EXPOSURE ASSESSMENT FOR PREVALENCE OF LUNG RELATED DISEASES IN COTTON OPERATIVES (GINNERS)

H. Chaudhry, M. Ijaz, M. Saeed, A. Tahir, Z. Ahmad*, N. Nisar, Z. Asghar, S. Atif, F. Aslam and N. Ghani

Department of Environmental Science, Lahore College for Women University, Lahore
*College of Earth and Environmental Sciences, University of the Punjab, Lahore 54590, Pakistan
Corresponding author's email: hinachaudhry.env@hotmail.com

ABSTRACT: This study was conducted on exposure assessment for the prevalence of lung related diseases in cotton ginners. The study included 75 subjects in the age groups of 15–65 years from similar socio-economic status. Fifty subjects were exposed to cotton dust, while 25 were not exposed. The pulmonary function test, peak expiratory flow rate (PEFR) was performed to diagnose the presence of any lung related disorder. The decrease in PEFR showed an obstructive impairment. PEFR values of exposed subjects (M = 272.80 SD = 95.94) were compared with the unexposed subjects (M = 545.00 SD = 101.55). The difference between the two groups was significant, t(df) = -11.360, p = 0.000. The main results revealed that the subjects exposed to cotton dust had more respiratory disorders than unexposed subjects ($p<0.01$). The prevalence of chronic bronchitis, occupational asthma, inhalation fever, chronic obstructive pulmonary diseases and cough were 42%, 18%, 34%, 6% and 80%, respectively among the exposed vs (0%) among unexposed. It was concluded that 52% cotton ginners had all types of byssinosis while no lung related diseases prevailed among the unexposed subjects.

Key words: ginners, cotton dust, respiratory disorders, bronchitis and asthma.

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INTRODUCTION

Cotton is a fibre cash crop grown under a broad range of climates and soils. Pakistan is the fourth largest cotton producer in the world. The textile industry in Pakistan is the largest among all the manufacturing industries that has generated huge employment for both skilled and unskilled labor (Memon, 2011). Ginning is the lifeline of the textile sector where raw cotton is used as the main raw material. In the ginnery, the cotton which has been picked from the fields, is opened and mixed by throwing into the air. The cotton is then passed through the gins, which comb out the seeds, after which it is tightly packed into bales to be transported to the nearby spinning mills (Khan and Saadia, 2006). The dust produced during the handling and processing of cotton is considered cotton dust. Thousands of workers are exposed to cotton dust while busy in collecting cotton from the fields and in large textile mills during carding, blowing, spinning and weaving (Imbus, 2010).

Numerous studies have investigated the respiratory health effects in people exposed to cotton dust (Shi *et al.,* 2010). The most conspicuous effects of exposure are clinical symptoms of bronchoconstriction together with a decline in expiratory flow over the work-shift. Many workers exposed to cotton dust in industries develop byssinosis (Woestijne, 2009). The symptoms of this occupational lung disease resemble those of bronchial asthma which is accompanied by lung function changes and obstructive ventilator impairment is suggested (Arnoldsson, 2003). Byssinosis is characterized by a feeling of chest tightness on the first day of the working week that improves as week progresses. It has been used to describe the acute and reversible response of exposure to cotton dust. The disease, however, may progress to a stage in which symptoms are present throughout the working week, and may eventually result in severe pulmonary disability as exposure continues reported by (Trupin *et al.,* 2003).

Length of exposure, cumulative or average dust concentration, past levels of dust exposure and the ''mill effect'' i.e that may be caused by grade of cotton or degree of contamination with Gram negative microorganisms have all been identified as possible causes of the development of byssinosis (Glindmeyer *et al.,* 1991). In some studies, smoking was found to be another cause of byssinosis. Exposure to cotton dust has also been reported to be associated with chronic bronchitis, cough, and dyspnea, which are regarded as non-specific respiratory symptoms (Christiani *et al.,* 2004).

The relationship between the prevalence of byssinosis and dust exposure in cotton ginning industries is important to identify the safety measures (Wang *et al.,* 2005). The National Institute for Occupational Safety and Health (NIOSH) recommended that exposure to cotton dust can be reduced to the lowest feasible limits. Although occupational lung diseases may not be cured,

they can be prevented only. Improving ventilation, wearing protective equipment, changing work procedures and educating workers about the hazardous effects of the workplace are the safety measures for the prevention of these life taking diseases. The huge number of workers in industries handling cotton around the world should, therefore, be more careful about exposure to inhalation of cotton fibres (Beck, 2002).

In Pakistan, there are lacks of studies on exposure assessment for prevalence of lung related diseases among ginners. In present study occupational exposure to cotton dust is examined by the standardized American Thoracic Society (ATS) questionnaire and a pulmonary function test, Peak Expiratory Flow Rate (PEFR) performed to make diagnosis amongst cotton operatives (ginners) and control group. The PEFR values of control group and that of workers exposed to cotton dust are statistically compared to check the prevalence of lung related diseases in cotton operatives (ginners).

The objective of present study is to measure the Peak expiratory flow rates of respondents in order to assess their lung functions. The study also aims to identify the causes and prevalence of lung related diseases in ginners.

MATERIALS AND METHODS

Study area and sampling: The present study was based on exposure assessment for prevalence of lung related diseases in cotton ginners. The cotton ginning factory was located near Sheikhupura, Pakistan. It was established in 2002. The main technical sections of the factory comprised of blow room, carding, drawing, roving, ring and auto cone sections. There were 200 male temporary workers in the factory. The number of workers which were randomly selected as an experimental group for the study was 50. Control group consisted of 25 workers belonging to the same socioeconomic background as ginners but they were not exposed to cotton dust at all. Cross-sectional study period was 1 year.

Experimental design: An epidemiological cohort study was carried out to assess the prevalence of lung related diseases in cotton ginners. Lung functioning was checked by using peak flow meter. Change in lung functions was assessed by taking across shifts measurements. A questionnaire was used to get information about the worker's health particularly information about the lung functions. The PEFR values of control group and workers exposed to cotton dust were compared to check the prevalence of lung related diseases in cotton ginners.

Peak Flow Meter: Peak flow meter was used to measure air flowing out of the lungs this test is called peak expiratory flow rate (PEFR). It was measured by keeping the peak flow meter into worker's mouth and blowing into forcefully.

Questionnaire designed for the health assessment: A modified ATS standardized respiratory symptom questionnaire was used to collect data related to respiratory diseases, including chronic bronchitis, chronic cough, and dyspnea and other respiratory syndromes. Questions related to symptoms of lung diseases due to cotton dust, present and past health, dyspnoea and tightness in the chest, wheezing, cough, sputum production, asthma, hay fever, and smoking habits were asked along with additional questions about the use of personal protective equipment.

Data interpretation and analysis: The data was subjected to standard statistical analysis and presented in the form of tables, graph and pie charts. Independent sample t-test was used to compare PEFR of exposed and control groups. PEFR values were compared with standard normal values (Mrindha *et al.*, 2011) to assess degree of lungs impairment in respondents of exposed and control groups.

RESULTS AND DISCUSSION

Fifty cotton ginners were selected whose age ranged between 15 to 65 years. Almost all the subjects were involved in the profession of cotton ginning, at least for one year. General information revealed that workers with age (years) 15-25 42%, 26-35 28%, 36-45 10%, 46-55 10%, and 56-65 10% participated in the study. 56% workers were illiterate, 36% were primary school certificate holders, 4% were educated to middle 2% were metric and 2% were intermediate. 80% of workers were married and 20% were single.

The occupational history of workers was probed and it showed that 13% of workers were working there for the last ten years in the ginning sector which has been shown in Fig-1. 80% of workers in the ginning factory had the problem of cough while 20% respondents did not show cough.

The questions related to phlegm revealed that 74% workers had the problem of producing phlegm. 60% of the workers had episodes of cough and phlegm. 59% of workers felt wheezy and whistling chest when they had cold while 41% of workers chest felt wheezy and whistling apart from cold. 30% of workers had attack of wheezing and whistling that made difficulty in breathing. 64% of workers suffered difficulty in breathing when hurrying at high altitude or walking up steep hill while 54% walked slower than people of their age on the plain area because of breathlessness.

The questionnaire based survey revealed that 10% were having an injury or operation affecting their chest, 12% had heart trouble, 20% suffered from bronchitis, 10% reported hay fever, 36% were having

pneumonia and 12% suffered from other chest trouble. The percentage of smokers was 68% and nonsmokers were 22% and ex-smokers were 10%.

The questionnaire asked about chest tightness and shortness of breath on working days or Mill fever revealed that 52% of operatives were having different grades of byssinosis. Among which, 26% were having grade ½ byssinosis (Chest tightness and/or shortness of breath sometimes on the first day of the workweek), 12% were having grade 1 byssinosis (Chest tightness and/or shortness of breath always on the first day of the workweek), 8% were having grade 2 byssinosis (Chest tightness and/or shortness of breath on the first workday and on other days of the workweek), 6% were having grade 3 byssinosis (Chest tightness and/or shortness of breath on the first workday and other days as well as impairment of lung functions which has been presented in Fig-2.

The results of occurrence of lung related diseases among workers showed that 42% were having chronic bronchitis (Fig-3). The data obtained regarding the use of personal protective equipment gave the following results, 0% of workers were using respirators (which are essential in protecting the pulmonary health), 0% of them were using masks (Fig-4). When the question was asked about the health effects of cotton dust, 70% of operatives told that they did not know the health effects of cotton dust. 40% of them had faced accidents from slips and fall, 36% of them encountered accidents related to equipment, 8% affected by fire incidents in their workplace, 6% suffered from short circuits and 10% faced other accidents.

The average PEFR values before and after work shift with different age groups is shown in Fig-5 and 6. The average PEFR value before work shift for age group 15-25 ranged from 250-350 L/min and for age group 26-35 ranged from 250-350 L/min, PEFR values for age group 36-45 ranged from 250-200 L/min, for age group 46-55 which ranged from 200-350 L/min and for age group of 56-65 ranged from 175-200 L/min. The average PEFR values after work shift with different age groups were as follows for age group 15-25 ranged from 150-250 L/min, for age group 26-35 ranged from 175-350 L/min, for age group 36-45 ranged from 400-200 L/min, for age group 46-55 the PEFR values ranged from 160-350 L/min and for age group 56-65 PEFR values ranged from 150-100 L/min.

The average PEFR values before and after work shift with different height groups has been shown in Fig-7 and 8. The average PEFR values before work shift with different height groups were as follow, height group from 150-160 centimeter ranged from 250-300 L/min, the PEFR values for height group 161-170 centimeter ranged from 300-175 L/min, the PEFR values for height group 171-180 centimeter ranged from 400-200 L/min, the PEFR values for height group 181-190 centimeter ranged from 450-150 L/min. The average PEFR values after work shift with different height groups were as follows. The height group from 150-160 centimeter ranged from 150-175 L/min, the PEFR values for height group from 161-170 centimeter ranged from 300-150 L/min, for height group from 171-180 centimeter ranged from 350-100 L/min and for height group from 181-190 ranged from 400-150 L/min. The PEFR values for control group fell within normal range. The PFER values for control group ranged from 360-550 L/min.

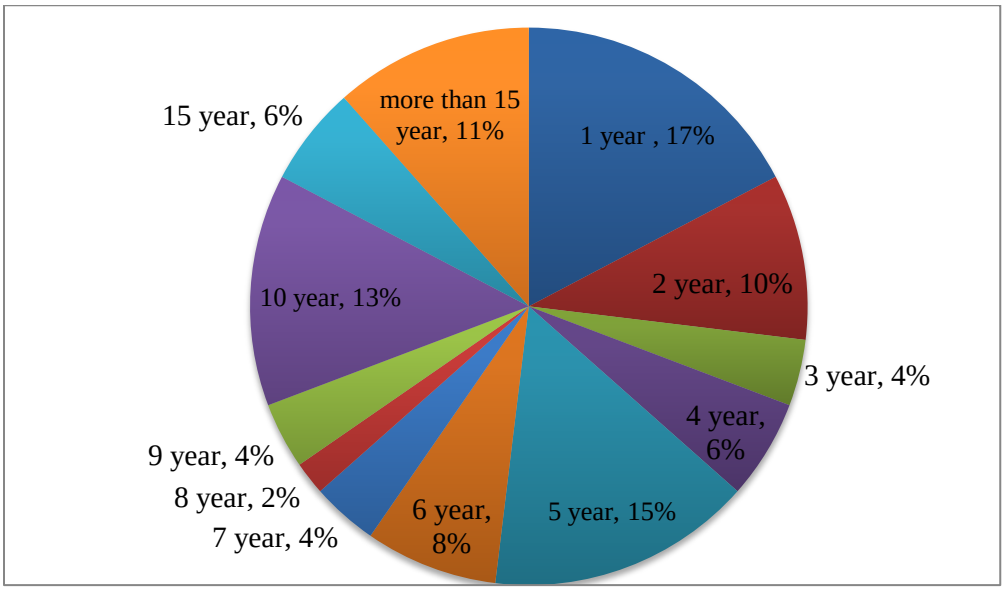

Figure 1. Worker's years of exposure in dusty environment (ginning factory)

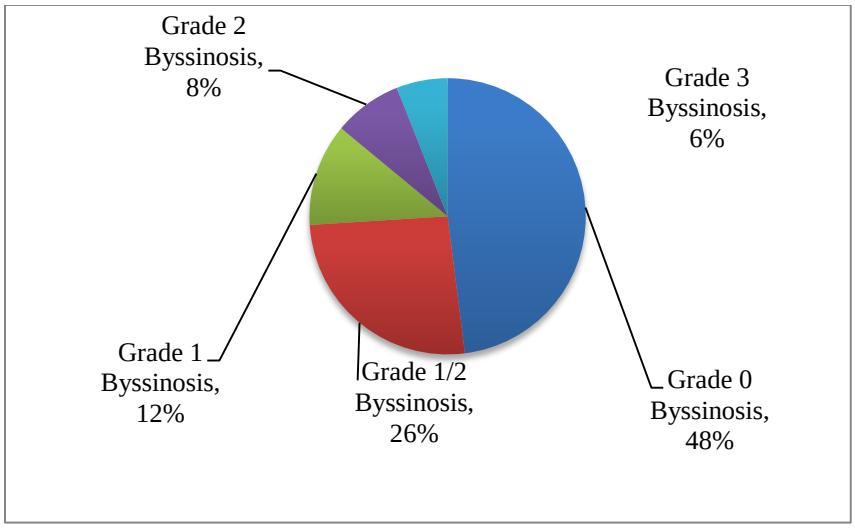

Figure 2. Workers with different grades of byssinosis

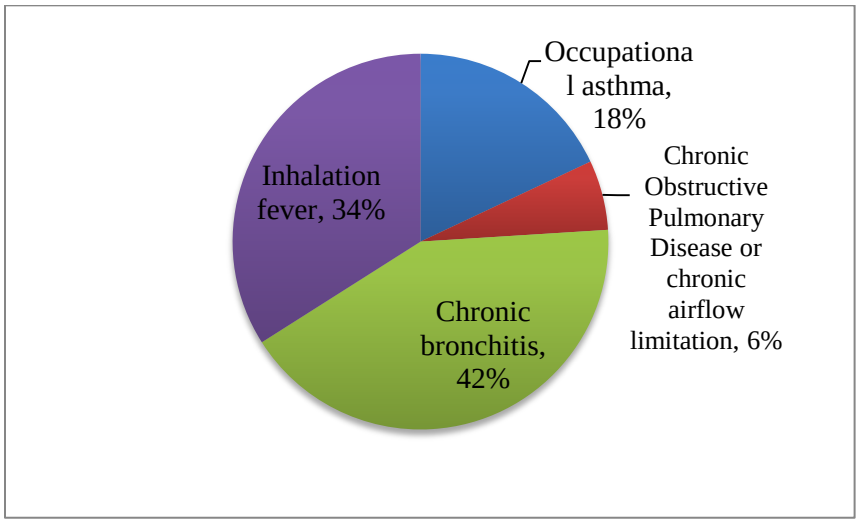

Figure 3. Lung related diseases in cotton ginners

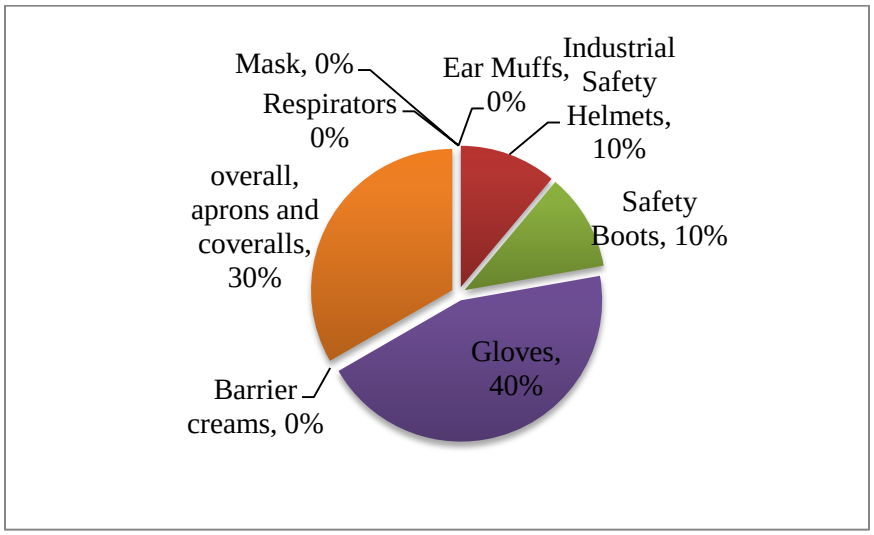

Figure 4. Workers using different Personal protective Equipment

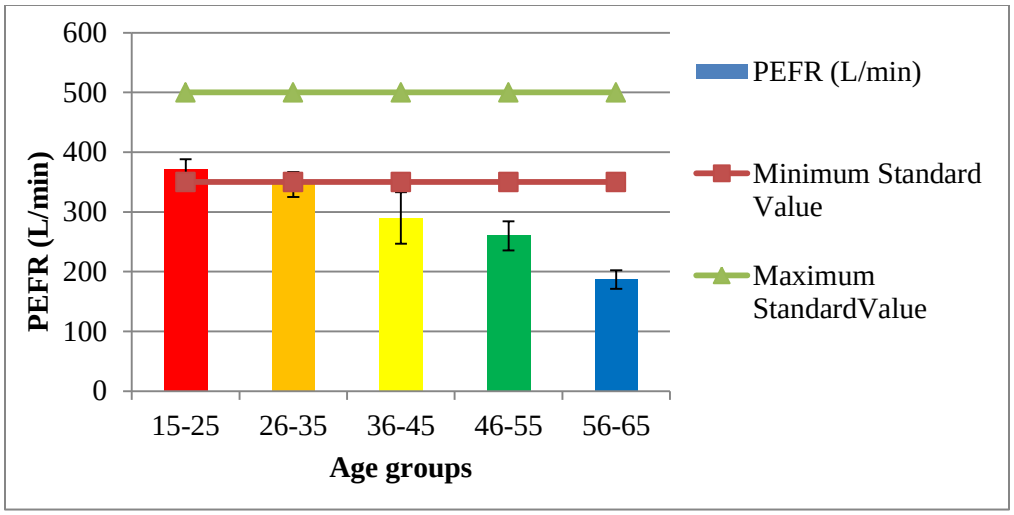

Figure 5. PEFR of workers of different age groups before work shift in ginning factory

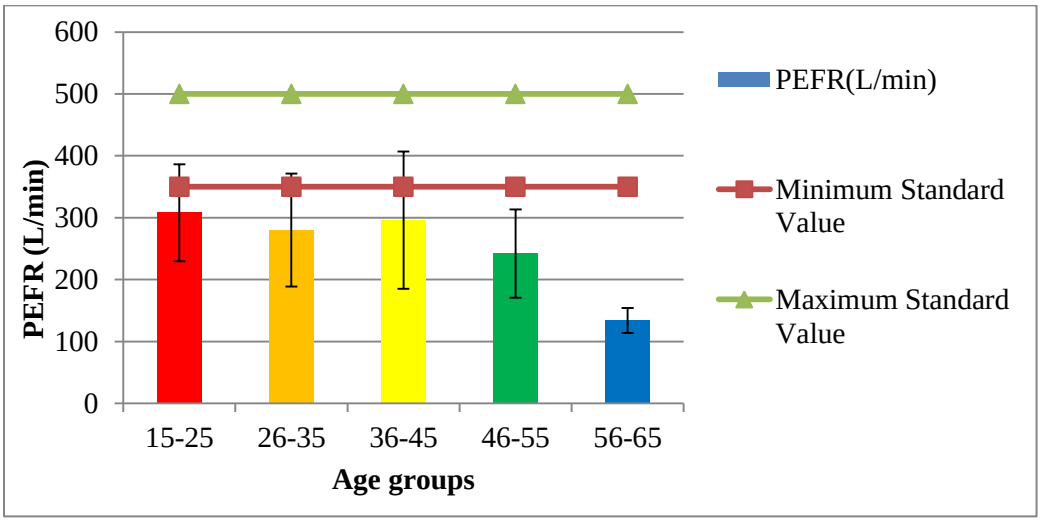

Figure 6. PEFR of workers of different age groups after work shift in ginning factory

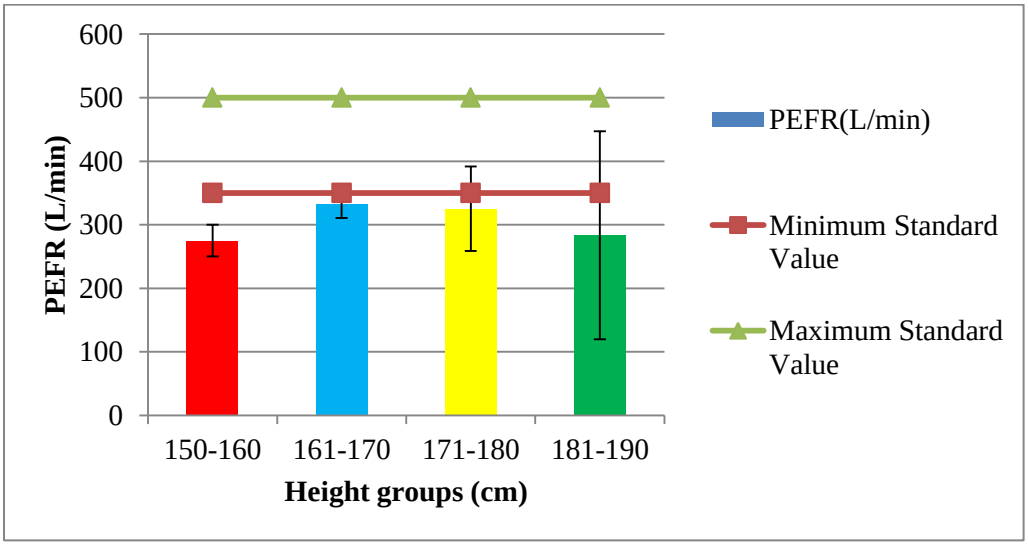

Figure 7. PEFR of workers with different height groups before work shift in ginning factory

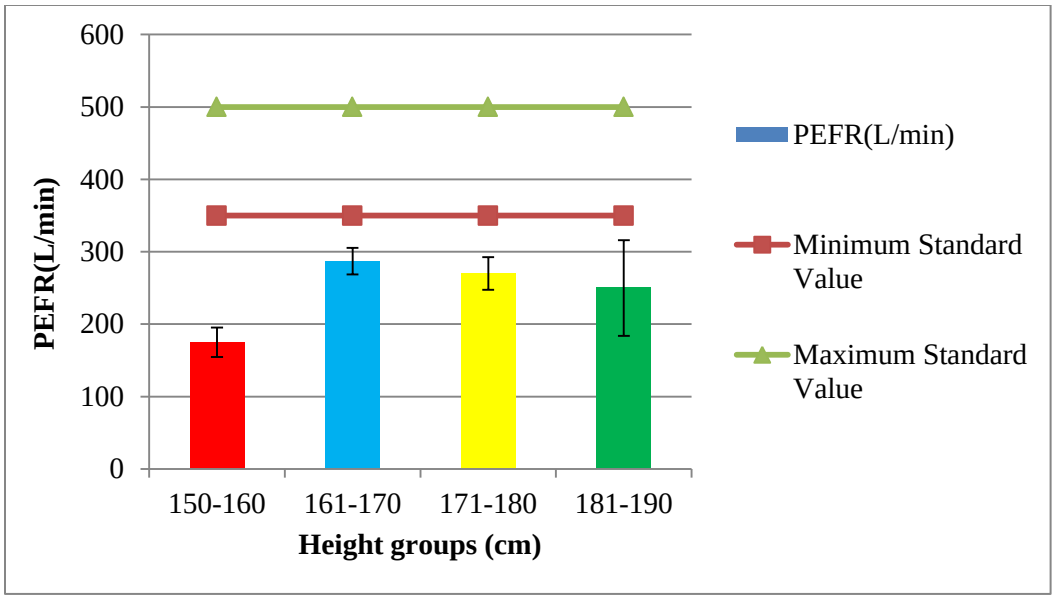

Figure 8. PEFR of workers with different height groups after work shift in ginning factory

Table 1. No. of exposed and unexposed workers before and after work shifts which fall within or below the normal Peak expiratory flow rate PEFR values according to height.

Height (cm)	Age (years)	Normal PEFR values L/min	No. of individuals within normal range				No. of individuals below normal range			
			Exposed		Unexposed		Exposed		Unexposed	
			Before work shift	After work shift	Before work shift	After work shift	Before work shift	After work shift	Before work shift	After work shift
150-160	15-65	350-400	-	-	2	2	2	2	Nil	Nil
161-170	15-65	405-450	3	1	8	8	18	20	Nil	Nil
171-180	15-65	455-500	4	3	11	11	20	21	Nil	Nil
181-190	15-65	505-550	-	-	4	4	3	3	Nil	Nil
Total			**7**	**4**	**25**	**25**	**43**	**46**	**-**	**-**

The cotton dust in working environment caused problems of frequent cough and phlegm production. This appeared to be a positive relationship between the exposure to cotton dust and symptoms of a cough, phlegm and dyspnea and was in line with the work of (Fishwick *et al.,* 2006) where Substantial chronic respiratory effects in ginning workers were observed. It was observed that cotton ginners had more respiratory diseases and symptoms than the subjects of control group and had statistically significant low PEFR values. Overall, the data provided further supportive evidence for the chronic effects of exposure to cotton dust (Lai and Christiani, 2013).

The duration of exposure, poverty, overtime duties, fatigue, no protective measures, malnutrition, over-crowding and inefficient medical health check up have contributed to low values of PEFR. The duration of exposure to cotton dust was essential in the expression of lung related diseases. The older age individuals had more years of exposure and suffered from several serious lung related problems reported by (Massoud and Taylor, 1964). As a result chronic respiratory symptoms were much more prevalent in older cotton textile workers than in similar control populations (Schoenberg *et al.,* 2005). Several older aged ginners had impaired lung functioning and had a severe attack of wheezing and whistling.

Most of the cotton operatives were cigarette smokers. Byssinosis prevalence and severity was increased in cotton textile workers who smoke in comparison with workers who did not smoke (Liebers *et al.,* 2008). The combined effects of cotton dust and cigarette smoking led to chronic lung related problems in cotton ginners. The workers with the smoking habits had very low PEFR values as compared to the non- smokers. This showed that the cigarette smoking can lead to the severe chronic respiratory lung diseases and lung cancer.

The symptoms of chest tightness were also observed in cotton ginners, which increased with years of exposure and duration of exposure. It is not always related to decreases in pulmonary function and probably had different pathological background. One suggestion is that it was caused by the accumulation of platelets in the lung capillaries, as was observed in animal models (Sangeeta, 2012). This accumulation, which occurred a few hours after exposure, would increase pressure in pulmonary arteries and could cause a subjective feeling of chest tightness. There was a further evidence that the cotton ginners suffered impaired ventilatory capacity and undue breathlessness on exertion. The present study revealed that most of the cotton ginners had pneumonia, bronchitis, heart troubles in the past, these were becoming contributing factors to impairment of lung function.

The agent in the cotton dust that caused the symptoms of byssinosis was not known, but it is believed to be a contaminant on the cotton. One currently held theory is that it is a bacterial product that is bract leafy portion of the cotton (Lai *et al.,* 2012). Extensive research continues to be done in an effort to identify and eliminate the problem.

The present study showed that the symptoms of lung related diseases and PEFR values of most of the ginners were very severe and were below the normal range. Those workers who were working in the ginning factory for long period of time were suffering from severe respiratory problems as compared to those workers who were not working in the factory for long period.

The control group which was selected for present study with the same age group, height and social status as an experimental group. The control group was not exposed to cotton dust but working in the same area in food making factory. PEFR test was performed and all control group respondents showed normal values thereby had no significant respiratory problems and had enough sound health.

Measures to control dust reduced the rates of byssinosis and other respiratory problems, yet byssinosis remained important occupational disease in many developing countries. Chinese cotton textile workers reported a higher prevalence of byssinosis symptoms reported (Christiani *et al.,* 2006).

Large number of workers who just joined the ginning occupation had the problem of cough and phlegm production and these were early signs of byssinosis. Prevalence of all grades of byssinosis in workers was considerably high and increased frequency of byssinosis was due to the exposure to the dusty environments. The Chest tightness and/ shortness of breath on the first workday and other days as well as impairment of lung function was more in older individuals' due to loss of some lung function with increased age and exposure to cotton dust in ginning factory.

Lack of awareness, education, training and lack of use of personal protective equipment and non-implementation of occupational health and safety were the reasons why the workers of ginning factory suffered from byssinosis and lung related diseases and other health problems. It is necessary to adopt all possible methods to protect the health of the workers. It was found that the workers were not aware of the long-term effect of their working conditions and hazards present in their working environments. This exacerbates the rate of occurrence of byssinosis and lung related diseases in the workers. Measures should be taken to prevent the hazardous effects of dust in industrial occupations to provide a healthy environment for the workers.

Conclusion: In conclusion, the study showed PEFR values of subjects exposed to cotton dust were significantly low ($p<0.01$) which is indicative of impaired pulmonary function. Prevalence of byssinosis among ginners was 52%. Organic dust exposure in the ginning industry leads to obstructive lung disease that has features of both asthma and chronic obstructive pulmonary diseases (COPD).

REFERENCES

Arnoldsson, H., A. Bouhuys, and S.E. Lindell (2003). Byssinosis. Differential diagnosis from bronchial asthma and chronic bronchitis. Alt. Med. Scand. 173: 761.

Beck, G.J., E.N. Schechter, L.R. Maunder and R.S. Schilling (2002). A prospective study of chronic lung disease in cotton textile workers. Ann. Intl. Medi. 97: 645–651.

Christiani, D.C, E.A. Eisen and D.H. Wegman (2006). Respiratory disease in cotton textile workers in the People's Republic of China. Scand. J. Wrk. Env. Hlth. 12: 40–45.

Christiani, D.C., D.H. Wegman, E.A. Eisen, H.L. Dai and P.L. Lu (2004). Cotton dust exposure, across-shift drop in FEV1, and five-year change in lung function. Amer. J. Resp. Critl. Cre. Medi. 150: 1250-1255.

Fishwick, D., A.M. Fletcher, C.A. Pickering, R. Mclniven and E.B. Faragher (2006). Lung functions in Lancashire cotton and manmade fiber spinning mill operatives. Occup. Env. Medi. 53(1): 46-50.

Glindmeyer, H.W., J.J. Lefante and R.N. Jones (1991). Exposure-related declines in the lung function of cotton textile workers. Relationship to current workplace standards. Amer. Rvw. Resp. Dis. 144(3): 675–83.

Imbus, H.R. (2010). Cotton Dust. Amer. Indus. Hyg. Assoc. J. 47(11): 712-716.

Khan, S.A. and A. Saadia (2006). Pulmonary Function Studies in Pakistani Cotton Ginners. Pak. J. Physiol. 2(1).

Lai, P.S and D.C Christiani (2013). Long term respiratory health effects in textile workers. Curr. Opni. Pul. Medi. 19(2): 152–157.

Lai, P.S., J.M. Fresco and M.A. Pinilla (2012). Chronic endotoxin exposure produces airflow obstruction and lung dendritic cell expansion. Amer. J. Respi. Cel. Mol. Biol. 47: 209–217.

Liebers, V., M. Raulf-Heimsoth and T. Brüning (2008). Health effects due to endotoxin inhalation. Arch. Toxi. 82: 203–210.

Massoud, A and G. Taylor (1964). Byssinosis: Antibody to cotton antigens in normal subjects and in cotton card-room workers. Lancet. 284(7360): 607 -610.

Memon, A.N. (2011). Textile spinning: Costly cotton makes yarn expensive. Pak. Txtl. J. 60(2): 38.

Mrindha, A., A. Ruhul and L. Kabir (2011). Peak expiratory flow rate (PEFR)-A simple ventilatory lung function test. J. Shd. Suhrwrdy. Medi. Col. 3(2): 44-47.

Sangeeta, V. (2012). A Study of pulmonary function tests in workers of different dust industries. Intl. J. Bas. Apld. Medi. Sc. 2(2): 2103-2277.

Shi, J., J.Q. Hang and A.J. Mehta (2010). Long-term Effects of Work Cessation on Respiratory Health of Textile Workers: A 25-Year Follow-up Study. Amer. J. Resp. Crtl. Cre. Medi. 182: 200–206.

Shoenberg, J.B., A. Bouhuys and G.J. Beck (2005). Epidemiology of chronic lung disease in a cotton mill community. Lung. 154: 167–86.

Trupin, L., G. Earnest and M. San Pedro (2003). The occupational burden of chronic obstructive pulmonary disease. Euro. Resp. J. 22: 462–469.

Wang, X.R., H.X. Zhang and B.X. Sun (2005). A 20-year follow-up study on chronic respiratory effects of exposure to cotton dust. Euro. Resp. J. 26: 881–886.

Woestijne, K.P., A. Bouhuys, A. Barbero and R.S.F. Schilling (2009). Chronic respiratory disease in hemp workers. Amer. J. Medi. 46: 526.