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Health Hazards and Socioeconomic Effects of Stone Crushing Industry on Its Workers: A Case Study of Sargodha, Pakistan

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Abstract: Stone crushing industry is a dominant but still environmentally unorganized sector in Pakistan. Its different operations cause significant environmental impacts including air and noise pollution in the vicinity as well as vibration effects far-off. A questionnaire survey was conducted in stone crushing industrial area of Sargodha, Pakistan to assess its harmful health and economic impacts on workers engaged in different activities of stone crushing and production. According to this survey, many workers were aged, which increases the probability of health effects due to air pollutants. It was found that most of the workers were illiterate. Industrial section engaging maximum number of workers was hammering.The questionnaire results showed that there was no provision of any Personal Protection Equipment to the majority of laborer (94%). It means that most of the workers had no protection facility provided by the employer while working in the polluted industrial environment. Major health effects in workers of the industry were hearing problem (82%), skin irritation (75%) and respiratory problem (69%). Most of workers in the industry were on daily wages and their monthly salary was in the range of PKR. 8,000 to PKR 10,000, that is lesser than the minimum monthly salary fixed by the government for unskilled workers. It is concluded that stone crushing industry has harmful effects on workers' health and there is urgent need to provide training and Personal Protection Equipmentto them to minimize the health effects.

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1. Introduction

Industrial activities cause a number of environmental issues including air pollution, water pollution and soil contamination (Sivacoumar 2006; Gunkel et al. 2007; Mushtaq and Khan 2010; Nawaz et al. 2012a; Nawaz et al. 2012b). Industrial workers especially in developing countries have always been facing problems of polluted environment and are regularly exposed to dust and particulate matter (Davidson, et al., 2005; Iftikhar et al., 2009; Solanki et al., 2014). Stone crushing is very important industrial sector in Pakistan (Ilyas and Rashed 2010). It has small scale stone crushers in unorganized sector in different mountainous areas. These crushers provide basic material for road and building construction. They are engaged in highly labor intensive activities. It provides not only raw material for construction of roads, buildings, bridges, etc. but also provides livelihood to the local people. Different stages of stone crushing process involve drilling and blasting of rocks, transportation of the raw material, crushing, screening, size classification, material handling, storage operations and transportation of final product. Mining operations cause significant emissions of suspended particulate matter (SPM) in the atmosphere (Csavina, et al., 2012; Titi et al. 2015).

The particulates released from the crushing units having different size and weight, sustain in air for different time periods and can affect human beings and plants. Dust generated from stone is a "Primary Aerosol" and also has adverse effects on people, flora and fauna (Prajapati and Tripathi, 2008). Many studies have shown that there is significant association of SPM with a number of cardiovascular and respiratory health endpoints including mortality, hospital visits, respiratory illness, physiological

changes in pulmonary functions, etc. (Semban and Chandrasekhar, 2000; Sivacoumar et al., 2001; Semple et al., 2008; Iftikhar et al., 2009; Narkhede et al., 2012). There are hundreds of stone crushing units in mountainous areas of Sargodha. This study was conducted to assess the level of safety measures, different health effects on workers and their livelihood in stone crushing industry.

2. Materials and Methods

2.1 Study area

The area of this study was stone crushing industrial market in Sargodha district of Pakistan. Sargodha is largely an industrial and agricultural city. The main crops include citrus, rice, wheat and sugar cane. Citrus fruits such as oranges, mangoes, and guavas are main fruits grown in the district. Sargodha is located 172 kilometers northwest of Lahore. It lies about 30 miles from the M-2 motorway (Lahore-Islamabad motorway). The district has an area of 5,864 km^2 with population of 3.086 million (GoP, 2015).

Sargodha also has one of the largest stone crushing markets in Asia, which is located in the rural areas. The stone is acquired from hills through controlled blasting. Due to business expansion, hundreds of stone crushing units are being installed along the sides of Faisalabad-Sargodha Road and Sillanwali-Sargodha Road (Ilyas and Rashed 2010). The stone crushing industrial area mainly comprises of different markets, namely Market Pull 111 S.B., Market 116 S.B., Market 123 S.B., Market 126 S.B., Market 127 S.B. and many other small markets. All these stone crushing units are located in adjacent mountains, collectively known as Kirana Mountains.

2.2 Field visits and questionnaire survey

The sample size of the research study was 150 workers. Simple random sampling technique was used for data collection. The principle of simple random sampling is that every object has the same probability of being chosen. Each individual was chosen randomly and entirely by chance (unbiased), such that each individual had the same probability of being chosen at any stage during the sampling process. Data was collected from the different small and large size stone crushing units of the market. Questionnaire comprised of the following different sections;

Demographic information: This included questions regarding age, gender, marital status, number of family members, qualification, etc.

Working environment and safety of workers: The objective of this part of questionnaire was to categorize industrial workers into different groups on the basis of nature of job. It also gave information about status of workers' safety in the industry.

Health effects of industry: In this part of the questionnaire, different effects of industrial pollution were observed in the laborers.

Economic effects of industry: This part consisted of monthly income of workers and their level of satisfaction on the job.

Table 1: Workers' Demographic information: age, marital status, qualification and family size

Demographic Information	Classes	Workers (%)
Age Group (Years)	15-30	37
	31-45	44
	> 45	19
Marital Status	Single	21
	Married	79
Qualification	Illiterate	44
	Primary	25
	Middle	10
	Matric	18
	Intermediate	3
Family Size (Member per family)	≤3	6
	4	7
	5	13
	6	27
	7	19
	8	10
	≥9	18

3. Results and Discussion

3.1 Demographic information

Table 1 shows demographic information of workers. All the workers were classified into three broad age groups i.e., 15-30, 31-45 and >45 years. It was observed that most of workers (44%) had age between 31 and 45 years, while 37% of them had age of 15-30 years and the other workers (19%) had age above 45 years. The probability of health effects of air pollutants increases with higher age due to more susceptibility (Sacks et al., 2011). According to this survey study, majority of the workers (79%) were married that indicated that most of the workers were earning money not only for themselves but also for the dependents at home.

It was found that 44 % of the workers were illiterate and the other workers had different levels of education, including primary (25%), middle (10%), matric (18%) and intermediate (3%) qualification. High number of illiterate workers in the stone crushing industrial area is because of the fact that they could not afford the expenses of their education. They also had to work to meet the basic needs of their families.

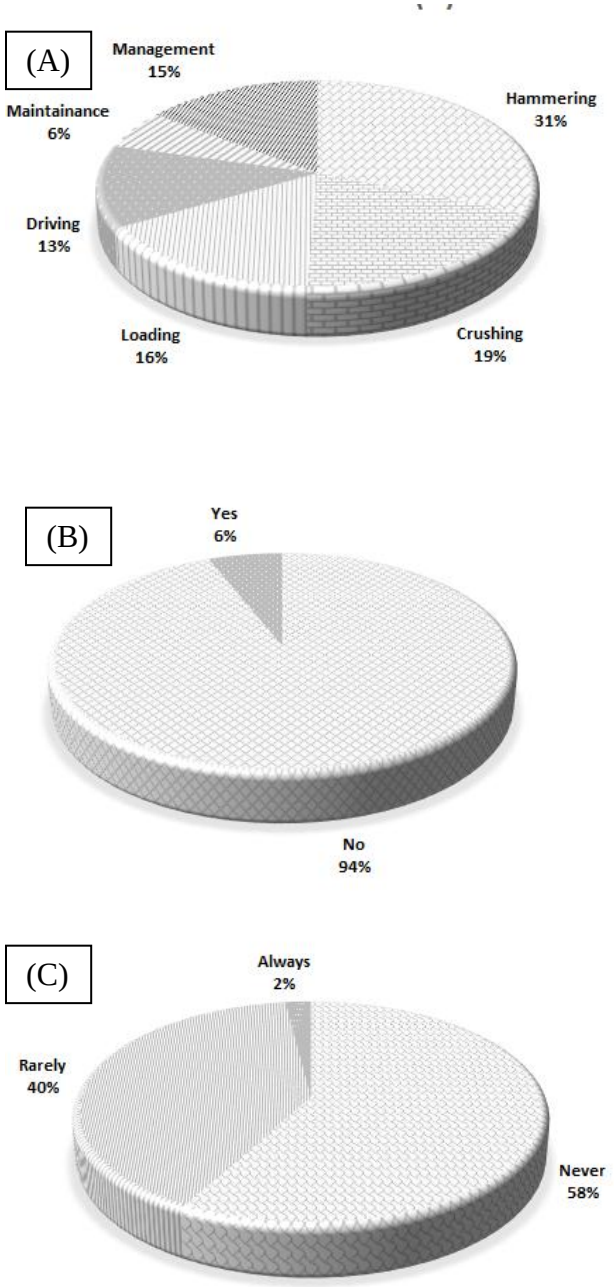

Fig. 1. Workers in different sections and status of precautionary measures; (A) workers in different industrial sectors (%); (B) provision of PPE by the industry (%); (C) Use of PPE by workers (%)

This study also showed that workers belong to joint family system. Largest family sizes of workers was 6 (27%), followed by 7 (19%) and 9 (18%). Number of dependents on workers increases with increase in family size. It is important to note that the stone crushing industry is only the source of income for large number of people living in the surrounding villages. This industry has positive socioeconomic effects on the poor and illiterate people of the area.

3.2 Working environment and safety of workers

Workers were classified into broad six categories on the basis of nature of work, namely; management, maintenance, hammering, crushing, loading and driving. Figure 1A represents percentage of workers working in different sections of stone crushing industry. Industrial section engaging maximum number of workers (31%) was found to be of hammering. Second most important section was that of crushing, employing 19% of the workers. This was followed by loading section engaging 16% of workers. Other sections include driving, maintenance and management, employing 13%, 6% and 15%, respectively.

It was found that Personal Protection Equipment (PPEs) were provided to only few workers (6%) of stone crushing industry (Fig. 1B). There was no provision of any PPE to the rest of laborer (94%) working in the polluted industrial environment. This poses great health risk to workers of stone crushing industrial area. The PPE are considered essential for the workers all over the world and there are so many organizations, which work for the safety of the workers and enforce the industries to provide them the safety and protection equipment (OSHA, 2003).

The study showed that 58% workers never use PPE during work in the industry. There were 40% workers who rarely use such protection equipment. Only few workers (2%) were found who use these equipments. Obviously, Government and controlling authorities should play a key role in encouraging and enforcing the concerned industries to provide safe and healthy working conditions to workers. However, due to the lack of interest and no monitoring system, it is not practiced properly in such industries (Fig. 1).

Never or rare use of PPE during work increase the susceptibility of workers to different pollutants in the industry including particulate matter, dust, heavy metals and noise. It is important to note that PPE were provided to only 6% of workers by the industry and only 2% workers were using these equipments regularly (Fig. 1C). This is due to lack of awareness among workers about possible adverse effects of pollutants on their health. Workers with low awareness have high exposure to hazards and low perception (Behrens and Brackbill, 1993).

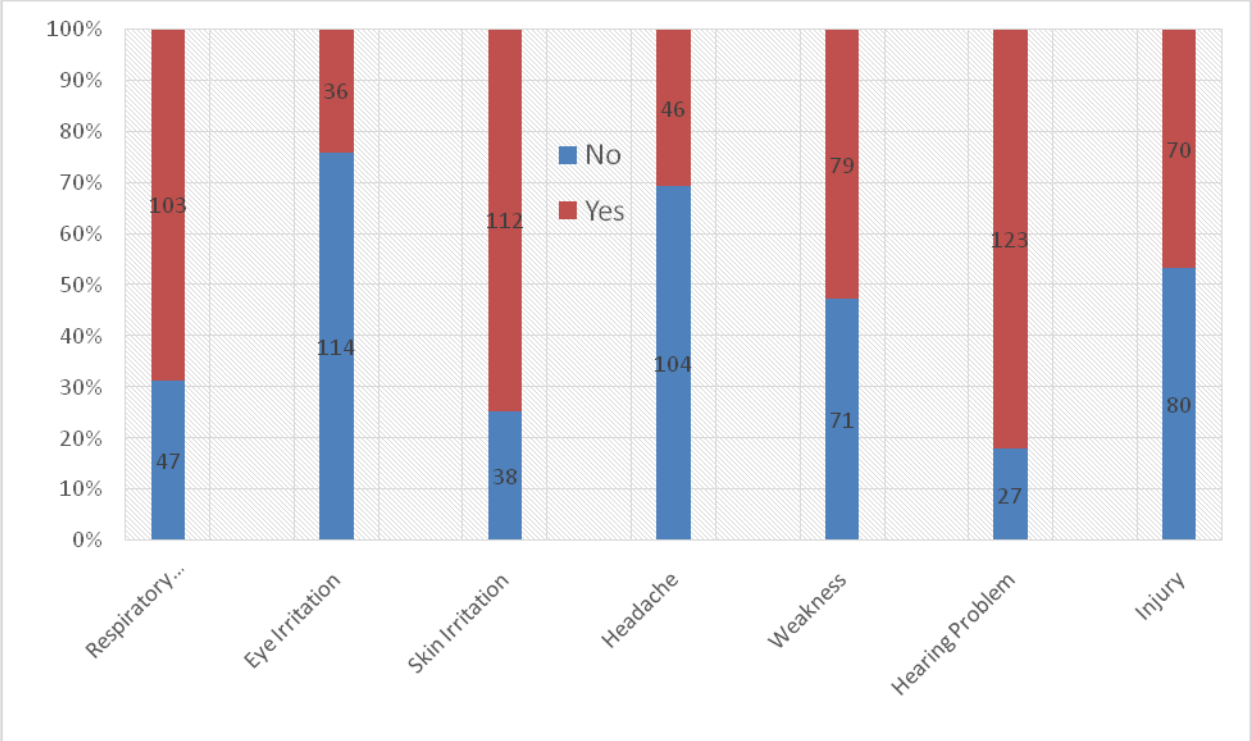

Fig. 2: Health problems in workers caused by the stone crushing industry

The exposure of human body to any kind of dust for a longer period may cause harmful effects through inhalation, ingestion as well as by skin and eye contact depending upon the physical and chemical properties of dust and its source (WHO, 1999; Schlesinger, 2007; Girolamo et al., 2012).

3.3 Health problems of workers

Different health effects of stone crushing industry on its workers are shown in Figure 2. The most common health problem among workers caused by crushing industry was hearing problem. This problem was observed in 82% workers in the industrial area. Constant loud sound can cause a serious problem with no cure, medically known as "tinnitus". Exposure of workers without PPEs to noise causes increased pulse rate, blood pressure, muscle tensing, anxiety, sleeplessness and weakness (Mazurek et al. 2010). The labors working are suffering from various diseases such as lungs diseases, throat, and skin allergy due to inhaling in the polluted air caused by stone crushing operations (Ilyas and Farooq, 2010).

About 53% workers were suffering with weakness and fatigue. The second most common health problem among workers was skin irritation, which was observed in 75% workers. The other very important health effect was respiratory problem. Large numbers of workers (69%) were suffering with respiratory problems including cough, chest pain, asthma, throat infection, etc. Respiratory problems were more common in workers of crushing section due to dust and particulate matter, as shown in Figure 3. The respiratory problems were found to be directly related to the silica dust exposure, found in the stone crushing industry (Iftikhar et al., 2009). In Nigeria the quarry workers in the stone crushing industry were found suffering from the pulmonary issues (Nwibo and Ugwuja, 2012). Sivacoumar et al. (2006) found that stone crushing units at Pammal, Tamil Nadu (India) cause high levels of dust generation in the vicinity of the crushers and in the nearby communities. The average values of pulmonary function in workers of such units were significantly lower than the average values reported for normal workers.

Narkhede et al. (2012) studied the respiratory illness in stone crusher workers. Due to no use of PPEs, exposure of particulate pollutant component to workers causes impaired lung function (Semple et al., 2008). The workers were mostly suffering from breathing and musculo-skeletal problems. It was also found that 25% of the workers had a problem of eye irritation. Many workers (31%) were found having headache problem. It was due to the high noise generated by the crushing machines, hammering and blasting in the industrial area.

Fig. 3. Crushing units of Sargodha stone crushing industrial area (Pull-111) causing air pollution

Almost half of the target workers (47%) had injuries because of accidents while working in stone crushing industry. This is due to lack of precautionary measures, no use of PPEs and overtime job. Dembe et al. (2005) found 61% higher injury hazard rate for workers with overtime schedules as compared to workers without overtime due to higher exposure. Although laws addressing for labor health protection exist, that are not being implemented in such work places (Ilyas and Farooq, 2010).

3.4 Economic effects of industry

Figure 4 shows income level of different workers of stone crushing industry. Most of workers in the industry were on daily wages and their monthly salary was found around PKR. 8,000 (34%) and PKR. 10,000 (31%). According to them, this salary was too low to meet basic necessities of their family. This study found that there were also few workers (3%) who had a monthly salary less than PKR 5,000. Only 22% workers were getting salary PKR. 12,000 or more. This is because that these workers belong to maintenance and management section of the industrial plants. The Government of Pakistan has fixed the minimum wage rate (PKR. 11,000) for unskilled employees in 2014-15 budget, which is awfully low (GoP, 2014). It indicates that most of the workers were getting monthly salary less than the minimum monthly salary.

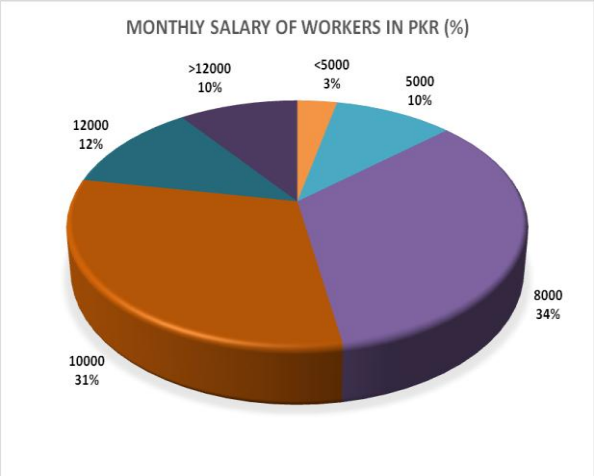

Fig. 4. Monthly salary of workers of the industry

This is due to lack of employment opportunities in the area and the poor people were being exploited with lengthy working hours and low reward. Majority

of workers in such industrial units in developing countries are employed informally without any written contract. Therefore, they have no benefits other than daily wages and are excluded from social security schemes. It causes a severe risk to their health as they cannot afford health bill (Ilyas and Rashed, 2010).

4. Conclusion

The study reveals that although stone crushing industry is one of the major industries in Pakistan but it is environmentally as well as socially neglected. The results indicated that the large numbers of workers in the stone crushing industry were illiterate; there was lack of provision of proper PPEs for the safety of workers at potential sites. Moreover the survey indicated that the health impacts in workers includes hearing disorders, dermatological impacts, respiratory problems, eye irritation, in addition to these headache and accidental injuries were also noted. The socioeconomic part of the survey indicated that most of the workers in this industry were working on daily basis and their monthly salary was found to be lower as compared to the minimum monthly salary for unskilled workers, fixed by the government of Pakistan.

5. Recommendations

It is recommended that there is a core need for the development and implementation of proper health care and safety guidelines in mining and stone crushing sector of Pakistan. The workers must be provided with proper PPEs including helmet, glasses, breathing filters etc. depending upon nature of duty of workers. The workers should be trained about importance of PPEs, possible health hazards and precautionary measures for personal protection. This should be made compulsory to wear proper work gears as it was observed that in many cases the workers are provided with protective gears but workers do not prefer to use it as they feel uncomfortable working with these PPEs. Emergency Plan should be prepared and workers should be trained for it. Medical, transportation and other facilities should be offered along with wages to reduce the economic constrains and enhance quality of life.

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Competing Interests: The authors declare that there is no potential conflict of interest.

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