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Status of Silicosis and Health Effects among Industrial Workers of Faisalabad District, Pakistan

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Abstract: Silicosis is a disease of much concern almost in every corner of the world, due to its severe and prolonged bad effects on human health. A questionnaire-based research study was conducted in silica-related industries in district Faisalabad for assessing the status of silicosis and possible health effects among workers. The study comprised of two different types of questionnaires for getting the response from workers. The first questionnaire consisted of questions regarding general details of the workers, working history, smoking history, symptoms of lung-related diseases, and their treatment. It was used for workers of the crushing, grinding, and brick kiln industries of Faisalabad. Fifty workers from industries were interviewed for this purpose. For the second questionnaire, St. George Respiratory questionnaire approach was used. It was used to interview thirty patients from private and government hospitals in Faisalabad. The results of this study were analyzed using the method described in the St. George Respiratory questionnaire manual. The results of the first experiment revealed that the crushing industry had the maximum number of people suffering from silicosis as well as other lung-related diseases. The lung-related diseases specifically silicosis was found among workers (44-68%) of crushing, grinding and brick kiln industries in district Faisalabad. A significant number of workers showed the symptoms of shortness of breathing. Moreover, the maximum number of silicosis patients was found in the grinding industry. The results of second questionnaire represented that the patients with lung-related diseases had lower visual symptoms of the disease and more negative expression of the proposed activity component of the study. Furthermore, the internal consistency and validity of the data was high. In conclusion, the crushing industry had the maximum number of people suffering from silicosis.

Keywords: Silicosis; Health Effects; Industrial Workers; Pollution: Respiratory Diseases.

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1. Introduction

Faisalabad is the third-largest city of Pakistan, with its fast-growing population. It is the industrial hub, with significant contribution to the economic development of Pakistan (Farooqi et al., 2017). Major industries include textile units, flour mills, oil (refinery/ processing), various engineering units and pharmaceutical industries (Javed and Qureshi, 2019). The industrial sector produces new problems related to human health and sustainability of all types of life on this planet. Air pollution has severely affected human health since industrialization (Gurluk, 2009; Yuan et al., 2020). It is obvious that air pollution is the most important cause of many human diseases, like skin cancer, eye disease and heart and lung diseases (Sun and Zhu, 2019; Turner et al., 2020; Zhao et al., 2019). It is well reported in the literature that air pollution increases the rate of premature death and hospitalization (Simkovich et al., 2019; Dominici et al., 2003; Kampa and Castanas, 2008).

The intensity and severity of diseases depend on the rate, time and duration of exposure to air pollution (Hu and Guo, 2021; Usmani et al., 2020). It ranges from nausea, respiratory problems, and skin irritation to cancer. It also causes birth effects, increased rate of infant mortality and many other diseases (Goyal et al., 2019; Karimi and Shokrinezhad, 2020). Diseases like cancer, respiratory disorders and cardiovascular problems are associated with particulate matter

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emission (Correia et al. 2013; Loomis et al. 2013; Pope et al. 2009). Health effects could also be categorized as acute or chronic depending upon many factors. The most vulnerable systems of human being are respiratory and cardiovascular systems (Kurt et al., 2016; Manisalidis et al., 2020; Matus et al., 2012; Saleh et al., 2020;).

Among different chronic obstructive pulmonary diseases (COPD), silicosis is a burning issue, with worldwide spread (Martínez et al., 2010; Sen et al., 2016). Around 3.7 million deaths in the year 2012, can be attributed to air pollution related deaths, among these silica dust related lung diseases are main contributors. Further increase in the these diseases is predicted, with serious health implications in future (WHO, 2014).

Silica (SiO_2), commonly found as quartz. Respirable crystalline silica dust, produced in many industries (dust trades), has a significant role in the spread of silicosis (Mossman and Glenn, 2013). This is mainly due to its sharp pointed crystals with highly reactive surfaces and extremely cytotoxic nature (Leso et al., 2019). Key factors determining the risk of silicosis development depends on amount of inhaled respirable crystalline silica dust, cumulative exposure, and susceptibility of an individual. Moreover, the extent of disease severity also depends upon the size, shape and concentration of dust particles (Hedlund et al., 2008; Leung et al., 2012).

After inhaling, respirable silica particles can reach the lower respiratory tract and the zones of gaseous exchange. Subsequently, inflammatory process are triggered leading to reactive oxygen species production, impairment of pulmonary parenchyma and potentially causing fibrogenesis and over prolonged periods increases the risk of lung cancer (Sato et al., 2018). Silicosis is incurable and irreversible lung disease, and may be progressive even after dust exposure has ceased. Consequently, early diagnosis and control of respirable dust are available measures to restrict disease manifestation and no curative therapies are currently available (Barber et al., 2019; Hoy and Chambers, 2020).

Industrial progress with the rapid expansion of building material manufacturing units like cement, sand, bricks and ground stone are producing silica dust at alarming rates, especially in developing countries (Hnizdo and Vallyathan, 2003). Silicosis is not only affecting the developing countries, but the developed countries are also equally affected by this disease. In Pakistan, studies related to silicosis epidemiology are very rare, scanty and localized. Moreover, lack of provision of proper safety measures for the industrial workers also intensifies the problem. Faisalabad is a populated industrial area with a major proportion of population working in industries (Javed and Qureshi, 2019). Considering the above-mentioned facts, the present survey-based study was conducted to assess the status of silicosis disease in silica-related industries and health effects among workers of industries in the Faisalabad district, Pakistan.

2. Materials and Methods

2.1. Study Area

This study was carried out in district Faisalabad using two different types of questionnaires from the patients of different government and private hospitals and from the laborers of industries including marble crushing, marble grinding and brick kilns. District Faisalabad lies in Northwest of Province Punjab (31.42 Nº and 73.08 Eº at an altitude of 184 m from sea level), between two rivers (Chenab and Ravi rivers) of Punjab (Javed and Qureshi, 2019). Faisalabad has made marvelous progress in the field of industry since independence. In textile exports it has almost 70% share at present and also called the "Manchester of Pakistan" (Javed and Qureshi, 2019). In textile, all types of subunits like weaving, finishing, dyeing and designing all are present abundantly in the city and its premises. Due to rapid industrial development, all the associated industries for living like building, chemical, motor vehicle and other also developed in this city at a fast pace (FCCI, 2020).

2.2. Sample and Data Collection

Simple random sampling was used for the survey. Fifty laborers from industries and thirty patients from different hospitals of Faisalabad, were interviewed using prescribed Performa.

The data was collected in district Faisalabad using two different types of questionnaires. For the first type of questionnaire, data source for this study are the laborers working in industrial units of marble crushing and grinding and of brick kilns. For the second type of questionnaire, the data was collected from the patients of different public and private hospitals, who were suffering from lung-related diseases. The selection criteria for a laborer to be interviewed were 3 years of active affiliation with that particular industry and a minimum of 20 year age. Moreover, for a span of two months, different hospitals were visited randomly for selection of 30

patients suffering from silicosis and other respiratory diseases from each hospital for interviewing them about probable causes of their illness using St. George's Respiratory Questionnaire.

Questionnaire 1: It comprised of 32 questions under the heading of general details, working history, smoking history, disease symptoms and treatment details. General details included name, age, gender and address of the patient. The purpose of general details was to confirm the pre-decided age and locality of the worker. Working history focused on the type of industry, laborer's affiliation with the particular industry in years and daily working duration. It generated information about the duration of exposure and a minimum time in which a patient can get negative effects of silicosis on his health. Smoking history included current smoking status, the year of starting smoking, whether stopped the smoking and if stopped, how long ago the laborer did so. There were also questions about the smoking intensity of the laborer *i.e.* how many cigarettes a smoker laborer does smoke per day. The disease history information told about the presence of any lung-related disease in the laborer at any stage of life. Questions were regarding any lung disease in them in the past life, the span of any lung-related disease, presence of phlegm in the chest cavity and the number of years of suffering from any lung-related disease. It also comprised of the questions regarding general symptoms like shortness of breath, trouble in walking or running, presence of any one or more disease among pneumonia, emphysema, asthma and silicosis at any stage of life. Treatment details include questions like hospitalization history of a laborer in case of any lung-related disease, frequency of hospitalization and level of satisfaction from the available medical facilities.

Questionnaire 2: A total of 30 patients were interviewed in aggregate from both, public and private sectors. This questionnaire had two major sections. The first section had general details including; patient name, name of hospital, type of hospital *i.e.* private or state-owned, smoking status of the patient and educational level. It also included the brief details of the patient's profession. The second section was St. George's Respiratory Questionnaire developed for the assessment of health impairment (Respiratory system and activity impairment). This section had further two sub-sections. The first section had questions regarding the ailment like coughing, phlegm, shortness of breath, attacks of wheezing, number of chest troubles during the last year, duration of chest troubles, average number of good days per week in the last year and time of wheezing. All these questions were to assess the general breathing impairment in the patients and its link with the specific profession. The second part of St. George's Respiratory Questionnaire was about the assessment of patient's behavior regarding the ailment. It included the questions like the importance of breathing problem for the patient, employment of patient, relation of his profession with the disease incidence and intensity, body's general response towards breathing and coughing problem, effect of patients coughing on his social circle as per patient's understanding, effect of medicine on the treatment of the disease, effect of the disease on his daily routine and his response towards the ailment.

3. Results and Discussion

3.1. Status of Lung Diseases in Workers

The workers of all the industries were found suffering from different lung diseases. The maximum number of workers, suffering from lung diseases, was observed in the crushing industry whereas, the minimum diseased workers were found in the grinding industry (Fig. 1). It showed that in the crushing industry, there is a relatively higher probability for a worker to be diseased as compared to other two industries. It is well reported in the literature that the workers who are associated with the marble industry are constantly exposed to dust containing silica and calcium carbonate, which causes lung-related disease in them (Pilkington et al., 1996). Prolonged exposure to silica dust can even cause lung cancer. So, in this case, the occurrence of lung-related diseases in workers of the marble industry is also due to exposure to the silica dust.

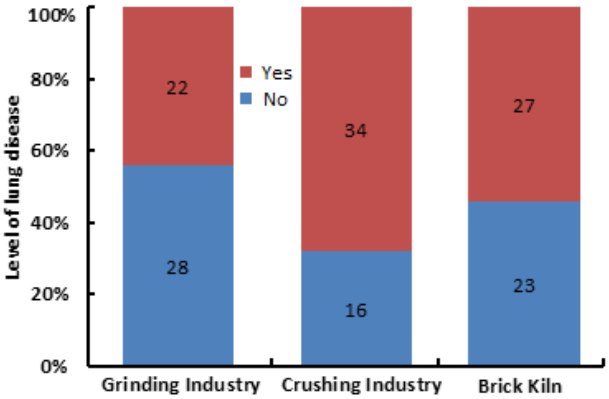


Fig 1: Lung diseases in workers of different industries in district Faisalabad during 2016-17.

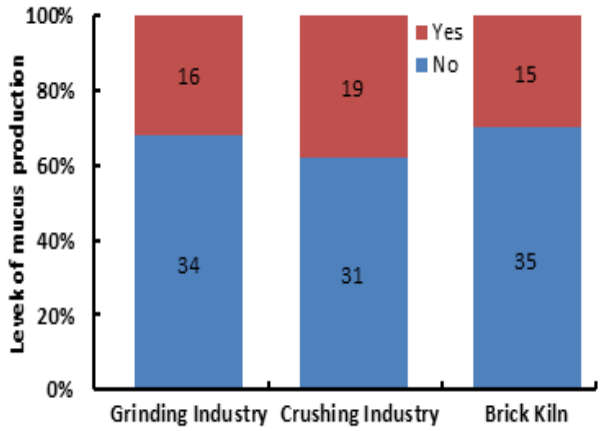


Fig 2. Mucus production in workers of different industries in district Faisalabad during 2016-17.

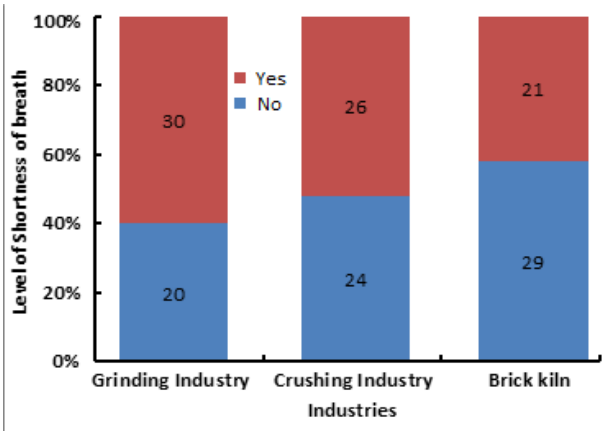


Fig. 3. Shortness of breath in workers of different industries in the district Faisalabad during 2016-17.

The frequency of different lung-related diseases in the workers of different industries shows that all the industries have persons with lung-related diseases like pneumonia, emphysema, asthma and other chest illnesses and injuries as shown in Fig. 1 and 2. The highest number of workers was found suffering from silicosis in the grinding industry and was followed by the asthma in the crushing industry. The brick kiln industry had all the diseases in a lesser number of persons than both types of marble industries except silicosis. It ranked 2nd among all three industries for silicosis. Silicosis is a major disease in all the industries, where people are exposed to silica dust particles. Silica has a significant role in the spread of this disease due to its sharp-pointed crystals with highly reactive surfaces and extremely cytotoxic nature. In this study, the highest number of persons for all types of industries is silicosis. It depicts that silicosis is the most common disease in these industries. The problem of mortality has been found due to prolonged exposure of workers to silica while working in industries (Hassani et al. 2017; Carneiro et al. 2017; Silanun et al, 2017).

3.2. Status of Other Health-Related Factors

3.2.1. Shortness of Breath in workers

Figure 3 shows the shortness of breath in workers of crushing, grinding and brick kiln industries of district Faisalabad. A varied level of breath shortnesswas observed in all three industries. It ranged from 42-60%. The maximum number of workers who experienced breath shortness was found in the grinding industry and a minimum was found in in brick kilns.

It shows that the grinding industry has more injurious effects on the general health indicators of the affiliated workers. Shortness of breath is an associated and compulsory condition for many lung-related diseases like asthma, emphysema and silica. In the current situation, many of the workers were suffering from different lung-related diseases, so they also exhibited the symptoms of breathing problems. In the current case, the grinding industry has the maximum number of workers who expressed their concerns about the breathing problems that might be due to higher emission of silica particles from the industry that damaged their lungs. So, they experienced breathing problems. Symptoms of respiratory problems consisting of coughing were also found among workers by Thongtip et al. (2019).

3.2.2. Smoking Status

The smoking status of workers in different industries indicated that all the target industries have workers with smoking habit (Fig. 4). Maximum number of smokers was found in the crushing industry, followed by the brick kiln and the minimum number of smokers was recorded in the grinding industry. In aggregate, out of 150 workers, 83 were smokers that account for more than 50% of the total persons, who were interviewed in different industries. Smoking is prevalent in almost every country and every society. According to an estimate of WHO, smoking causes about 3 million deaths, every year. Pakistan has a very high prevalence of smokers (Alam, 1998). The lower-income group of our society smokes cigarettes, generally for imitating the rich class. Smoking increases the ill effects of lung-related diseases and the risk of radiological progression from simple to complicated silicosis (Lee et al. 2001; Yang et al. 2006).

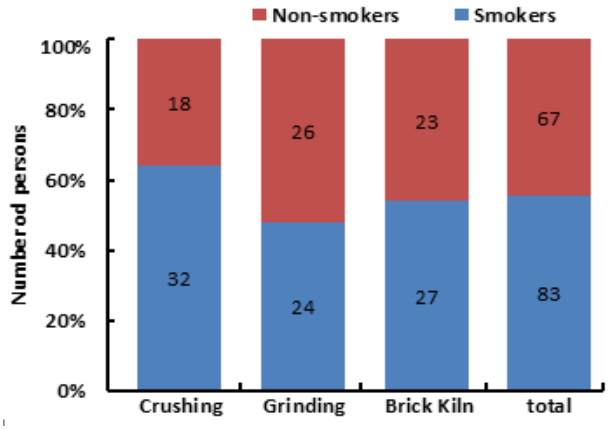


Fig. 4. Smoking status in different types of silica industries in the district Faisalabad during 2016-17.

The smoking status of patients was also analyzed and recorded during the interview as presented in Fig. 5. It represents that majority of the patients were smokers. Out of 30 patients interviewed, 21 were smokers. Smoking is injurious to human health. Their suffering from lung-related diseases might be due to their smoking habit, or this smoking habit might have accelerated their disease. Moreover, it is also a well-established fact that people working in silica emitting industries are more susceptible to lung disease due to their constant exposure to silica dust.

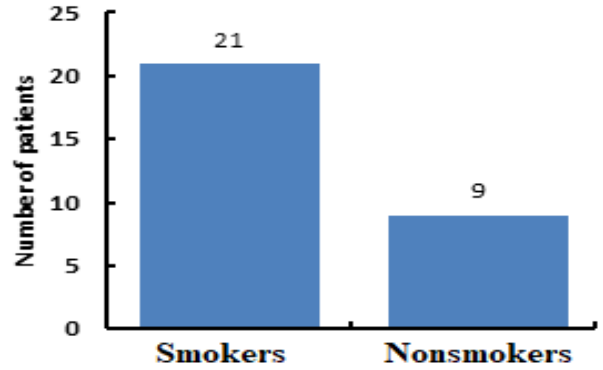
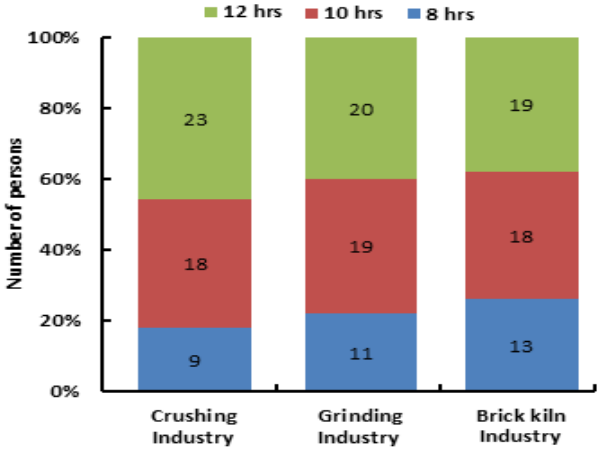


Fig. 5. Smoking status of patients suffering from lung-related diseases in different government and private hospitals of Faisalabad.

3.2.3. Working Duration

The working duration of workers in crushing, grinding and brick kiln industries of district Faisalabad is shown in Fig. 6. The working duration ranged from 8 to 12 hours in all the industries. Most of the workers had a duration of 12 hours of work in all the industries. Moreover, in the crushing industry, there was maximum number of people in 12 hours range and minimum number of workers was from crushing industry.



Fi.g 6. Working hours pattern adapted by workers of different industries in district Faisalabad during 2016-17.

The crushing industry had minimum number of laborers form 08 hours range. According to Occupational Safety and Health Administration (OSHA, 2018), exposure to silica is a health hazard to workers involved in manufacturing, finishing and installing natural and manufactured stone countertop products.

3.2.4. Status of Medical Facilities for Silicosis Patients in Faisalabad

The data presented in Fig. 7 shows the comparison of availed medical facilities by the patients of different lung diseases in district Faisalabad. The graph shows that only a minor portion of the people availed private medical facilities, while the majority of them went to government hospitals for their treatment.

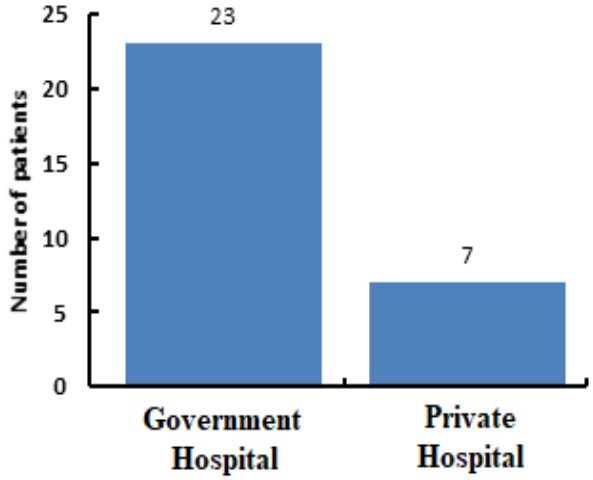


Fig 7: Comparison of inclination of patients towards private and government medical facilities for their treatment.

The more inclination of the people towards the government hospitals might be due to limited available resources possessed by them for medical treatment or availability of more facilities in the government hospitals. It is a general fact that poor patients in developing countries prefer to visit state-owned hospitals for their treatment. It is due to the inexpensiveness of these hospitals. Moreover, some literate and well to do people also consider it better to get treatment from the government due to the availability of expensive modern machinery and qualified doctors in government hospitals. However, a minor portion of the people under the study also visited private hospitals. Outbreaks of silicosis is expected to occur in the near future, if the risks that are associated with the manufacturing are not urgently recognized by managers and workers, or well-defined precautionary preventive programs are not suitably applied (Pérez-Alonso et al., 2015; Friedman et al., 2015).

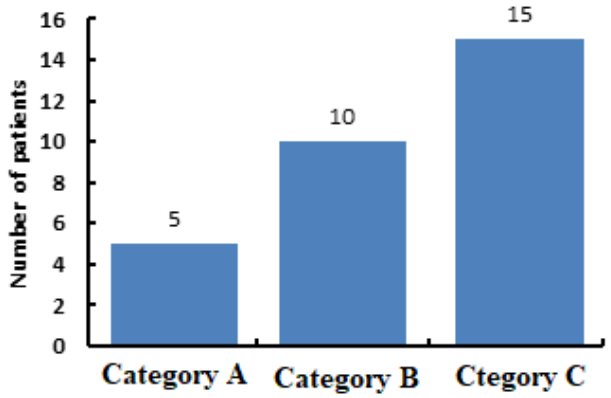


Fig. 8: Job-based categories of patients (Category A, Office Workers; Category B, Non silica related industries; Category C, Silica-related industries).

The categorical distribution of patients based on job and profession is represented in Figure 8. The data presented in the figure shows that maximum number of patients belonged to category A *i.e.* office workers. It was followed by the persons belonging to category B i.e. the people working in silica-related industries and the maximum number of patients was from silica-related industry. Hence, it is proved that the maximum number of patients with lung-related diseases are those who work in silica-related industries. It is also depicted from Fig. 8 that in category A people had more inclination towards private treatment and the people belonging to category 3 opted for the government hospitals for their treatment. Moreover, in the category B, the trend remained more or less equal for private and government hospitals for the treatment of lung-related diseases.

4. Conclusion

The lung-related diseases specifically silicosis is present in workers (44-68%) of the crushing, grinding and brick kiln industries- in district Faisalabad. A significant number of workers showed the symptoms of shortness of breathing. Moreover, maximum number of silicosis patients was found in the grinding industry. Moreover, the patients interviewed from different hospitals depicted that maximum patients were from silica-related industries and most of them had the facility of state-organized medical treatment for their lung-related diseases. It was also observed that workers had smoking habits or patients had more probability to get suffered from lung-related diseases. The government should formulate and implement policy measures for industrialists to make the working environment safe and work-friendly for the workers. Awareness should be increased among industrial workers about the use of precautionary measures to keep them safe from exposure to silica dust as much as possible. Civil society and media should play a role in disseminating knowledge and awareness among the public about silicosis and its possible negative health effects. Medical facilities should be made sufficient in hospitals for curbing the increasing problem of silicosis and other lung-related diseases.

Competing Interest Statement: All the authors declare that they have no competing interests.

Author's Contribution: Saba Farooq: Data collection and analysis, Preparation of thesis; Dr. Rab Nawaz: Supervision of entire research work, revision of the manuscript ; Iqra Nasim: Preparation of paper draft from thesis; Muhammad Atif Irshad: Improvement of the manuscript.

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