SANDEE

Working Paper No. 123–17

The Health Burden of Dust Pollution in the Textile Industry of Faisalabad, Pakistan

Muhammad Khan

ECONOMICS & THE ENVIRONMENT

South Asian Network for Development and Environmental Economics (SANDEE) PO Box 8975,
EPC 1056, Kathmandu, Nepal.
Tel: 977-1-5003222 Fax: 977-1-5003299

SANDEE research reports are electronic preprints output from research projects supported by the South Asian Network for Development and Environmental Economics. The papers are circulated for discussion and comments. A summary of the findings of SANDEE reports are also available as SANDEE Policy Briefs.

Muhammad Khan
The Health Burden of Dust Pollution in the Textile Industry of Faisalabad, Pakistan

Keywords
Textile
Cotton dust
Byssinosis
Health diary
Health cost
Pakistan

SANDEE Working Paper No. 123–17

The Health Burden of Dust Pollution in the Textile Industry of Faisalabad, Pakistan

Muhammad Khan
COMSATS Institute of Information Technology
Lahore Pakistan

July 2017

South Asian Network for Development and Environmental Economics (SANDEE)
PO Box 8975, EPC 1056, Kathmandu, Nepal

SANDEE Working Paper No. 123–17

The South Asian Network for Development and Environmental Economics

The South Asian Network for Development and Environmental Economics (SANDEE) is a regional network that brings together analysts from different countries in South Asia to address environment-development problems. SANDEE's activities include research support, training, and information dissemination. Please see www.sandeeonline.org for further information about SANDEE.

SANDEE is financially supported by the International Development Research Center (IDRC), The Swedish International Development Cooperation Agency (SIDA), the World Bank and the Norwegian Agency for Development Cooperation (NORAD). The opinions expressed in this paper are the author's and do not necessarily represent those of SANDEE's donors.

This Working Paper series of electronic preprints based on research funded by SANDEE and supported with technical assistance from network members, SANDEE staff and advisors.

Faculty Advisor
Jeffrey Vincent

Staff Advisor
Heman Das Lohano

Comments should be sent to

Muhammad Khan
Email: mkhan_490@yahoo.com/mkhan@ciitlahore.edu.pk

Contents

Abstract

1. Introduction **1**

2. Model and Estimation Methods **2**

2.1 The Economic Model 3

2.2 Econometric Specification and Estimation Methods 3

2.2.1 Dose Response Function 4

2.2.2 Estimation of the Health Response Function 4

2.2.3 Estimation of the Averting Activities Function 5

2.2.4 Estimation of the Mitigating Activities Function 5

3. Data **5**

3.1 Study Area 5

3.2 Sampling and Data Collection 5

4. Results and Discussion **6**

4.1 Descriptive Statistics 6

4.2 Health Cost 9

4.3 Results of the Dose Response Function 10

4.4 Results of the Health Production Function 13

4.5 Results of the Demand Function for Averting Activities 14

4.6 Result of the Demand Function for Mitigating Activities 15

5. Conclusion **15**

Acknowledgements **16**

References **17**

Tables

Table 1: The definition and summary statistics of variables used in the analysis 7

Table 2: The health cost estimates 10

Table 3: Ordered Probit analysis of the dose response function 11

Table 4: Marginal effects of the dose response function (Probit models) 12

Table 5: Marginal effects of the health production function 13

Table 6: Marginal effects of the mitigating and averting activities (Probit models) 14

Figures

Figure 1: Education of workers by gender 6

Figure 2: Employment status of respondents 8

Figure 3: Use of mask by workers 8

Figure 4: Prevalence of byssinosis and cough by work section 9

Figure 5: Distribution of work section by gender 13

Appendix

Appendix: Survey Questionnaire and Health Diary 21

Abstract

The study focuses on the high incidence of occupational health hazards faced by women and men working in the textile industry of Pakistan. One of the most relevant risk factors is exposure to airborne dust generated by fibers, which causes byssinosis and other respiratory impairments. Since these illnesses affect workers' health, productivity and quality of life very seriously, we estimate the disease burden and cost through a study of workers in the textile industry of Faisalabad, Pakistan. We collected the data from a randomly selected sample of 206 workers from 11 textile spinning factories in August 2013, using a two-week Health Diary and a survey questionnaire. The survey results show a significant number of workers to experience respiratory symptoms including byssinosis, chronic cough, phlegm, blood with phlegm, bronchitis, asthma and tuberculosis. The results from health diary show that roughly 9% of workers had to visit the doctor for treatment during those two weeks. The average monetary loss to the ill workers is PKR 4096 per month which accounts for 32 percent of their income. The regression results show that the probability of respiratory diseases is significantly higher for those who smoke cigarettes or work in sections that are dusty or high in temperature. The results of the health production function show that the number of work hours lost due to respiratory diseases is significantly higher for those who work in dusty sections while it is significantly lower for those who wear a mask. The research highlights the importance of promoting a safety culture in textile mills through the provision of occupational safety and health training to workers and through the implementation of appropriate dust control standards in the industry.

Keywords

Textile, Cotton dust, Byssinosis, Health diary, Health cost, Pakistan

The Health Burden of Dust Pollution in the Textile Industry of Faisalabad, Pakistan

1. Introduction

Every year, about 2.3 million workers die from occupational accidents and diseases worldwide, with 2 million, the highest number, dying from work-related diseases and 0.3 million from occupational injuries (ILO, 2006). Occupational illnesses and injuries are also associated with high economic and social costs. The economic cost alone is equivalent to 4% of the annual global GDP, or USD 2.8 trillion, which is attributed to sickness absence, workers' compensation, interruption of production, and medical expenses (ILO, 2006).

The textile industry is a major labor intensive industry in today's world and employs approximately 60 million workers globally (ILO, 2009). Broadly, the textile sector can be categorized as ginning, spinning, weaving, and finishing and garments units. Textile workers, especially in the spinning process[1], are exposed to a large amount of cotton dust with deleterious effects on their lung function (WHO, 2008). Cotton dust exposure at textile industries adds considerably to the occupational burden of disease globally (Nafees *et al*., 2013).Workers in spinning units experience inescapable, constant and repeated exposure to dust over months and years which result in byssinosis,[2] a disabling lung disease caused by inhaling cotton dust in textile firms (Schilling *et al*., 1964). Depending on the intensity and duration of exposure, byssinosis victims experience chest tightness, cough, phlegm, breathlessness, irritation of the respiratory tract, chronic respiratory disorder, chronic bronchitis, irreversible airway obstruction, wheezing, asthma, tuberculosis, lung-function loss, eye sight problems, skin diseases and, even, mortality.[3]

Many studies from across the globe have reported on the relationship between respiratory illnesses and work environment in the textile industry (Wang & Christiani, 2003; Jaén *et al*., 2006; Alemu *et al*., 2010; Mishra *et al*., 2004; Raza *et al*., 1999; Nafees *et al*., 2013). Over the years, the prevalence of byssinosis has gradually declined in developed countries due to improvements in dust control measures. Studies from UK, for instance, have found only 3% of byssinosis in spinning and 0.3% in weaving workers (Raza *et al*., 1999; Cinkota *et al*., 1988). However, the situation in developing countries is still far from satisfactory with large numbers of textile workers continuing to suffer from respiratory illnesses. Studies have reported very high prevalence of byssinosis in Ethiopia (at 43.2%), in China (at 22%) and in India (at 30%) (Parikh *et al*., 1989; Christiani *et al*., 2001; Woldeyohannes *et al*., 1991).

---

[1] The textile spinning process produces high dust pollution, creating major environmental concerns for indoor air pollution.

[2] Byssinosis is difficult to define because there are no specific radiologic/pathologic changes in lungs. However, the findings of acute and chronic irreversible airflow obstruction and typical symptoms in workers exposed to cotton dust are sufficiently characteristic to permit the diagnosis (Bates, 2010). Two standard approaches are commonly used to diagnose byssinosis: pulmonary function tests (i.e., forced vital capacity [FVC], forced expiratory volume in first second [FEV1], and peak expiratory flow rate [PEFR] and Schilling's grading of the disease (Schilling *et al*., 1955): Grade 0: no symptoms of chest tightness or breathlessness on Monday (or first day of work after a break); Grade ½: occasional chest tightness or breathing difficulty on the first day of the working week; Grade 1: chest tightness or breathlessness on Monday only; Grade 2: chest tightness or breathlessness on Monday and other weekdays; Grade 3: Grade 2 symptoms accompanied by evidence of permanent impairment in capacity from reduced ventilator defect (Bates, 2010; Jiang *et al*., 1995). These grades suggest that there was progression in reversible "asthma like reaction" to dust in the cotton mills on the first day of the working week (Grade ½ and Grade 1) to one of irreversible airway obstruction (Grade 2 and Grade 3) (Farooqui *et al*. 2008).

[3] For research focusing on the health burden of cotton dust exposure, see Love *et al*. (1986); Mathur & Misra (1972); Zuskin *et al*. (1976); Salvaggio *et al*. (1986); Wang & Christiani (2003); Jiang *et al*. (1995); Jaén *et al*. (2006); Bates (2010); Yih-Ming *et al*. (2003); Schilling *et al*. (1964).

The textile industry is the largest manufacturing sector in Pakistan. The industry provides employment to more than 40% of the manufacturing sector's work force while contributing 8% to the GDP and constituting 55% of export earnings (Government of Pakistan, 2014). In Pakistan's textile industry, the emphasis is on the spinning activity while a major portion of the good quality yarn is exported (Malik, 2002; Government of Pakistan, 2014). Despite the significant role that the textile industry plays in the economy, the Government of Punjab has identified it as one of the most polluting industries in the country (2008). A survey by the Centre for Improvement of Working Conditions and Environment (CIWCE) has reported that a majority of factories in the industry lack basic hygiene facilities and adequate exhaust filters which aggravate the situation (Government of Punjab, 2002). Although recent statistics and epidemiological data are lacking in data on specific illnesses, the estimates show that over 800,000 workers are directly exposed to cotton dust in textile plant operations and yarn preparation areas (Shafqatullah, 1999).

Several studies have provided evidence on links between the concentration of airborne dust in the working environment and the prevalence of respiratory symptoms in textile workers in Pakistan (Nafees *et al*., 2013; Saadat *et al*., 2006; Farooque *et al*., 2008; Anjum *et al*., 2009; Memon *et al*., 2008; Saleema *et al*., 2007). These studies have reported moderate to high (8-35%) levels of byssinosis in textile mills. The studies have also found chronic respiratory morbidities, for example, chronic bronchitis, bronchial asthma, tuberculosis and other obstructive pulmonary diseases among exposed workers to be very high. Thus, it may be concluded from the literature that dose-response relationships have been repeatedly established between health effects and levels of dust in cotton mills. What is missing in the literature is the economic valuation of this pollution. Dust-associated illnesses ultimately affect workers' health, productivity, quality of life and overall welfare very seriously. Therefore, from a policy perspective, estimates of the health cost to workers due to dust pollution in the textile industry are very important in order to set standards for cotton dust pollution and allocate resources for workers' welfare and social security. The Pakistani textile industry provides a perfect laboratory for this kind of research since it employs a significant proportion (approximately 15 million) of the global textile sector labor force (BOI, 2007; Khan *et al*., 2015).

Hence, our study not only provides fresh epidemiological evidence of the suffering of workers from respiratory diseases but also estimates of the cost of negative health problems due to dust pollution in the textile industry in the district of Faisalabad. We collected representative data on the current workforce in the textile spinning mills of Faisalabad using a two-week health diary[4] and a questionnaire survey of workers. Our data shows the textile workers to suffer from multiple respiratory diseases at work. The analysis indicates the work section and smoking to be the most important determinants of respiratory morbidities in spinning mill workers. The gender of the worker, i.e., whether female, also increases the likelihood of respiratory symptoms. The health cost results show that the per month actual mean cost is Pakistani Rupees (PKR) 4096 though this health cost estimate does not take into account the free treatment of many workers at social security hospitals. Nor does it include the opportunity cost of the time taken up for treatment (i.e., time spent in waiting and travel for treatment of worker and/or the accompanying person). The per month cost estimates are equal to 32% of the worker's wage. Given the low income status of a majority of workers, the economic cost of illness places a significant financial burden on workers and their families. The situation calls for appropriate interventions from policy makers.

2. Model and Estimation Methods

Two types of methodologies could be utilized to measure the health cost of dust pollution: Contingent Valuation (CV) approach or Cost of Illness method. The CV approach measures the maximum amount a person would be willing to pay or to sacrifice in order to receive a good or to avoid something undesired, such as pollution (Freeman, 2014). The CV method, however, has been criticized for relying on stated preferences instead of observable

[4] Health diaries have been intensively used in health studies in recent times as a data collection tool (Murty *et al*., 2003; Gupta, 2006; Chowdhury and Imran, 2010; Adhikari, 2012).The advantages of diaries include greater accuracy, fewer recall problems, improved ability to determine the order of events, and the ability to capture events of low salience. In addition, diaries do not require participants to summarize experiences or behaviors (Sudman, 1974).

behavior while there is still debate among researchers regarding the validity and reliability of the CV method. In our study, we therefore adopt the Cost of Illness approach, which estimates the sum of lost wages due to work days lost and the mitigation and averting expenditure borne due to illness.

2.1 The economic model

We use the model of the household health production function, described in Freeman (2014), originally formulated by Grossman (1972), and extended by Harrington and Portney (1987) in our study. The status of health of an individual depends on the exposure to pollution, mitigating activities and other physical and socio-economic characteristics such as age, gender, smoking, income, and education (Freeman, 2014). The health production function can thus be written as:

$$S = S\ (D, B, G) \quad (1)$$

where S is a measure of the health status estimated by the number of sick days; D is exposure to pollution or dose; B is the mitigating activities undertaken to improve health; and G is the vector of personal characteristics of the individual. Exposure to pollution depends on the concentration of pollution, averting activities, and personal characteristics:

$$D = D\ (C, A, G) \quad (2)$$

where C is the concentration (quantity) of pollution and A is the amount of an averting activity. Substituting equation (2) for equation (1) yields:

$$S = S\ (C, A, B, G) \quad (3)$$

The individual's utility-maximization problem is:

$$Max\ u(Z, F, S) \quad (4)$$

subject to:

$$I + P_w\ (T - F - S) = Z + P_A A + P_B B \quad (5)$$

where Z denotes the consumption of numeraire good; F denotes leisure; I denotes non-wage income; P_w is wage rate; T is total available time; P_A is price of averting activities; and P_B is price of mitigating activities. The individual selects Z, F, A and B that maximize his or her utility subject to the budget constraint. Note that S in the utility function depends on A and B which are choice variables. The consumption of the all-purpose commodity or numeraire (Z), normalized with a price of one, and leisure (F) increases the utility of the individual while illness (S) results in disutility. Solving this utility-maximization problem yields the demand functions for averting activities (A) and mitigating activities (B):

$$A = A(I, P_w, P_A, P_B, C, G) \quad (6)$$

$$B = B\ (I, P_w, P_A, P_B, C, G) \quad (7)$$

These demand functions give the optimal quantities of $\boldsymbol{A}$ and $\boldsymbol{B}$, as functions of income, prices, pollution level and personal characteristics (Freeman, 2014).

2.2 Econometric specification and estimation methods

Based on the above model, the study estimates the dose response function, health production function, and the demand functions for mitigating and averting activities using the appropriate regression models.

2.2.1 Dose response function

In the dose-response function in equation (2), the dose or exposure to pollution is measured by the prevalence of respiratory diseases, for example, byssinosis, asthma, blood phlegm, chronic cough and bronchitis in textile workers, which depends on environmental and factory characteristics (*C*), averting activities (*A*), and personal characteristics of workers (*G*). The econometric specification of equation (2) can be written as:

$$D = D\ (C, A, G) + \varepsilon \qquad (8)$$

where the dependent variable D represents the status of illness. Equation 8 will be estimated for the following respiratory diseases including byssinosis, asthma, blood phlegm, chronic cough and bronchitis. In the case of byssinosis, the dependent variable is defined as the categorical variable (0, 1, 2, 3): that is, 0 if no byssinosis, 1 if occasional chest tightness on Monday, 2 if frequent chest tightness on Monday only, and 3 if chest tightness on Monday and other days. Given that the byssinosis categories are in ordered form and the dependent variable is an ordered response variable, we use the ordered Probit model. For other diseases, including asthma, blood phlegm, chronic cough and bronchitis, the dependent variable is defined as binary. We, therefore, use the binary response Probit models for asthma, blood phlegm, chronic cough, and bronchitis.

The right hand side of equation (8) includes the independent variables, i.e., environmental and factory characteristics (*C*), averting activities (*A*) and personal characteristics (*G*), and the error term (ε). The environmental and factory characteristics include work section, dust level, and temperature. We use dummy variables to represent the work sections of the spinning mill. In the model, the work sections include the opening section, blow room section, card room section, simplex section, ring frame section, and auto cone section.[5] We select the ring frame section as the base dummy since it is one of the relatively less dusty sections. The dust level is a categorical variable defined as 1 for less dust than normal, 2 for normal dust levels, and 3 for more dust than normal. Temperature is a continuous variable. The averting activities include use of mask which is a binary variable and equals 1 for use of mask. Personal characteristics include age, smoking, gender, and marital status. The last two characteristics are binary variables, i.e., 1 if male, 0 otherwise; and 1 if married, 0 otherwise. Age is measured in years and smoking is measured in terms of the number of cigarettes smoked per day.

2.2.2 Estimation of the health production function

With regard to the health production function in equation (3), the econometric model is specified as:

$$S = S\ (C, A, B, G) + u \qquad (9)$$

where the dependent variable S is the number of days sick due to dust induced illnesses which is a function of the environmental and factory characteristics, averting activities, mitigating activities (visit to doctor), personal characteristics, and error term u. The independent variables have already been defined above. In this model, the data of the dependent variable (i.e., work hours missed) is a continuous variable which is censored at zero for most of the observations. Since the Tobit model is appropriate for this kind of data, it is estimated.

---

[5] Spinning mills normally comprise the following six sections. These sections also show stages of the spinning process: Opening/mixing section, which is the first stage of the spinning process where the fibers are separated from sacks. It is a highly polluted section since it is the initial stage of the spinning process; Blow room section, which is the second step in the spinning process, where impurities are removed from cotton fibers. This, too, is quite polluted since a lot of cotton dust is generated in the cleaning process; Card section, the third stage of the spinning process, is where fibers are separated by processes like carding and drawing and slivers are made. This could also be characterized as a highly polluted section, particularly as it generates the highest level of micro dust;
Samplex section, the fourth stage of the spinning process, is where slivered fibers are transformed into ravings, which is relatively less polluted than the first three sections; Ring section, the fifth stage of the spinning process, is where yarn is produced, which is a relatively less dusty section; Autocone section, which is the last stage of the spinning process, is where yarn is wound on bobbins, which, too, is a less dusty section.

2.2.3 Estimation of the averting activities function

With regard to the averting activities function in equation (6), the econometric model is defined as:

$$A = A(I, P_w, P_A, P_B, C, G) + \omega \quad (10)$$

The dependent variable in this model is use of mask, which represents averting activity. Data on prices were not available. Thus, this model was estimated using explanatory variables including income related variables, environmental and factory characteristics, and personal characteristics. The income-related variables include employment status and monthly income. The use of mask data is binary. Hence, we use a Probit model for analysis.

2.2.4 Estimation of the mitigating activities function

The economic model for the mitigating activities function in equation (7) is redefined in the econometric model as:

$$B = B\,(I, P_w, P_A, P_B, C, G)+e \quad (11)$$

where the dependent variable is visit to doctor. As data on prices were not available, this model was also estimated using explanatory variables including income related variables, environmental and factory characteristics, and personal characteristics. We again use the Probit model for analysis as the dependent variable is binary.

3. Data

3.1 Study Area

The study was carried out in the Faisalabad district, which is the third largest industrial town in Pakistan with a population of more than 3 million. At present, there are 612 large industrial units in the district out of which 248 are textile units (Ishfaq, 2006). In addition, there are a large number of subsidiary textile units, known as power looms. Due to the high concentration of textile units in the district, Faisalabad is called the textile city of Pakistan. Labor force participation in the industry in Faisalabad is also very high due to the large number of industrial units (Khan *et al*., 2013). However, the district is facing serious air and water pollution due to industrialization and urbanization. There is as yet no monitoring of air quality in the city. Nor does any facility exist for the treatment of effluents from the industrial plants (Ishfaq, 2006).

3.2 Sampling and Data Collection

The study adopted a multistage random sampling technique to select workers for the study. In the first stage, we selected 11 spinning mills randomly from the list available at the All Pakistan Textile Mills Association (APTMA), Faisalabad while, at the second stage, a well-informed and middle-level worker (called 'monitor' in the survey) was selected from each factory on payment to help us with contacting workers in each factory for participation in the survey and to liaise between the survey team and respondents. Of the workers thus contacted, we randomly selected 210 workers among whom we distributed the "health diary" in August and September of 2013. Each worker was asked to complete the "health diary" each night for 15 consecutive nights. The diary contained detailed information on the health condition of the worker and its implications. After 15 days, we received 206 completed diaries[6] and carried out a survey in the form of an interview among the 206 workers who had completed the diaries. The worker survey questionnaire elicited information on workers' socio-economic characteristics, occupational exposure, chronic diseases, etc. The questionnaires for both surveys were based on questionnaires used in byssinosis and health cost studies in recent times (Wang & Christiani, 2003; Gupta, 2006; Adhikari, 2013). A medical practitioner specializing in chest-related diseases provided expert input on developing the health section of

[6] The overall response rate was high which may have had something to do with the giving of cash payments or souvenirs to respondent workers and monitors. To minimize possible biases, the survey was accompanied by an agreement that the identity of the respondents will not be revealed at any stage.

the questionnaire which added much value to the questionnaire. We pretested both the health diary and the general worker survey in April 2013 at one of the spinning mills. We fine-tuned the questionnaires (see Appendix) based on the pre-test experience.

4. Results and Discussion

4.1 Descriptive Statistics

Table 1 provides the descriptive statistics of the variables used in the model. With regard to gender, most of the workers (86%) in the sample are male. The average age of the worker is 28 years (see Table 1). A majority of the workers (95%) are literate although, in terms of education levels, a majority of female workers fall into the lower categories in comparison with male workers (see Figure 1). The average wage of workers is PKR 13392 although the average wage of female workers is PKR 9857 in contrast with PKR 13949 for male workers (not reported in the table), which indicates that earnings of female workers are 30% lower than that of male workers. In 45% of the cases, even the minimum wage law (PKR 10,000 per month in 2013) did not appear to apply. More than half (52%) are casual workers with only 30% of employees being permanent and entitled to a fixed wage. Among them, there were no females. The data reveals a significant percentage (at 16.5%) to work for a daily wage (see Figure 2).[7]

We asked the workers whether the factory provided them with face masks or whether they were expected to purchase their own face masks. A majority of workers said that face masks were provided by the factory at no cost. However, despite availability, the use of safety masks was low with only 14% of workers saying that they often use masks, 64% using it sometimes, and 22% openly admitting that they never use masks while at work (see Figure 3). Similarly, despite free availability of ear plugs to a majority of workers, the use of ear plugs was almost non-existent in our sample (see Figure 3). These results are quite similar to results of previous studies in Pakistan and other developing countries that show infrequent use of protective masks among textile workers (Malik *et al*., 2010; Howyida *et al*., 2012; Mahmoud *et al*., 2004; Anjum *et al*., 2009).

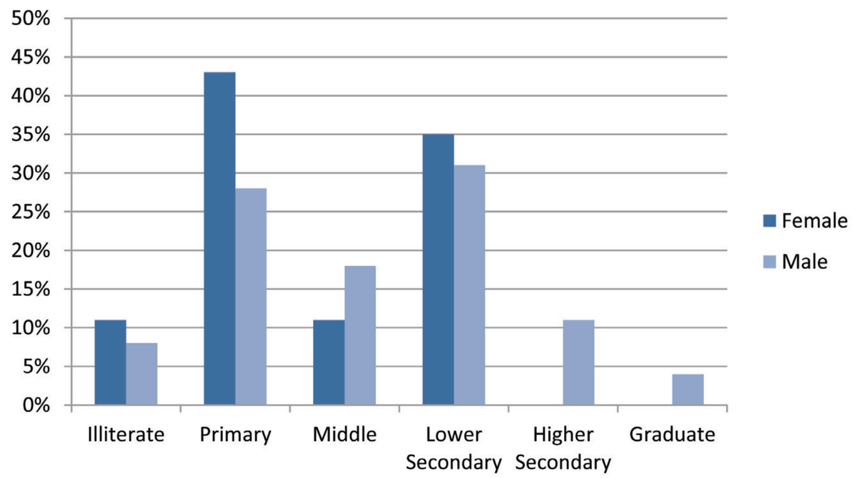

Figure 1: Education of workers by gender

[7] **Regular paid employee with fixed wage**: permanent (or fixed term contract) employee with a fixed wage. This worker is entitled to all labor and social security benefits. **Casual paid employee**: workers with no job security who are not entitled to sick and parental leave and can be terminated at any time without prior notice. They are entitled to some but not all the benefits given to permanent/regular workers. **Daily worker at fixed pay**: These workers are hired on a per day basis at a fixed rate with specified hours of work per day. **Paid worker at piece rate**: These workers are paid a rate per piece manufactured or produced or a task performed.

According to the survey, a significant number of workers complained of respiratory symptoms. As evident in Table 1, 36% of workers complained of chronic cough, 18.9% of phlegm, 9% of blood with phlegm and 17% of at least one episode of bronchitis. Additionally, 4.4% and 5.3% were suffering from asthma and tuberculosis, respectively. Given the infrequent use of protective measures, the results are not surprising which are comparable with those of studies in many developing countries including South Asia (Mberikunashe *et al*., 2010; Alemu *et al*., 2010; Howyida *et al*., 2012; Aminian *et al*., 2013; Farooque *et al*., 2008; Mishra *et al*., 2003; Ghasemkhani *et al*., 2006; Wang *et al*., 2003).

Table 1: Definition and summary statistics of variables used in the analysis

Variables	Definition	Mean	Standard Deviation	Minimum	Maximum
Dose Response Function Variables (D)					
Byssinosis	0 if no byssinosis, 1 if occasional chest tightness on Monday, 2 if chest tightness on Monday only, 3 if chest tightness on other days as well as Monday	.354	.76	0.00	3.0
Chronic Cough	1 if worker experiences chronic cough; 0 otherwise	.359	.48	0.00	1.00
Blood phlegm	1 if worker experiences blood phlegm; 0 otherwise	.092	.29	0.00	1.00
Asthma	1 if worker experiences asthma; 0 otherwise	.053	.22	0.00	1.00
Bronchitis	1 if worker experiences bronchitis; 0 otherwise	.170	.38	0.00	1.00
Health Production Variable (S)					
Work hours lost	Number of work hours lost in 15 days	2.37	6.66	0.00	56.00
Averting Activities Variables (A)					
Use of Mask	1 if worker uses mask	.14	.32	0.0	1.0
Mitigating Activities Variables (B)					
Visit Doctor	I if visit doctor in 15 days	.09	.29	0.0	1.0
Medical expenditure	Medical expenses borne in 15 days (PKR)	7.77	34.09	0.0	358.0
Personal Characteristics (G)					
Male	1 if male	.86	.34	0.0	1.0
Age	Years	28.34	6.94	15.0	45.0
Smoking cigarettes	Cigarettes per day	3.49	6.85	0.0	30.0
Married	1 if married	.61	.48	0.0	1.0
Education	Total years of education	7.85	3.20	0.0	14.0
Income Related Variables (I)					
Income per month	Pakistani rupees	20320	8653.8	5500.0	50000.0
Wage per month	Pakistani rupees	13392	5734.2	2000.0	29000.0
Permanent employee	1 if permanent	0.30	.46	0.0	1.0
Casual employee	1 if casual	0.52	.50	0.0	1.0
Daily wage workers	1 if daily wage worker	0.17	.39	0.0	1.0
Environmental or Factory Characteristics (C)					
Dust level in section	1 if less dust than normal, 2 if normal/routine level dustiness, 3 if more dust than normal.	2.18	.29	1.0	3.0
Ring section (base section)	1 if work in ring section	.20	.40	0.0	1.0
Opening section	1 if work in opening section	.22	.42	0.0	1.0
Blow room section	1 if work in blow room section	.13	.33	0.0	1.0
Card room section	1 if work in card room section	.16	.37	0.0	1.0
Samplex section	1 if work in samplex section	.17	.38	0.0	1.0
Ring section	1 if work in ring section	.12	.32	0.0	1.0
Temperature in work section	Centigrade	32.8	.60	31.0	34.0
Total observations	206				

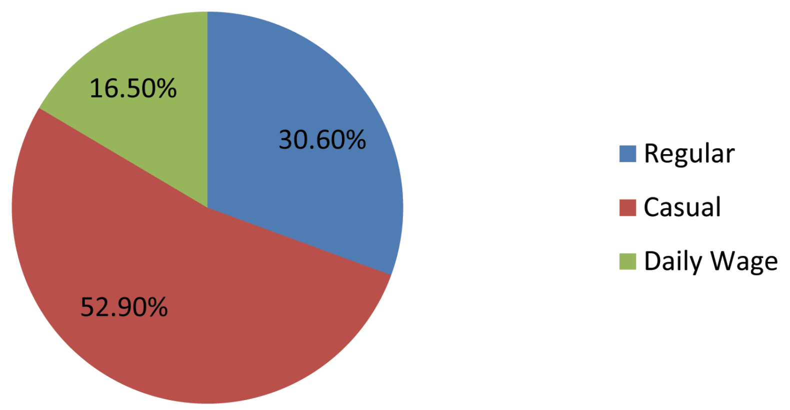

Figure 2: Employment status of respondents

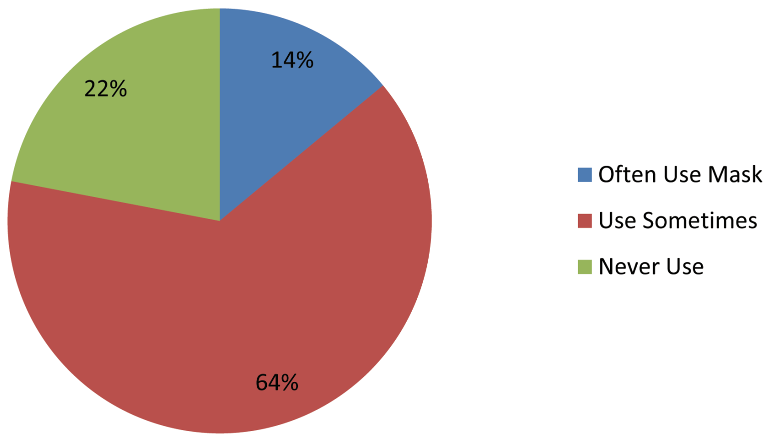

Figure 3: Use of mask by workers

There are two standard instruments to measure byssinosis: the Pulmonary Function Test (PFT) and the byssinosis questionnaires using Schilling's grading criterion. Although both are equally acceptable as diagnostic criteria for byssinosis, a majority of studies, as evident from the literature, have applied Schilling's grading methodology to diagnose byssinosis in comparison with the smaller number of studies using Pulmonary Function Test (PFT). In recent times, a few studies have attempted to verify the result across different diagnostic criteria for byssinosis (Farooque *et al*., 2008; Memon *et al*., 2008; Wang *et al*., 2002). These studies have collected self-reported data from textile workers about symptoms of byssinosis using the standard questionnaires of Schilling's grading methodology for diagnosing the disease, which would then be followed by medical examinations of the workers. Since the variation in results across the two techniques was negligible, both the Pulmonary Function Test (PFT) and the standard byssinosis questionnaire can be deemed acceptable diagnostic criteria for assessing byssinosis. Thus, for the purposes of this study, byssinosis was defined using Schilling's grading of the disease: no byssinosis (grade 0); byssinosis grade ½; byssinosis grade 1; and byssinosis grade 2 & 3.[8] The results indicate that the

[8] Grades 2 and 3 symptoms are jointly described because grade 3 symptoms can be precisely diagnosed only through the spirometry or Lung Function Test (LFT), which has not been undertaken in the case of the present study.

overall prevalence of byssinosis among textile workers is 22.3% (with 7.8% classifiable as grade ½; 13.1% as grade 1 and 1.4% as grade 2 or 3). A majority of the studies in Pakistan have reported similar results. For example, Farooque *et al*. (2008) reported 19% byssinosis in Karachi while Saleema *et al*. (2007) reported 14.4% byssinosis in Faisalabad although the 35% reported by Memon *et al*. (2008) is much higher than that of both previous studies and the present study. The results also reveal that the occurrence of the disease varies considerably depending on the concentration of cotton dust in the work environment. Thus, we find the highest proportions of byssinosis and other respiratory symptoms among those working in the blow room section followed by the card and opening sections (see Figure 4). These results clearly point to an association between dust levels in the mill and symptoms of byssinosis.

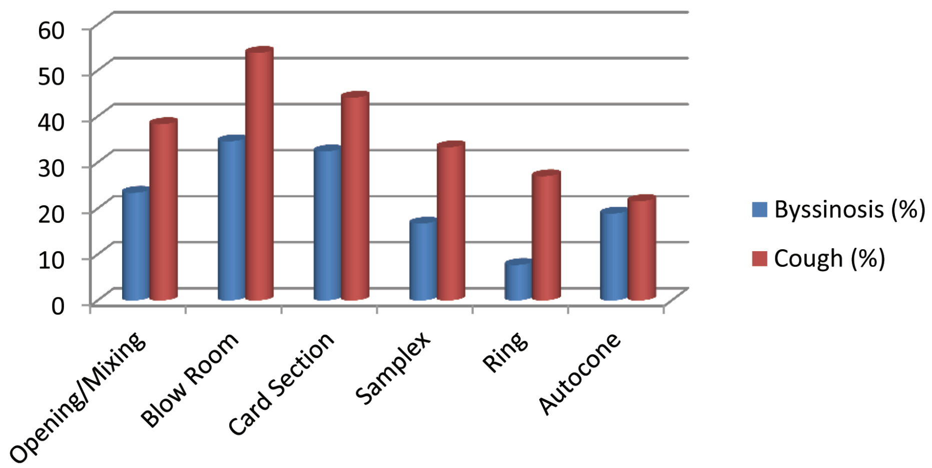

Figure 4: Prevalence of byssinosis and cough by work section

4.2 Health Cost

The cost of the health effects that workers bear due to pollution in the factory must be accounted for. Such valuation provides us monetary estimates of the economic burden of the diseases to workers. The results show that more than 9% of workers visited a doctor during the specified two-weeks as reported in the health diary. The per month mean treatment cost of ill workers is PKR 4096 which includes the treatment cost, travel cost and cost of workdays missed due to illness (see Table 2). The above cost estimates are certainly less than the real cost of health damage since we have only included the actual costs that are borne by the workers themselves, not the cost to the government of the free treatment that many workers received at social security hospitals Further, we did not include the opportunity cost of treatment time (time spent in waiting and travel for treatment of workers and/or accompanying person).[9] Given the low wages in textile mills and the weak economic position of the workers, this cost places a significant financial burden on workers, accounting for roughly 32 % of their income.[10]

[9] In addition, the cost of work days lost is not fully reflected in the estimates because, although many workers actually missed work, the economic cost of work hours missed either to the employee or employer is not included in the calculation. Furthermore, these estimates do not include expenditures on averting activities and the opportunity cost of time associated with medical care (the time spent on traveling and waiting at doctor's clinic and the time of the attendant or accompanying person, etc.). Also the estimates are lower bound estimates because it does not take into consideration losses that are incurred due to reduced efficiency and the discomfort caused by illness.

[10] This cost is particularly high for female workers given that half of the female textile industry workers receive less than the minimum wage stipulated by the government.

Table 2: The health cost estimates

Variable name	Estimated value for workers who visited doctors	Estimated value from total sample
Proportion of workers visited a doctor during the 15-day health diary survey (%)	-	0.09
Average treatment cost (in PKR)	993	89.4
Average travel cost (in PKR)	339	30.5
Average cost of work days missed (in PKR)	716	64.4
Total health cost in 15 days (in PKR)	2048	184.3
Estimated total health cost per month (in PKR)	4096	368.6
Health cost as % of income	32%	2.9%
Observations	20	206

4.3. Results of the dose response function

In this section, we present the results of the regressions, which investigate the factors that influence the development of respiratory diseases in the textile mills. We estimate an ordered Probit model for byssinosis and four Probit models for asthma, chronic cough, blood with phlegm, and bronchitis. Table 3 presents the ordered Probit model estimates as well as the marginal effects. The Pseudo R^2, which measures the overall goodness of fit of the model, is 0.1061. It is noteworthy that a positive (or negative) value of a coefficient, combined with an increase in the corresponding explanatory variable, will increase (or decrease) the probability of the highest ordered byssinosis (i.e., byssinosis grade 2 or 3) and decrease (or increase) the probability of no byssinosis (Garrido *et al*., 2014).

With regard to factory characteristics, the results show that the probability of developing byssinosis is significantly higher for individuals who work in dusty sites and in spaces of higher-than-average temperature. The coefficients for dusty work sections such as the opening section, blow room section and card room section are positive and significant at the 1% level. The marginal effects of work section dummies specify that if a worker moves from the ring (base) section to the opening section, the probability of no byssinosis decreases by 30% or the probability of byssinosis increases by 30% (14% for grade 1/2, 7% for grade 1 and 9% for grade 2 or 3). Similarly, the probability of developing byssinosis increases by 49% (grade ½ by 16%, grade 1 by 11% and grade 2 or 3 by 20%) if a worker moves from the ring section to the blow room section while the probability of no byssinosis decreases by 49%. Likewise, the probability of developing byssinosis increases by 49% if a worker moves from the ring section to the card room section (grade ½, grade 1 and grade 2 & 3 categories of byssinosis increases by 17%, 11% and 20%, respectively). Again, the probability of no byssinosis decreases by 49% for the said worker. The high prevalence of byssinosis in these sections may be due to high dust concentrations since the dust level is associated with the section type. Hence, most of the variation in dust is captured by section type which turns the explanatory variable dust-level non-significant.

The results, therefore, clearly establish the relationship between dusty work sections and the development of byssinosis. The results are in line with both expectations and conventional wisdom since the opening, blow room and card room sections are earlier steps in textile processing and are, consequently, more polluted than the simplex, ring and autocone sections. The literature also corroborates the correlation between the occurrence of the disease and the levels of concentration of cotton dust in the work environment. White (1989), who examined 2411 textile workers in six textile mills in South Africa, found that byssinosis was highest (44%) among bale opening and blow room workers. In contrast, a lower prevalence of 5% and 7% was observed in the card and ring frame sections, respectively. Similar results have been reported by Parikh *et al*. (1989) in three textile mills in India where the prevalence of byssinosis was 30% in blow rooms and 38% in card rooms. A study by Gupta and Gupta (1988) found the prevalence of byssinosis in the blow room to be 37%, card room 47%, spinning 17%, weaving 22%, and finishing 7%. A more recent study in India by Mishra *et al*. (2003) underscores the fact that work in the spinning and weaving sections is an important factor in the development of byssinosis in textile workers. Studies in Pakistan corroborate these findings. Farooque *et al*. (2008) and Memon *et al*. (2008), for example, have identified the work section as a major contributory factor of disease. Saleema *et al.* (2007) have found the dusty work section to be the main cause of symptoms of byssinosis.

Table 3: Ordered Probit analysis of status of illness (D)

	Dependent variable: byssinosis				
Independent variables	**Coefficient**	**Marginal effects**			
		No byssinosis	**Grade 1/2**	**Grade 1**	**Grades 2 & 3**
Environmental & factory characteristics (C)					
Opening section	0.951***	-.304***	.141***	.070***	.093***
Blow room section	1.40***	-.487***	.167***	.111***	.208***
Card room section	1.42 ***	-.488***	.174***	.112***	.202***
Simplex section	1.012*	-.336*	.146*	.078*	.111*
Autocone section	.962 *	-.317*	.141*	.073*	.101*
Dust level in section	.342	-.092	.053	.020	.019
Temperature in section	.459***	-.124***	.029***	.026***	.026***
Averting activities (A)					
Use of mask	.266	-.078	.042	.017	.018
Personal characteristics (G)					
Male	-.136	.038	-.021	-.008	-.008
Age	.023	-.006	.003	.001	.001
Smoking cigarettes	.034***	-.009***	.005***	.001***	.001***
Married	-.024	.006	-.003	-.001	-.001
Observations	206				
Pseudo R squared	0.1061				

Note: ***, ** and * denote significance at 1%, 5% and 10%, respectively

Table 3 shows the results for other (relatively less dusty) work sections like simplex and auto cone sections also to be positive. However, they are significant at only the 10% level, which means that the average risk of byssinosis is increasingly aggravated by dusty work sections. In fact, the largest positive parameter of grade 2 or 3 byssinosis is the blow room section followed by the card room section. This shows the blow room and card room sections to be the most critical factors as regards disease prevalence, work in which sections significantly increases the average risk of developing the highest grade byssinosis by textile workers. Other than work section variables, a variable of importance to this study is the temperature variable, which is positive and a highly significant contributor to the development of byssinosis among sample workers. A one-unit increase in temperature causes a 3% point increases the likelihood of developing byssinostic symptoms of each grade ½, grade1 and grade 2 or 3. This shows that an increase in temperature enhances the risk of byssinosis among workers.

Among personal characteristics, smoking is the only variable significant at the 1% level establishing the fact that smoking cigarettes significantly increases the probability of developing byssinosis. The marginal effects indicate that an increase in smoking by one cigarette would increase the probability of byssinosis by 0.9% (grade 1/2 of byssinosis increasing by 0.5%, grade 1 of byssinosis increasing by 0.2% and grade 2 or 3 of byssinosis increasing by 0.2%). This result is congruent with previous studies where, too, byssinosis is found to be significantly higher among smokers than non-smokers (Wang *et al*., 2003; Yih-Ming *et al*., 2003; Jaen *et al*., 2006; Farooque *et al*., 2008). A study in Taiwan has found that, since smoking potentiates the effect of cotton dust exposure on byssinosis, the prevalence of impaired lung function was significantly higher among smokers than non-smokers (Liou *et al*., 1994). Jaiswal (2011) has similarly reported significantly higher symptoms of byssinosis among smokers in India.

Table 4 gives the Probit regression results for asthma, blood phlegm, chronic cough and bronchitis, according to which the pseudo R squared value is 0.25 for asthma, 0.22 for blood phlegm, 0.08 for chronic cough and 0.11 for chronic bronchitis. Among environmental and factory characteristics, the coefficient of the dust pollution variable carries a positive sign for all the respiratory diseases, which result is highly significant (at the 1% or 5% level) for chronic respiratory diseases except chronic cough. The results indicate that an increase in dust level in the factory increases the likelihood of respiratory diseases. To be more specific, the marginal estimates show that a one-unit increase in dust level causes a 1%, 8% and 21% increase in asthma, blood phlegm and bronchitis, respectively. The association between the concentration of airborne dust in the working environment and the prevalence of respiratory symptoms among textile workers has been established in many studies from different countries (Schilling *et al*., 1964; Jaén *et al*., 2006; Saleema *et al*., 2007; Memon *et al*., 2008; Hinson *et al*., 2014; Jiang *et al*., 1995; Fantahum & Abebe, 1999; Jaiswal, 2011). The result therefore, is in line with previous research. The coefficient of temperature is positive and significant with chronic cough and blood phlegm, signifying an increased level of respiratory diseases with increasing temperature.

Among the non-occupational (personal) factors, we find that smoking cigarettes is significantly associated (at 1%) with asthma, blood phlegm and chronic bronchitis. The non-significant effect of age suggests that the effect of dust is either not a cumulative one or that resistance develops among workers over time. We find marital status also not to be statistically significant. Another variable of interest is the use of mask which turns out to be insignificant with regard to all respiratory symptoms. Most coefficients of the variables have the required signs though they are not significant.

Table 4: Marginal effects of the dose response function (Probit models)

	Dependent Variables			
Independent variables	**Asthma**	**Blood phlegm**	**Chronic cough**	**Bronchitis**
Environmental & factory characteristics (C)				
Opening section	0.727(110)	0.924(18.7)	0.100(.135)	0.179(0.154)
Blow room section	.979(19.6)	.993 (2.36)	.343 (.137)***	.238 (.182)
Card room section	.958(33.5)	.988 (4.27)	.241 (.138)*	.290 (.178)**
Simplex section	-	.961 (11.6)	.110 (.137)	.270 (.172)
Autocone section	.734 (120)	.936 (17.5)	-.061 (.134)	.065 (.145)
Dust level in section	.018 (4.13)**	.060 (3.12)***	.029 (.117)	.214 (.081)***
Temperature in section	.003(.693)	.013 (.716)	.163 (.058)***	.075 (.042)*
Averting activities (A)				
Use of mask	.003(.720)	.009 (.466)	.048 (.118)	-.030 (.069)
Personal characteristics (G)				
Male	-.062 (10.0)***	-.032 (1.48)	-.127(.122)	-.281 (.127)***
Age	-.000(.104)	-.001 (.100)	.003 (.005)	.002 (.003)
Married	-.000(.212)	-.005 (.302)	-.019(.076)	-.015 (.052)
Smoking cigarettes	.007 (.171)***	.002 (.114)***	.002 (.005)	.007 (.003)***
Constant	-14.61	-18.03	-15.39***	-15.00***
Observations	206	206	206	206
Pseudo R squared	= 0.25	0.22	0.08	0.15

Note: ***, ** and * denote significance at 1%, 5% and 10%, respectively. Standard errors are in parenthesis.

The study also investigated the possible influence of gender on chronic respiratory diseases, the results for which show that the gender of the worker is statistically significant for asthma and bronchitis and has the expected negative sign for all cases. The results show male workers to have a 6% lower probability of developing asthma and a 28% lower probability of developing bronchitis symptoms compared to female workers. The result is statistically significant at the 1% level and conforms with prior expectations as the women work in the relatively more dusty work sections (see Figure 5). In short, it is apparent from the coefficients derived from regression models that byssinosis and other respiratory diseases are closely associated with smoking and dusty work sections.

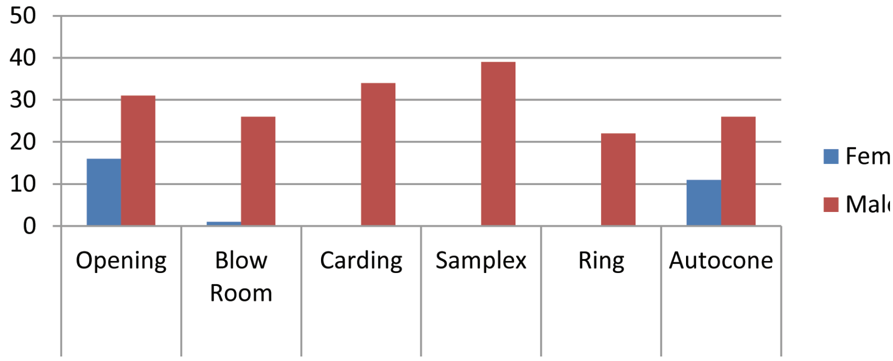

Figure 5: Distribution of work section by gender

4.4 Results of the Health Production Function

The health production function is estimated using the Tobit regression model, the results for which are presented in Table 5. The goodness of fit of the model shows that Pseudo R^2 is 0.061. The coefficients of all the environmental and factory variables are significant with the expected positive signs except those for temperature and the blow room section, indicating that workers in the opening, card room, samplex, and autocone sections report significantly higher absences from work than those in the ring section (i.e., base section). The marginal effect of the dust pollution variable, in particular, reveals that a one-unit increase in the dust level in the mill leads to 5 hours of work lost. Similarly, all else being constant, if a worker moves from the ring section to the opening, card room, simplex or auto cone section, the work hours lost increases by 3 hours, 2.8 hours, 2.65 hours and 3.4 hours, respectively, in the reference period of 15 days. This shows that the number of work hours lost is comparatively higher among workers in the dusty sections compared to the less dusty sections. The temperature and blow room variables however turn out to be insignificant. Nevertheless, the overall results clearly demonstrate the positive association between work hours lost and dust pollution in the mills.

Table 5: Marginal effects of the health production function

Independent variables	Dependent variable: work hours missed
	Marginal effects
Environmental or factory characteristics (C)	
Opening section	3.030855** (7.79395)
Blow room section	1.99992 (8.44162)
Cardroom section	2.824387* (7.95631)
Samplex section	2.652059* (7.87867)
Autocone section	3.392343** (8.0256)
Dust level in section	4.940254*** (6.08618)
Temperature in section	.0963761 (2.69426)
Averting activities (A)	
Use of mask	-2.430088** (6.68886)
Mitigating activities (B)	
Visit to doctor	1.673862 (5.74918)
Personal characteristics (G)	
Male	-1.248238 (5.2968)
Age	.0302423 (.27675)
Married	.0256365 (3.55745)
Cigarette smoking	.012446 (.26823)
Observations	206
Pseudo R squared	0.0613

Note: ***, ** and * denote significance at 1%, 5% and 10%, respectively. Standard errors are in parenthesis.

The coefficient of the use of mask (averting activities) variable is negatively and significantly related (at the 10% level) to work hours lost, suggesting that the use of the mask leads to reduced work hours lost. The marginal effect indicates that the probability of work hours lost decreases by 2.4 hours for users of mask compared to non-users. The result carries an important policy implication for mill management in terms of improving the safety culture in factories. Farooqui *et al*. (2008) derives a similar result. They have shown that strict enforcement of the use of safety masks by mill management in Karachi, Pakistan, resulted in significantly fewer respiratory diseases and related health complications. On the contrary, the coefficient of the visit to doctor (i.e., mitigating activities) variable correlates positively with work hours lost, indicating that the probability of work hours lost increases for those workers who visit a doctor for treatment. The result however is not significant. All other variables for personal characteristics also turn out to be insignificant.

4.5 Results of the Demand Functions for Averting Activities

Table 6 gives the regression estimates of averting activities where the dependent variable is the use of mask, the Pseudo R^2 value for which is 0.19. The income of workers shows a positive association with use of mask although it is not significant. Similarly, the price of mitigating activities variable is not significant with the use of mask. The coefficients of the blow room and card room section variables from environmental and factory characteristics indicate negative relationships with the use of mask at the 5% level of significance. The marginal effects indicate that all else being constant, the use of mask decreases by 7% and 8%, respectively, if the worker moves from the base section (ring section) to either the blow room or card room section. These results highlight obvious carelessness on the part of those working in blow room and card room sections compared to those in the ring section. The temperature variable also turns out significant and negative vis-a-vis use of mask. The marginal effect shows that a one-unit (i.e., centigrade) increase in temperature leads to a 6% decrease in the use of mask, which suggests that the higher temperature induces workers to wear the face mask less.

Table 6: Marginal effects of mitigating and averting activities (Probit models)

Independent variables	Dependent variables	
	Use of mask	Visit to doctor
Income related variables (I)		
Monthly income	.003 (.002)	-.001 (.001)
Permanent employment	.046 (.065)	.209** (.099)
Daily wage worker	.058 (.071)	-.026 (.029)
Environmental or factory characteristics (C)		
Opening section	.033 (.077)	-.047 (.030)
Blow room section	-.073 (.035)**	-.019 (.038)
Card room section	-.077 (.036)**	-.033 (.028)
Simplex section	-.009 (.061)	-.001 (.043)
Auto cone section	.073 (.094)	-.006 (.043)
Temperature in section	-.061 (.031)**	-.016 (.020)
Dust level in section	.020 (.069)	-.062 (.566)
Personal characteristics (G)		
Age	.003 (.003)	-.008*** (.003)
Male	-.099 (.087)	.043** (.024)
Education	.037 (.025)	-.008 (.019)
Married	.058 (.036)	.004 (.028)
Observation	206	206
Pseudo R squared	0.19	0.20

Note: ***, ** and * denote significance at 1%, 5% and 10%, respectively. Standard errors are in parenthesis.

Among personal characteristics, the results indicate the use of mask to be lower among male workers than female workers. Being male decreases the likelihood of use of mask by 17%, which indicates men to be relatively less cautious about safety at work. However, this may not necessarily be the case in reality. Women in Pakistan routinely use a shawl called the dupatta to cover their head and face which could be interpreted to mean a higher use of a face mask. Hence, higher or lower use of a face cover has more to do with a gendered cultural practice than a concern with safety. The result is not anyway significant. The worker's education, mitigating expenditures, age, marital status and dust level are also not significant determinants of mask use.

4.6 Results of the Demand Function for Mitigating Activities

We estimate the demand function for mitigating activities (i.e., visit to doctor) using the Probit regression model, the results for which are also given in Table 6. The goodness of fit statistics of the model shows that Pseudo R2 is 0.20. It shows the income variable to negatively affect the demand for mitigating activities although the result is not significant statistically. Similarly, the environmental and factory characteristics are not significantly related to demand for mitigating activities.

Among variables for personal characteristics, a positive relationship holds between the permanent worker dummy and visit to doctor at the 1% level of significance. The marginal effects of the permanent worker dummy indicate that being a permanent worker increases the likelihood of visit to doctor by 21% compared to base (i.e., casual) workers. The likely reason for this is the availability of free treatment from social security hospitals for permanent workers, something not normally available to other workers. The coefficient of age is negative and highly significant at 1%, indicating that increase in age of worker by one year leads to a decrease in the probability of visit to doctor by 1%. One possible reason for this could be that, with advancing age, workers become habituated to respiratory symptoms and do not bother to consult a doctor. Another possible reason could be that workers have developed resistance over time to respiratory symptoms and, therefore, do not need regular medication. The probability of a visit by a male worker to the doctor is also 5% higher than that for female workers, suggesting that, though male workers have experienced less burden of disease than female workers, the number of visits to doctors is also relatively higher. The weaker financial position of women vis-à-vis men, their employment status (i.e., casual, daily paid or piece rate), and lack of social security compensation which is dependent on job status may be the main reasons for the gender difference in visits to doctor.

5. Conclusions

Women and men working in the textile industry are exposed to a large number of occupational hazards affecting health. One of the most significant risk factors is exposure to airborne dust generated by fibers, which cause byssinosis and other respiratory impairments. These illnesses affect workers' health, productivity and quality of life very seriously. The present study has estimated the diseases and the associated economic burden for textile workers in Faisalabad, Pakistan. The study was undertaken in 11spinning mills in the Faisalabad district, the data for which were collected via a worker survey and a two-week health diary from a random sample of 206 workers. The results indicate that a majority of the workers are male and literate. Despite literacy, use of safety gadgets is low. The data show female workers to be discriminated in employment status, wages and work conditions which, in turn, increase their health burden.

The data shows that textile workers suffer from multiple diseases at work. Respiratory illnesses are higher among workers in dusty sections and among smokers. The respiratory illnesses are also high among female workers, probably due to the higher number of women workers in dusty sections. The respiratory illnesses contributed to functional limitations such as increased visits to doctors and loss of working hours. The analysis indicates that an increase in the level of dust and work in dusty sections amplify work hours lost. However, the number of work hours lost dwindles with a higher level of use of the face mask.

We obtain the economic burden of illness through the cost of illness approach. The analysis reveals that textile workers bear a significant monetary cost (PKR 4096 per month) in terms of medication, travel cost and work days lost due to respiratory morbidities. Keeping in view the bleak financial status of a majority of workers in the industry, the economic cost of illness places a significant financial burden on workers and their families. Again, the illness cost is higher for those who work in dustier sections.

The results of this study carry policy implications and can be used for appropriate interventions. For example, the estimates of respiratory illness symptoms show considerable variation between different work sections. Hence, the obvious correlation between respiratory illness symptoms and dusty worksites would be helpful in setting dust standards for the industry. It is imperative that personal protection, in the form of face masks, be mandated and punitive measures be introduced and instituted by the factory management against workers who are in violation of the directive in order to ensure their compliance with factory rules on the use of protective gear. Authorities should also take steps to carry out health education programs to raise the awareness among workers regarding the importance as well as proper use of personal protective gear in the textile industry. The Directorate of Workers Education (DWE) should be directed as well as equipped to promote a safety culture in textile mills by providing OSH training and advisory services to both the workers and management. In addition, the Labour Department should make the annual medical exam for workers compulsory on the part of factory owners and management for early detection and diagnosis of such occupation-related illnesses.

Acknowledgements

I wish to acknowledge the financial support from the South Asian Network for Development and Environmental Economics (SANDEE) that made this research possible. My heartfelt thanks go to my advisor, Jeffery Vincent, for his valuable comments and professional advice throughout the research. My sincere and deep appreciation is also due to Priya Shyamsundar for keeping track of the research in a very personal way. I am also grateful to the advice, support and close assistance from Heman Lohano towards completing this manuscript. I have also gained much from Mani Nepal and from the comments of resource persons at different stages of this study and I am thankful to them all. I especially thank Neesha, Anuradha, Bhawana and Malvika for their assistance with the logistical aspects to the project.

[11] A good example of such action is found in Farooqui *et al*. (2008) who reported that mill management in the city of Karachi, Pakistan, had placed a fine of PKR 100/= on whosoever would not wear the safety masks while working. This resulted in the higher use of safety gadgets and significantly lower incidence of respiratory illnesses.

[12] A study in Egypt concluded that educational interventions towards increasing workers' knowledge on and compliance with the use of personal protective equipment was effective and that, at the conclusion of the initiative, there was drastic improvement in the use of personal protective equipment by worker (Howyida *et al*., 2012).

References

Adhikari, N. (2012), 'Measuring the health benefits from reducing air pollution in Kathmandu Valley', SANDEE Working Paper No. 69-12, South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu, Nepal.

Ajeet, S., D. Aniruddha, K. Meenal and N. Jaydeep (2010), 'To study the prevalence of chronic respiratory morbidities and related epidemiological factors among spinning mill workers', *Global Journal of Health Science* **2**(2):111-116.

Alemu, K., K. Abera, and D. Gail (2010), 'Byssinosis and other respiratory symptoms among factory workers in Akaki textile factory, Ethiopia', *Ethiopian Journal of Health Development* 24(2):133-139.

Aminian O., S. Amir, R. Mozafari, K. Sadeghniiat, F. Chavoshi, and M. Saraie (2013), 'Study of respiratory symptoms and pulmonary function in cotton textile workers', *The Journal of Basic and Applied Scientific Research* 3: 33-36.

Anjum, A., A.A. Mann, and M.A. Anjum (2009), 'Health concerns among workers in weaving industry: a case study of Tehsil Faisalabad, Pakistan', *Journal of Agriculture and Social Science* 5: 106–108

Bates, D.V., A.R. Gotsch, S. Brooks, P. J. Landrigan, J. L. Hankinson and J. A. Merchant (2010), 'Prevention of occupational lung disease', *Chest Online, Official Journal of the American College of Chest Physicians*. Available at: www.chestjournal.chestpubs.org [Accessed on October 17, 2011]

Board of Investment (2007), Government of Pakistan (Homepage of Board of Investment, Government of Pakistan) (online). Available at: http//www.pakboi.gov.pk [Accessed on March 22, 2017]

Choudhary, T. and M. Imran (2010), 'Morbidity cost of vehicular air pollution: examining Dhaka City in Bangladesh', SANDEE Working Paper No. 47-10, South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu, Nepal.

Christiani, D.C., X.R. Wang, and L.D. Pan (2001), 'Longitudinal changes in pulmonary function and respiratory symptoms in cotton textile workers: a fifteen-year follow-up study', *American Journal of Respiratory Care* 163: 847-53.

Cinkotai, F.F., A. Rigby, C. Pickering, D. Seaborn, and E. Faragher (1988), 'Recent trends in the prevalence of byssinotic symptoms in the Lancashire textile industry', *British Journal of Medicine* 45: 782-9.

Fantahum, M. and Y. Abebe (1999), 'Self-reported disease conditions among workers of textile mill in Bahiroar, North West Ethiopia', *Ethiopian Journal of Health Development* 3(2): 151-156.

Farooque, M.I., B. Khan, E. Aziz, M. Moosa, M. Raheel, M. Kumars and F.A. Mansuri (2008), 'Byssinosis: as seen in cotton spinning mill workers of Karachi', *Journal of Pakistan Medical Association* 58(2): 95-98.

Freeman, A.M. (2014), *The Measurement of Environmental and Resource Values*: Theory and Methods, Washington, D.C.: Resources for the Future.

Ghasemkhani, M., S. Firouzbukhsh, K. Azam, and F. Gardashi (2006), 'Cotton dust exposure, respiratory symptoms and PEFR in textile workers', *Journal of Medical Science* 6(3): 458-462.

Government of Pakistan (2014), *Economic Survey of Pakistan* 2013-14, Finance Division, Islamabad.

Government of the Punjab (2008), 'Discussion paper for waste water treatment system in Punjab', The Urban Unit, Planning & Development Department, Lahore, Pakistan.

Government of the Punjab (2002), *Directory of Industrial Establishments*, Directorate of Industries, Punjab, Pakistan.

Grossman, M. (1972), ‘On the concept of health capital and the demand for health’, *Journal of Political Economy* 80(2): 223-255.

Gupta, U. (2006), ‘Valuation of urban air pollution: a case study of Kanpur City in India’, South Asian Network for Development and Environmental Economics (SANDEE) Working Paper No. 17-06, South Asian Network for Development and Environmental Economics (SANDEE), Kathmandu, Nepal.

Gupta, S. and B.K. Gupta (1988), ‘A study of byssinosis and associated respiratory disorders in cotton mill workers’, *Indian Journal of Chest Disease Allied Journal* 28: 183-188.

Harrington, W. and P.R. Portney (1987), ‘Valuing the benefits of health and safety regulations’, *Journal of Urban Economics* 22(1): 101-112.

Hinson, A.V., V. Schlünssen, G. Agodokpessi, T. Sigsgaards, and B. Fayomi (2014), ‘The prevalence of byssinosis among cotton workers in the North of Benin’, *International Journal of Occupational & Environmental Medicine* 5(4): 194-200.

Howyida, S.A. Hameed, A.A. Heba, A. Osama, and A. Latif (2012), ‘An intervention study to evaluate compliance with personal protective equipment among workers at Textile Industry’, *Journal of American Science* 8(7): 117-121.

ILO (2006), *Occupational Safety and Health: Synergies between Security and Productivity*, Geneva, Switzerland: International Labor Organization (ILO).

ILO (2009), ‘Implications of the global financial and economic crisis on the textile and clothing sector’, WCMS 162597, International Labour Office, International Labour Organization, Geneva, Switzerland

Ishfaq, A. (2006), ‘City report of Faisalabad’, City District Government, Faisalabad, Pakistan.

Jaen, A., J.P. Zock, M. Kogevinas, A. Ferrer and A. Marin (2006), ‘Occupation, smoking, and chronic obstructive respiratory disorders: a cross sectional study in an industrial area of Catalonia, Spain’, *Environmental Health* 5:2-7.

Jaiswal, A. (2011), ‘A study of the occupational health function among female textile workers’, *International Journal of Sociology and Anthropology* 3(3): 109-114.

Jiang, C.Q., T.H. Lam, C. Kong, C.A. Cui, H.K. Huang, D.C. Chen, J.M. He, P.Z. Xian, and Y. H. Chen (1995), ‘Occupational Diseases Prevention and Treatment Centre, Bai Yun Mountain, Guangzhou, China’, *Occupational and Environmental Medicine* 52: 268-272.

Khan, M. (2009), ‘Economic evaluation of health cost of pesticide use: willingness to pay method’, *The Pakistan Development Review* 48 (4): 459-472.

Khan, M., S. Akhtar, H.Z. Mahmood and K. Muhmood (2013), ‘Analysing skills, education and wages in Faisalabad: implications for labor market’, *Procedia Economics and Finance* 5: 423- 432.

Khan, A.W., H.M. Moshammer, and M. Kundi (2015), ‘Industrial hygiene, occupational safety and respiratory symptoms in the Pakistani cotton industry’, BMJ Open 2015;5:e007266. doi:10.1136/bmjopen-2014-007266.

Liou, S. (1994), ‘Occupational disease profile in Taiwan, Republic of China’, *Industrial Health* 32: 107-118.

Love, R.G., T. Smith, C.O. Jones, D. Gurr, C.A. Soutar, and A. Seaton (1986), ‘Respiratory symptoms in wool textile workers: an epidemiological study of respiratory health in West Yorkshire wool textile mills’, Research Report TM/86/04, IOM Institute of Occupational Medicine, Edinburgh, UK.

Mahmoud, T., A.M. Hosnia, and S. Mohamed (2004), ‘A study of occupational health hazards among Assiut spinning factory workers’, *University Bulletin for Environmental Researches* 7(1): 63-76

Malik, A.S. (2002), ‘Impact of environmental regulations on the textile sector of Pakistan’, Country Paper Prepared for Expert Meeting on Environmental Requirements and International Trade, Geneva, Switzerland.

Malik, N., A.A. Maan, T.S. Pasha, S. Akhtar and T. Ali (2010), 'Role of hazard control measures in occupational health and safety in the textile industry of Pakistan', *Pakistan Journal of Agriculture Sciences* 47(1): 72-76.

Mathur, K.C. and S.N. Misra (1972), 'Incidence of pulmonary disease among wool workers', *Indian Journal of Chest Diseases* 14: 172.

Mberikunashe, J., S. Banda, A. Chadambuka, N.T. Gombe, G. Shambira, M. Tshimanga, and R. Matchaba (2010), 'Prevalence and risk factors for obstructive respiratory conditions among textile industry workers in Zimbabwe', *Pan African Medical Journal* 6(1). Available at: http://www.panafrican-med-journal.com/content/article/6/1/full [Accessed on April 2, 2014].

Memon, I., A. Panhwar, D.K. Rohra, S.L. Azam and N. Khan (2008), 'Prevalence of byssinosis in spinning and textile workers of Karachi, Pakistan', *Archives of Environmental & Occupational Health* 63: 3.

Mishra, A.K., S.B. Rotti, A. Sahai, M. Mohan, K.A. Narayan (2003), 'Byssinosis among male textile workers in Pondicherry: a case–control study', *The Journal of Jawaharlal Institute of Postgraduate Medical Education and Research* 16(2): 70-73.

Mishra, A.K., S.B. Rotti, A. Sahai and M. Mohan (2004), 'Epidemiological study of chronic bronchitis among textile workers in Pondicherry', *Indian Journal of Community Medicine* 29(4): 10-12.

Murty, M.N., S.C. Gulati and A. Bannerjee (2003), 'Health benefits from urban air pollution abatement in the Indian Subcontinent', IEG Working Paper, Institute of Economic Growth, Delhi, India.

Nafees, A., F. Masood, and N. Sathiakumar (2013), 'Pattern and predictors for respiratory illnesses and symptoms and lung function among textile workers in Karachi, Pakistan', *Occupational and Environmental Medicine* 70 (2): 101–109.

Parikh, J.R., L.J. Bhjagia, P.K. Majumdar, A.R. Shah and S.K. Kashyap (1989), Prevalence of byssinosis in textile mills in Ahmadabad', *British Journal of Industrial Medicine* 46: 787-790.

Raza, S.N., A.M. Fletcher, and C.A. Pickering (1999), 'Respiratory symptoms in Lancashire textile weavers', *Occupational & Environmental Medicine* 56: 514–19.

Saadat, A.K. and A. Saadia (2006), 'Pulmonary function studies in Pakistani cotton ginners', *Pakistan Journal of Physiology* 2(1):1-4.

Saleema, B.S., A. Sajeela, S. Ayseha, A. Ilyas and K. Nikhat (2007), 'Determination of cotton dust concentration in different textile mills in Faisalabad and prognostic evaluation of byssinosis in its workers', Available at: www.iepkc.org [Accessed in November, 2013].

Salvaggio, J., C. O'Neil and B. Butcher (1986), 'Immunologic Responses to Inhaled Cotton Dust', *Environmental Health Perspectives* 66: 17-23.

Schilling, R., J. Hughes, F. Dingwall and J.C. Gilson (1955), 'An epidemiological survey of byssinosis amongst cotton workers', *British Journal of Industrial Medicine* 12: 215-27.

Shafqatullah, K. (1999), 'Cotton dust - a textile concern', Available at: www.opp.org.pk/articles /cottondust [Accessed in January, 2012]

Sudman, S.W. Wilson and R. Ferber (1974), 'The cost-effectiveness of using the diary as an instrument for collecting health data in household surveys', Research Report to the Bureau of Health Services Research and Evaluation, Survey Research Laboratory, University of Illinois, Urbana-Champaign, USA.

Wang, X., E. Eijen, H. Zhang, B. Sun, H. Dai and L. Pan (2003), 'Respiratory symptoms and cotton dust exposure: results of 15 year follow up observation', *Occupational and Environmental Medicine* 60: 935-941.

White, N.W. (1989), ‘Byssinosis in South Africa: a survey of 2411 textile workers’, *South African Medical Journal* 75: 435-442.

Woldeyohannes, M., Y. Bergevin, A. Mgeni and G. Theriault (1991), ‘Respiratory problems among cotton textile mill workers in Ethiopia’, *British Journal of Industrial Medicine* 48: 110-115.

Wooldridge, F.M. (2002), *Econometric Analysis of Cross Section and Panel Data* (edition), Cambridge, Massachusetts: MIT Press.

Yih-Ming, S., S.R. Jenn, Y.S. Jia, L. Ching, and H.L. Saou (2003), ‘Additive effect of smoking and cotton dust exposure on respiratory symptoms and pulmonary function of cotton textile workers’, *Industrial Health* 41: 109-115.

Zuskin, E., F. Valic and A. Bouhuys (1976), ‘Effect of wool dust on respiratory function’, *American Review of Respiratory Disease* 114: 705-709.

Appendix

Survey Questionnaire and Health Diary

Worker Health in the Textile Industry in Faisalabad

(SURVEY QUESTIONNAIRE)

My name is__________ and I am from COMSATS Institute of Information Technology, Lahore. This survey is conducted for the above research study by Dr. Muhammad Khan from COMSATS Institute of Information Technology, Lahore, with the supervision and assistance from the South Asian Network for Development and Environmental Economics (SANDEE). **The purpose of this survey is to collect data for a study on the health of textile workers in Faisalabad**. It is for research purposes only. Please answer the questions to the best of your knowledge. Answers will be kept completely confidential and will only be presented in a summary format. Your cooperation in this survey by way of providing accurate information is highly appreciated and duly acknowledged.

Start time […………………….] End time […………………….]

The survey ID# […………………….] Survey Date […………………….]

Worker ID# […………………….] Mill ID# […………………….]

Distance from house to factory in Km […………………….]

Part A: Personal General Information

A.1 Gender Male/Female [ ] A.2 Age [ ] years

A.3 What is the highest level of education that you have completed? ____________ years

A.4 How many people, including yourself, live in your immediate household? # of persons [ ]

(A household is defined as comprising all usual residents, where they sleep and share common facilities)

A.5 Marital Status [ ] 1. Married; 2. Single; 3. Divorced; 4. Widowed; 5. Separated

A.6 What is the total monthly expenditure of the household? PKR_________________

A.7 What is your monthly wage from all sources? PKR_________________

Part B: House Characteristics

B.1 Do you live in your house or in factory accommodation? [ ]

a. 1. House 2. Factory

b. No. of rooms [….]

B.2 Do you have a separate bathroom in your house? [ ] 1. Yes 2. No

B.3 Do you have a separate kitchen in your house? [ ] 1. Yes 2. No

B.4 Do you have any windows in your kitchen? [ ] 1. Yes 2. No

B.5 What types of fuel are currently being used in your kitchen?

Fuel type	Rank the usage (based on use)*	Fuel type	Rank the usage (based on use)*
1. Fire wood		6. LPG	
2. Animal dung		7. Electricity	
3. Other agricultural waste		8. Bio gas	
4. Natural Gas		9. Other (specify)	
5. Kerosene			

* Rank (1 = highest, 2= second highest... 9 = least (if all 9 options are available)

Part C: Work and Workplace Information

C.1 Please fill out the table below for lifetime work history and workplace information

From (year/month) to ((year/month))	Job title	Work hours/week	Mill section*	Employment status^

* 1=opening/mixing, 2=cleaning/blow room, 3=carding, 4=Samplex (drawing & combing), 5= ring, 6=Autocone

^1= Regular paid employee with fixed wage 2= Casual-paid employee 3= Daily worker by fixed pay

4. Paid worker by piece rate or work performed 5. Other (specify)................

C.2 In addition to your regular hours, do you also work overtime? [ ] 1. Yes 2. No

i. If yes, how many hours worked during last 2 weeks? [ ] ————————?

C.3 What is the wage of overtime work, e.g. PKR/hour? ... [ ].......

C.4 What is the wage of regular work, e.g. PKR/hour? ... [ ].......

C.5 Does your employer provide you with

1. Face Mask? [ ] 1. Yes 2. No (if no, go to a)

a. If no, please specify the source from which you obtain a mask .... [ ]....

b. How often do you use the mask during work? [ ]

(i) Never (ii) Sometimes (iii) Often (iv) Always

2. Ear plugs [ ] 1. Yes 2. No (if no, go to a)

a. If no, please specify the source from which you obtain ear plugs ....[ ]....

b. How often do you use ear plugs during work? [ ]

(i) Never (ii) Sometimes (iii) Often (iv) Always

C.6 Does your factory/social security institute provide you any kind of compensation in case of accident or illness? [ ]

1. Yes (If yes, go to A) 2. No

A. please specify what kind of compensation.......[ ]....

Part D:Byssinosis Symptoms and Chronic Diseases

D.1 Were you ill with a chest illness accompanied by a more frequent cough during the last two weeks?
[ ] 1 Yes (If yes, go to A and B) 2. No

A. Do you often cough in the morning or just after getting up? ("Often" means more than 5 days per week)
[ ] 1. Yes 2. No

B. Often cough during the day? [ ] 1. Yes 2. No

D.2 Do you usually bring up phlegm? [ ] 1. Yes 2. No

D.3 Do you bring up blood with phlegm? [ ] 1. Yes 2. No

D. 4 Do you usually feel chest tightness or shortness of breath? [ ] 1. Yes 2. No

A. If yes, please explain, when specifically

(1) After 1 day off [ ] 1 Yes 2. No

(2) At a change of shift [ ] 1 Yes 2. No

(3) Other times (days off or workdays) [ ] 1 Yes 2. No

D.5 Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?
[ ] 1. Yes 2. No

D.6 Do you have to stop for breath when walking on level ground or slight hill?

[ ] 1. Yes 2. No

D.7 Do you feel shortness of breath accompanied by wheezing? [ ] 1. Yes 2. No

D.8 Are you suffering from blood pressure? [ ] 1. Yes 2. No

If yes, when was it diagnosed? [ ] Months/year

D.9 Are you suffering from heart disease? [ ] 1. Yes 2. No

If yes, when was it first diagnosed?.......... Months/year

D.10 Are you suffering from Asthma? [ ]1. Yes 2. No

If yes, when was it first diagnosed? ____Months/year

D.11 Do you suffer from Tuberculosis? [ ]1. Yes 2. No

If yes, when was it first diagnosed? _______Months/year

D.12 Do you suffer from Lung Carcinoma? [ ]1. Yes 2. No

If yes, when was it first diagnosed? _______Months/year

D.13 Do you suffer from Bronchitis? [ ]1. Yes 2. No

If yes, when was it first diagnosed? ________ Months/year

Part E: Smoking information

E.1 Have you ever smoked? [ ]1. Yes 2. No

E. 2 Do you still smoke? [ ]1. Yes 2. No

E.3 When did you start smoking? [ ] years

E.4 How many cigarettes per day? _______________

Finished

Worker Health in the Textile Industry in Faisalabad

Health Diary

For Health Records

My name is__________ and I am from COMSATS Institute of Information Technology, Lahore. This survey is conducted for the above research study by Dr. Muhammad Khan from COMSATS Institute of Information Technology, Lahore, with supervision and assistance from the South Asian Network for Development and Environmental Economics (SANDEE). **The purpose of this survey is to collect data for a study on the health of textile workers in Faisalabad**. It is for research purposes only. Please answer the questions to the best of your knowledge. Answers will be kept confidential and will only be presented in a summary format. Your cooperation in this survey by way of providing accurate information is highly appreciated and will be duly acknowledged.

The survey ID # [............] Drop off Date [.............]

Worker ID # [...............] Picking up Date [...........]

Mill ID # [.................]

List of Illnesses:

The purpose of this health diary is to collect data for a study on the health of textile workers in Faisalabad. If you suffer from any of the illnesses listed below during the next 2 weeks, you are requested to record the illness and any medical expenses incurred by you on the form on the next pages. If you suffer from any illness other than the ones mentioned below during this two-week period, please write the names of those illnesses in line 20.

1) Headache	11) Vomiting
2) Dizziness	12) Dry Cough
3) Runny nose/ Flu	13) Cough with phlegm (no blood)
4) Fever	14) Cough with bloody phlegm
5) Skin infection/Rash	15) Wheezing
6) Shivering	16) Cough in the morning
7) Shortness of breath	17) Cough at other times of the day
8) Fatigue	18) Throat irritation
9) Excess sweating	19) Eye irritation
10) Stress/depression/anxiety	20) Other (please specify)

Codes: Type of Doctor

1) MBBS Doctor	2) Pharmacist	3) Homeopathic practitioner
4) Herbal Hakeem	5) Other................	6) None

Instructions for filling up the Health Diary:

Please fill in the diary at the end of each day before you go to sleep. This will take only a few minutes. You are requested to enter all medical expenses for you separately with date on the day you incur such expenses. **Medical expenses should include cost of medicines bought with or without consulting a doctor, doctor's fee, and cost of homeopathic, ayurvedic medicines, etc**. Please use a different row for each day.

A.1 No. of days of illness and no. of days lost due to workplace pollution-related illness

A.1.1	**A.1.2**	**A.1.3**	**A.1.4**	**A.1.5**					
Date (each row should be a different day)	Did you work this day 1= yes 0=no	How dusty was the work-place *	List all the diseases that you suffered on a given day, using the codes on the last page	**Medical Expenditure**					
				A.1.5.1 Doctor's fee +medication cost +diagnostics test fee (PKR)	A.1.5.2 Code of doctor	A.1.5.3 Travel cost to doctor's clinic +Diagnostic test center (PKR) Please note that if you used your own transportation, you must mention approximate cost	A.1.5.4 Total travel time (minutes)	A.1.5.5 Total waiting time (minutes)	A.1.5.6 Accompanying person (Y/N)

* More dusty than normal=1, Normal dustiness=2, Less dusty than normal=3

A. 1 No. of days of illness and work days lost due to pollution in textile factory (continues)

A.1.6			
Information on work days lost due to illness			
A.1.6.1	A.1.6.2	A.1.6.3	A.1.6.4**

Note: ** 1. Worse than normal 2. Normal 3. Better than normal

A.2 Hospitalization

A.2.1	A.2.2	A.2.3	A.2.4	A.2.5	A.2.6	A.2.7	A.2.8
Date entered hospital	Date discharged from hospital	Disease code	Type of hospital 1.private 2.govt.	Attendant family member (Y/N)	Travel cost to hospital (PKR). Please note that, if you used your own transportation, you must mention approximate cost	Medication and diagnostic test cost (outside hospital)	Total hospitalization bill

A.3. Noise and Temperature Information

A.3.1	A.3.2	A.3.3
Date	Temperature level	How Noisy was the work place***

***More noisy than normal=1, Normal noisiness=2, Less noisy than normal=3

SANDEE
P.O. Box 8975, E.P.C 1056, Lalitpur, Nepal
Street address: c/o ICIMOD, Khumaltar, Lalitpur, Nepal
Tel: 977 1 5003222, **Fax:** 977 1 5003299, **Email:** info@sandeeonline.org, **Web:** www.sandeeonline.org

SANDEE Sponsors