ±10.13	60.91 ±10.74	60.20 ±10.58	61.30 ±10.98
Height (cm)	162.75 ±5.66	165.20 ±5.88	162.42 ±5.6	163.06 ±6.43	161.8 ±4.30	163.29 ±6.78	164.22 ±6.49 ***	165.99 ±5.70 ***	163.27 ±6.74	159.99 ±10.41	160.92 ±5.85	159.51 ±12.19
BMI (kg/m^2)	21.70 ±3.15	22.15 ±3.67	21.64 ±3.13	22.07 ±3.77	21.65 ±3.10	22.15 ±3.92	22.53 ±3.21	21.86 ±3.13	22.89 ±3.22	24.05 ±5.50	23.27 ±4.08	24.46 ±6.14
FVC (L)	2.79 ±0.46 ****	2.83 ±0.42 **	2.79 ±0.46 ****	3.60 ±0.40	3.51 ±0.25	3.62 ±0.42	2.69 ±0.48 ****	2.67 ±0.42 ****	2.71 ±0.51 ****	3.88 ±0.82	3.69 ±0.33	3.91 ±0.98
FEV_1 (L)	2.40 ±0.51 ****	2.51 ±0.44 *	2.3 ±0.52 ****	3.11 ±0.50	3.07 ±0.28	3.11 ±0.55	2.27 ±0.54 ****	2.19 ±0.45 ****	2.31 ±0.58 ****	3.12 ±0.52	3.11 ±0.35	3.12 ±0.59
FEV_1%	85.32 ±10.54	88.26 ±7.55	84.98 ±10.84	86.43 ±11.64	87.64 ±4.99	86.21 ±12.51	83.66 ±11.66	82.02 ±11.34	84.55 ±11.84	82.38 ±9.76	84.24 ±7.92	81.42 ±10.59
$FEF_{200-1200}$ (L/min)	4.15 ±1.50 ****	4.57 ±1.03	4.10 ±1.54 ***	5.33 ±1.54	5.83 ±1.08	5.24 ±1.60	4.11 ±1.84 ****	3.57 ±1.58 ****	4.40 ±1.92 ***	5.75 ±1.69	5.77 ±1.62	5.70 ±1.76
$FEF_{25-75\%}$ (L/min)	2.71 ±1.07 ****	2.97 ±0.94	2.68 ±1.09 ****	3.80 ±1.06	3.50 ±0.94	3.85 ±1.08	2.67 ±1.20 ***	2.37 ±1.01 ***	2.83 ±1.27	3.28 ±1.11	3.52 ±1.16	3.15 ±1.08
$FEF_{75-85\%}$ (L/min)	1.34 ±0.75 *	1.36 ±0.66	1.34 ±0.77 *	1.67 ±0.64	1.47 ±0.36	1.71 ±0.67	1.03 ±0.46 *	0.96 ±0.44	1.07 ±0.47	1.23 ±0.55	1.26 ±0.59	1.21 ±0.54
PEFR (L/min)	414.49 ±98.53 ****	462 ±53.1	409.09 ±101.4 ****	484.85 ±76.49	468 ±48.17	487.86 ±80.80	407.14 ±93.38 ****	384.07 ±84.55 ****	419.60 ±96.34 *	477.95 ±79.15	501.33 ±71.60	465.86 ±81.26
Exposure (yr)	7.46 ±3.84	6.7 ±5.24	7.55 ±3.71	6.14 ±4.23	5.80 ±4.44	6.20 ±4.27	24.03 ±9.83	24.52 ±9.71	23.77 ±9.98	28.88 ±9.53	27.77 ±7.5	39.79 ±56.93

*p<0.05,**p<0.02,***p<0.01,****p<0.001 S= smoker, NS= non-smoker

Table 4 represents the correlation between pulmonary functions and duration of jute dust exposure of high and low age group workers. In most cases the relationship were insignificant and negative except FVC and FEV_1 of smoker of lower age group high dust zone and $FEF_{200-1200}$ of low dust zone and $FEF_{75-85\%}$ of non-smoker higher age group of high dust zone where the relationships were significant (p<0.05-0.02).

Table 4. Correlation between pulmonary function parameters with year of exposure to air borne dust to workers of high and low exposure.

Duration of Exposure					
		Lower Age Group		Higher Age Group	
		High Dust Zone	Low Dust Zone	High Dust Zone	Low Dust Zone
No. examined	NS	44	28	50	29
	S	5	5	27	15
FVC	NS	0.26	0.27	-0.13	0.09
	S	-0.91*	-0.65	0.20	0.41
FEV_1	NS	0.12	0.11	0.02	0.18
	S	-0.91*	-0.73	0.10	0.39
FEV_1%	NS	-0.12	-0.10	0.18	0.01
	S	-0.50	-0.33	-0.07	0.10
$FEF_{200-1200}$	NS	0.02	0.23	-0.02	0.28
	S	-0.86	-0.88*	0.18	-0.12
$FEF_{25\%-75\%}$	NS	-0.003	-0.06	0.10	0.10
	S	-0.73	-0.59	0.09	0.18
$FEF_{75\%-85\%}$	NS	0.08	-0.25	0.34**	-0.06
	S	-0.56	-0.41	-0.04	0.09
PEFR	NS	-0.15	-0.32	0.03	0.19
	S	-0.63	-0.48	-0.14	0.10

S=Smokers, NS=Non- Smokers; *p<0.05;**p<0.02

Table 5 represented the adjusted and crude OR of respiratory symptoms (dependent variable) on the basis of age, BMI, smoking habit, dust concentration and year of dust exposure(independent variables).It was found that in case of smoking habit and year of dust exposure, adjusted odds ratio values were much higher than crude odds ratio. Thus it indicated that smoking and duration of jute dust exposure were the main causative factors for byssinosis like symptoms of jute workers of present study.

Table-5: Odds ratio and 95% confidence interval by smoking habit and duration of exposure with byssinosis like symptoms at the multivariate level by adjusting age, BMI and dust concentration

Characteristics	**Crude OR**	**95% CI**	**Adjusted OR**	**95% CI**
Smoking habit				
Non-smoker	-	-	-	-
Smoker	1.73	0.90 - 3.31	2.254	1.263- 4.02
Duration of dust exposure				
<10 yrs	-	-	-	-
10-19 yrs	0.74	0.31- 1.71	2.13	0.998-4.55
>20 yrs	1.41	0.74-2.68	2.262	0.9-5.69

OR=Odds ratio, CI= Confidence interval

Table 6 represented the logistic regression equations of prevalence of respiratory symptoms. From the analysis of logistic regression equation and association of age, BMI ,dust concentration ,smoking habit and year of exposure with byssinosis like symptoms and chronic bronchitis at the multivariate level, it was found that both the smoking habit of the workers (p=0.006) and year of exposure to jute dust (p=0.051) were significantly associated with byssinosis like symptoms. Only smoking habit was significantly associated with chronic bronchitis.

Table 6. Logistic regression model for respiratory symptoms.

Variables	Coefficient	SE	P value	Adjusted OR	95% confidence interval	
					Lower	Upper
Byssinosis like symptoms						
Age	-0.002	0.017	0.894	0.998	0.964	1.032
BMI	-0.002	0.036	0.957	0.998	0.931	1.070
Smoking habit	0.813	0.295	0.006*	2.254	1.263	4.022
Dust Conc.	-0.021	0.273	0.939	0.979	0.574	1.672
Duration of exposure						
>20 yrs	0.816	0.470	0.083	2.262	0.900	5.687
10-19 yrs	0.757	0.387	0.051*	2.131	0.998	4.553
constant	-1.128	0.922				
Chronic bronchitis						
Age	0.006	0.019	0.738	1.006	0.970	1.044
BMI	-0.007	0.038	0.847	0.993	0.922	1.069
Smoking habit	0.852	0.304	0.005*	2.344	1.291	4.258
Dust Conc.	-0.340	0.290	0.241	0.712	0.403	1.257
Duration of exposure						
>20 yrs	0.388	0.494	0.432	1.474	0.560	3.880
10-19 yrs	-0.289	0.438	0.508	0.749	0.318	1.765
constant	-1.160	0.972				

*significant at $p<0.05$

Table 7 represented prevalence of byssinosis like symptoms, chronic bronchitis and bronchial asthma of workers in different departments of jute mill and it was found that occurrence of all the above respiratory abnormalities were highest in batching in comparison to weaving and winding sections, because in all the departments of jute mill, airborne dust concentration was greatly in excess of 0.2mg/m^3 of dust which was the threshold limit value recommended for cotton/jute dust by OSHA (Occupational Safety and health act of USA) and this threshold limit value recommended by health and safety guideline of the UK was 0.5mg/m^3. OR value was high and significant in batching department (high dust zone) in comparison to spinning, weaving, winding and others i.e. high dust concentration could produce four times risk in developing byssinosis like symptoms.

Table 7. Prevalence of Byssinosis, Chronic bronchitis and Bronchial asthma among workers exposed to Jute dust in different departments of Jute mill with Odds ratio and 95%Confidence interval.

Departments	No. Examined	Byssinosis like symptoms				Chronic Bronchitis				Bronchial Asthma			
		No	(%)	OR	CI	No	(%)	OR	CI	No	(%)	OR	CI
Batching	77	39	50.65	4.36	1.34-14.16	33	42.86	1.88	0.66-5.35	12	15.58	3.69	0.45-30.17
Winding /Spinning	46	12	26.09	1.5	0.42-5.36	11	23.91	0.79	0.25-2.52	2	4.35	0.91	0.08-10.62
Weaving	59	12	20.34	1.09	0.31-.82	9	15.25	0.45	0.14-1.47	3	5.08	1.07	0.11-10.90
Others	21	4	19.05	1.0	-	6	28.57	1.0	-	1	4.76	1.0	-
Total	203	67				59				18			

OR=Odds ratio, CI= Confidence interval

Figure 1 and 2 represented results of prevalence of Chest tightness and cough, pain in different parts of the body, liver dysfunction and skin problem of higher and lower age group. Here it was found that prevalence of chest tightness and cough was highest in higher age group (35.44%) but prevalence of liver dysfunction and pain in different parts of the body was higher in lower age group.

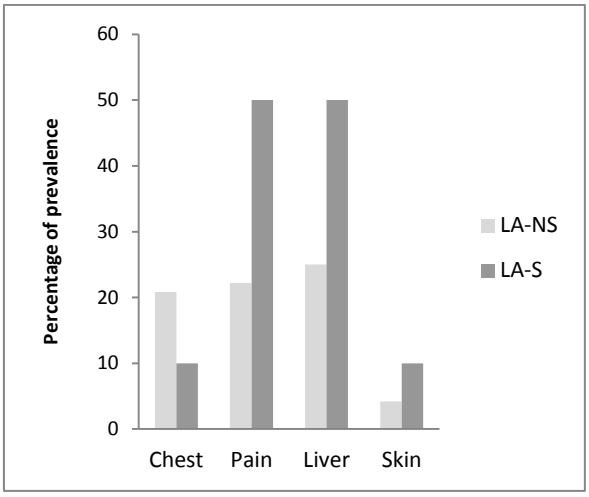

Figure 1. Prevalence of chest tightness, pain, liver dysfunction and skin irritation of lower age group smoker and non-smoker Jute workers from West Bengal LA-NS=Lower Age Group-Non Smoker; LA-S=Lower Age Group Smoker.

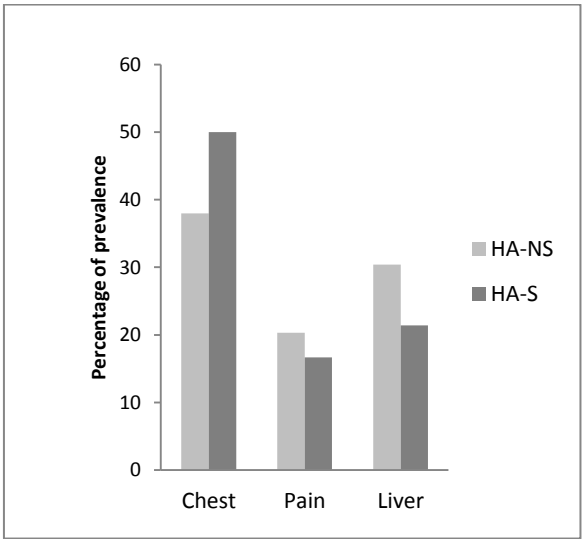

Figure 2. Prevalence of chest tightness, pain, liver dysfunction and skin irritation of higher age group smoker and non-smoker jute workers from West Bengal HA-NS=Higher Age Group-Non Smoker; HA-S=Higher Age Group Smoker.

Figure 3 and 4 represented prevalence of chest tightness, pain, liver and skin problem in both dusty and non-dusty areas of jute mill. It was observed that prevalence of chest tightness (33.33 %) and liver dysfunction (42.7%) was higher in dusty zone workers of jute mill in comparison to less dusty zone (32.47% and31.17% respectively).

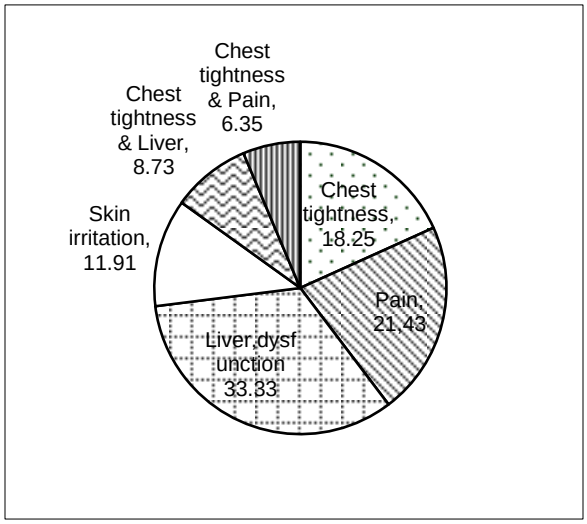

Figure 3. Prevalence of chest tightness, pain, liver dysfunction and skin irritation of Jute workers of Hazardous

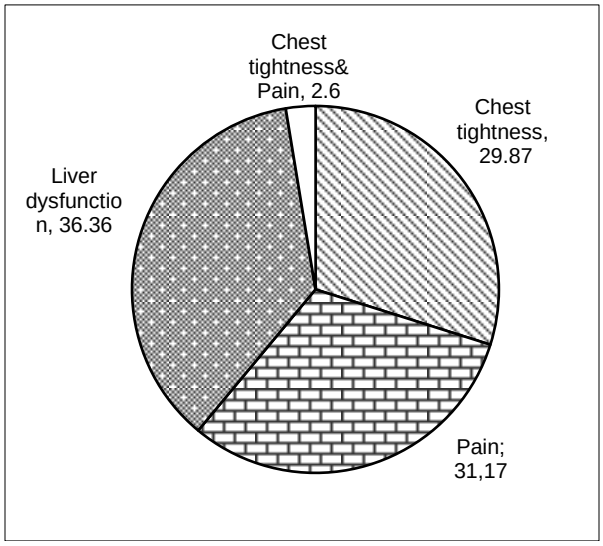

Figure 4. Prevalence of chest tightness, pain,liver dysfunction and skin irritation of Jute workers of Non-Hazardous zone

DISCUSSION

From the above results it was found that 50.65% workers of Batching, 26.09% from spinning and 20.34% from weaving had been suffering from byssinosis and 43%, 24%, and 15% of the respective departments mentioned above had been reported chronic bronchitis but 16%,4% and 5% of the respective departments documented bronchial asthma which corroborated with other developing countries where a rate of 30-50% has been reported [3,10 - 13]. Whereas in United States occurrence (%) of byssinosis in card room was 11% reported by Bouhuys et al. [14] and Merchant et al [15] reported the same as 26%. Besides, Cinkotai et al. [16] reported 10% prevalence of byssinosis in card room, 3% in Spinning and 3% in winding in United Kingdom. This differences in respective findings might be due to permissible concentration of jute dust which was 0.2mg/m^3 recommended in 1983 by ACGIH (American Conference Of Governmental Industrial Hygienist) [17] where as this permissible limit was 10 mg/m3 in China and other developing countries like India before 2009 [7].

In the present study chest compression and chest tightness and cough were found in higher age group workers (35.44%) in comparison to lower age group workers (25.96%) which corroborated with the study of Pakistani spinning and Textile workers (39.53%) [10]. Besides, 30-37% workers of present study exposed to 5-20 yrs. of jute dust experience byssinosis like symptoms, which was similar to the findings of Pakistani spinning and textile industry workers. It was not supported by Irfan et al. [18]. They stated that byssinosis was rare within 5 yrs. of exposure and usually required a period of dust exposure between 20-25 years because of modernization and mechanization of spinning mill with modern health friendly machines [10].

In our study, no significant correlation had been found between a year of exposure to jute dust with the pulmonary function parameters, but high prevalence of byssinosis was found in batching section. In case of Pakistani Spinning and Textile workers [10] high prevalence of byssinosis was in spinning as well as in dyeing sections of the mill. These results might be due to fewer numbers of subjects in weaving and winding sections in our study in comparison to other sections [10]. Besides ,maintenance of temperature and humidity was another factor for occurrence of byssinosis. Rise of temperature helped to float the dust particle but humidity counterbalance the same by settling down the dust that became heavy and hinder the entry of these dust particles into the airway of workers [18].

In the present study occurrence of respiratory abnormalities like, chest tightness, bronchial asthma were higher in the smoker group of jute workers which was supported by Wang et al [19], Mishra et al. [20]; Barawidjaja [11], Su et al. [21] but it did not corroborate with the study of Memon et al. [10] at the multivariate level when we adjusted for other factors than the univariate level. This might be due to the difference in sampling methodology [10], varying definition of disease [20]and type of raw jute processed [22]. On the basis of pulmonary function test, out of 82 workers 20(24.4%) lower age group workers showed restrictive pattern, 2(2.4%) had obstructive and 2(2.4%) gave the combined patterns of respiratory abnormalities, whereas out of 121 higher age group workers 35(29%) showed restrictive,4(3.3%) gave combined and obstructive pattern of respiratory abnormalities. This higher incidence of restrictive lung disease indicated that workers of present study were byssinotic [18].

In this study from logistic regression analysis, both smoking habit and year of dust exposure were found to be predictors of byssinotic like symptoms where smoking was the only predictor of chronic bronchitis. A majority of researchers in this area had shown that smoking habit and duration of work and exposure were associated with byssinosis [11,19,20,21,23]. However, contrary report showed no association of byssinosis with smoking habit and year of jute dust exposure by Altin et al. [3], Memon et al. [10], Raza et al. [24], Simpson et al. [25], Massin et al. [26]. Chen et al. (7) stated that smoking interacted with dust exposure was causing a decline in %FEV1. They also pointed out that jute dust exposure was a main cause of pulmonary function injury, and smoking helped in increasing this effect.

Our findings suggested that high concentration of jute dust exposure had been associated with decrease in FVC, FEV_1, and PEFR with a higher risk of developing chronic bronchitis, bronchial asthma, byssinosis and other respiratory symptoms. This indicated high occupational health hazards. Again, smoking was another etiological factor in respiratory system injury along with dust (10 mg/m^3) which was much higher than the said permissible limit of developed countries (0.2 mg/m^3) like USA, UK, Australia. Exposure to high dust in working environment, which would decrease the pulmonary function parameters of workers would be creating an alarming situation, if remained unchecked.

This baseline information regarding pulmonary function parameters of jute workers of West Bengal would be utilized to aid the development of a regional occupational health

database for use in local regulation and for intervention to develop safe and healthy working condition of jute mill workers. Therefore, we recommend:

1. Regular environmental monitoring to maintain dust concentration below 0.1mg/m^3 has been suggested.
2. Regular health check up and health awareness and education of workers.
3. Use of safety equipments.
4. Application of work rest cycle depending on the work load and prevention of overtime work.
5. Rotation from high dust to low dust departments etc.
6. Restriction of smoking within factory premises.

Conflicts of interest

The authors declared no conflicts of interest.

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