Occupational Safety and Health Practices in Cement & Stone Crushing Units in Punjab 2021

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Safety and Health
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Under ADP Scheme Capacity Building of Occupational Safety and Health (OSH)
Regime to Promote Safer Working Conditions at Workplaces)
Centre for the Improvement of Working Conditions & Environment
Directorate General Labour Welfare Punjab
Labour & Human Resource Department Government of the Punjab

Contents

List of Figure

List of Table

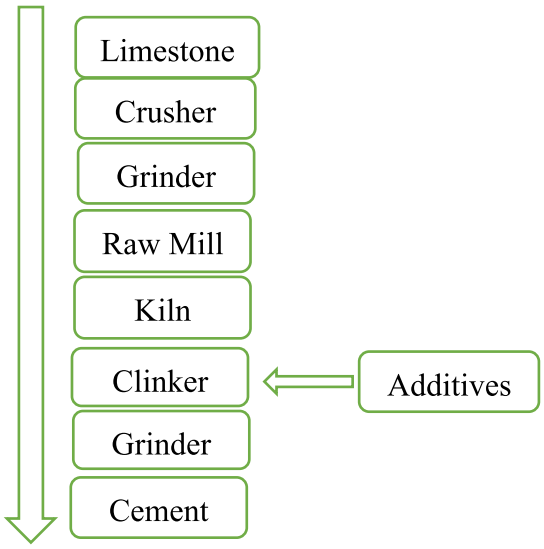
Acronyms

OSH	Occupational Safety & Health
ILO	International Labour Organization
PEQS	Punjab Environmental Quality Standards
OSHA	Occupational Safety & Health Administration
NCOC	National Command and Operation Center

1. Introduction

The cement industry for both developed and underdeveloped countries is vital from the economic point of view. It plays a crucial role in the economic development of a developing country and is well developed and enriched with the availability of plenty of raw stuff. Pakistan's cement industry is the 14th largest cement producer and ranked amongst five exporters [2], fulfilling the domestic needs and neighbouring countries [3].

Cement is a fine powder primarily consisting of a mixture of silicates, aluminates and alumino-ferrites. Many raw materials are used to manufacture Portland cement (EPA 1994). The manufacturing process comprises crushing, grinding, raw material preparation, kiln burning, and cement production. Quarrying of limestone is performed using explosives, and all raw materials are transported to the plant. The raw material is charged into a rotatory kiln, and the contents are heated over 2000^{o}C (2010) using coal or natural gas as a fuel. The kiln is tilted to allow the material at the other end of the plant and abruptly cooled to 100-200^{o}C. Finally, additives like gypsum and others are added, stored into the silos, packed in bags, and loaded on vehicles. However, these industries pose a threat to human health and the environment [1] (Figure).



Cement Manufacturing Process Flowsheet Diagram

Occupational Safety and Health (OSH) has become a public health concern in industrialized countries, especially in high-risk industries (Rachid et al., 2015). For example, cement manufacturing is one of those industries whose product is the most widely used construction material on earth. Because cement has been used widely, its health effects have become an important problem for employees and the environment (Koh et al., 2011). In addition, cement workers are exposed to dust which causes lung function impairment, chronic obstructive lung disease, restrictive lung disease, pneumoconiosis, and

cancer of the lungs and stomach at various production processes (Meo 2004). Therefore, ensuring healthy and safe working conditions for employees and contractors is a fundamental responsibility of the employer and is one of the most critical issues for the cement industry. Further, with the increasing complication of the industrial issue and the rapidly developing techniques in the big factories, risks assessment has become a crucial and best way to ensure workers' safety and health on the one side and maintain qualified labour on the other side (Tomar, 2014).

Workers at workplaces, especially in developing countries, have always faced polluted work environments and are regularly exposed to deleterious dust and particulate matter. Stone crushing and grinding is a crucial industrial sector in Pakistan. The occupational environment at the stone crushing sites poses a potential health threat to the workers since inhalation of dust particles containing free silica for an extended period may lead to occupational diseases like silicosis. Exposure to heavy dust concentrations from stone crushers may cause several diseases, mainly pneumoconiosis [4]. Respiratory damage resulting from such exposures can range from reversible functional changes to irreversible damage to the lungs, and in extreme exposures, causes lung cancer [5]. During the stone crushing operation, large-sized stone, mined from quarries in the size range of 200–300 mm, is crushed to smaller usable sizes, generally 6, 12, or 25 mm [6]. Airborne particulates pose a potential health risk to quarry employees in the form of respiratory, dermal, and ocular irritation [7,8]. Chronic exposure to dust in the stone cutting industry may increase the risk of respiratory problems and lung function impairment; cigarette smokers, long duration of work and non-usage of personal protective equipment (PPE) are at higher risk [9]. Accidents and injuries, hearing loss, dust-related lung diseases are major concerns among stone crushing and cutting workers. However, these diseases and health-related conditions can be prevented by improving the working conditions with simple means and minimal cost [12].

2. Objective:

The main objectives of this study are:

i. To conduct occupational safety and health risk assessment of cement manufacturing and stone crushing and grinding sectors in Punjab
ii. To formulate an analysis report on occupational diseases.

3. General Covid Guidelines by the Provincial Government

The COVID-19 pandemic has changed the world. As the science revealed that the COVID-19 virus was spreading via airborne droplets, public health and safety and health experts recommended using face coverings or respirators when around other people. COVID-19, which started in 2020 and is continuing into 2021, the SAA Centre for the Improvement of Working Conditions & Environment

(SAACIWCE), Directorate General Labour Welfare Punjab, Labour & Human Resource Department received multiple requests for COVID-19 related trainings and follow-ups of standard operating procedures and performed several compliance assistance activities on respiratory protection at workplaces. As a result, SAACIWCE provided valuable information about occupational safety and health, risk assessment activities and personal protection to groups of employers, workers, and future workers during the pandemic.

The pandemic has severely hampered the risk assessment activities on OSH during the field visits while maintaining the day-to-day guidelines issued by the Primary and Secondary Health Care Department, Government of the Punjab per the National Command Operation Centre (NCOC). During the OSH risk assessment activity, some questions related to the COVID-19 were also incorporated into the questionnaire. Some of the general guidelines are as follows:

1. Clean hands before putting a mask on, before and after taking it off, and after touching it.
2. Make sure it covers the nose, mouth and chin.
3. When you take off a mask, store it in a clean plastic bag, and every day either wash it if it's a fabric mask or dispose of it in case of a medical mask.
4. Avoid the 3Cs: spaces that are closed, crowded or involve close contact. Likewise, avoid crowded or indoor settings.
5. Regularly and thoroughly clean hands with an alcohol-based hand rub or wash them with soap and water.
6. Avoid touching eyes, nose and mouth.
7. Cover mouth and nose with bent elbow or tissue when cough or sneeze.
8. Clean and disinfect surfaces frequently, especially those which are regularly touched.
9. Stay home and self-isolate even if minor symptoms such as cough, headache, mild fever appear.

Analysis of the data showed that in the Cement & Stone Crushing sector, as handwashing facilities were provided to the workers, on average, every worker washed their hands eight times daily. In these times of the pandemic, wearing a mask at the workplace is mandatory.

3.1 Study Area

A total of six industries (3 cement and 3 stone crusher) were taken as samples throughout Punjab. Different tests have been performed in all the selected industries.

3.2 Sampling and Testing Instrument

Audiometry and spirometry tests were conducted to check workers' occupational health, noise, illumination, and total dust. The noise level monitoring was carried out to find out noise levels in the

workplace and noise exposure to employees. Its measurements were carried out with Casella Precision Sound Level Meter Type 2100. The light intensity monitoring was carried out to determine the illumination levels in different sections/areas using a lux meter (EXTECH, Color LED Light Meter LT-45). Total dust concentration and Audiometry testing of randomly selected industries' workers was carried out using a Sibelmed audiometer. Spirometry testing of randomly selected employees from various industries was performed using MIR Spirodoc Spirometer to diagnose their respiratory ailments. The measurement was carried out by

3.3 Data Collection

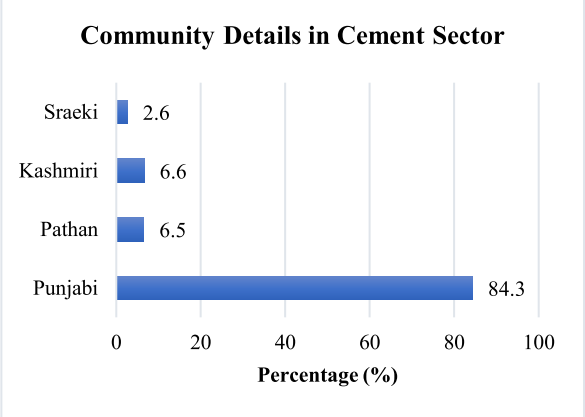
Data collection was carried out from individual units with the collaboration of employers by the technical OSH team of SAA Centre for the Improvement of Working Conditions & Environment (SAACIWCE), Labour & Human Resource Department, Government of the Punjab, Lahore by following complete Covid-19 guidelines. Different tests were conducted at each facility, including audiometry, spirometry, stack emission monitoring, noise level monitoring, illumination level testing, heat exposure monitoring and personal dust exposure level.

4. Results and Discussion

4.1 Sociodemographic status of workers

4.1.1 Community Details

Figure 1 shows 84.2% of the workers were Punjabi, 2.6% Saraiki, 6.6% Kashmiri and 6.6% Pathan employees working in the cement sector of Punjab. In contrast, the ratio of Punjabi and Pathan workers in stone crushing units were 93.5 and 6.5, respectively.



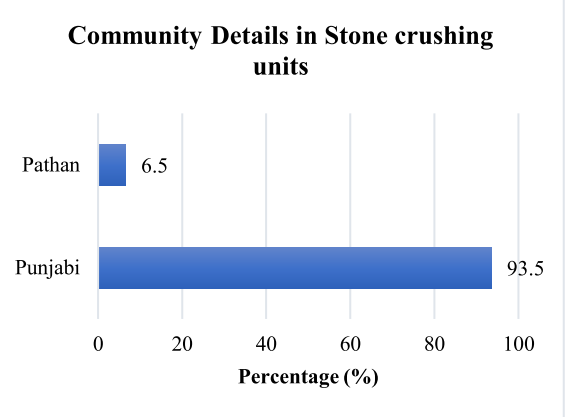


Figure 1: Community detail in Cement Sector **Figure 2: Community detail in Stone Crushing**

4.1.2 Religious status of workers

100% of the workers questioned in both the cement sector and stone crushing units were Muslims.

4.1.3 Educational status of workers

In the Cement Industry, the educational status of workers showed that 1.3% were illiterate, 7.9% of the workers had primary qualification, 10.5% middle, 34.2% matric, 22.4% intermediate, 18.4% graduate and 5.3% masters.

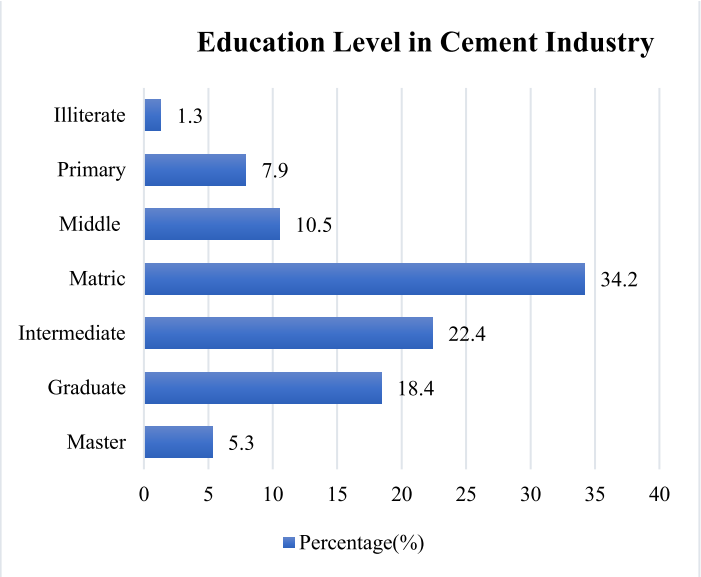


Figure 3(a)

In stone crushing, the educational status of workers showed that 6.5% were illiterate, 35.5% of the workers had primary qualification, 32.3% were middle, 22.6% werer matric, and 3.2% were intermediate. None of the workers questioned was graduate.

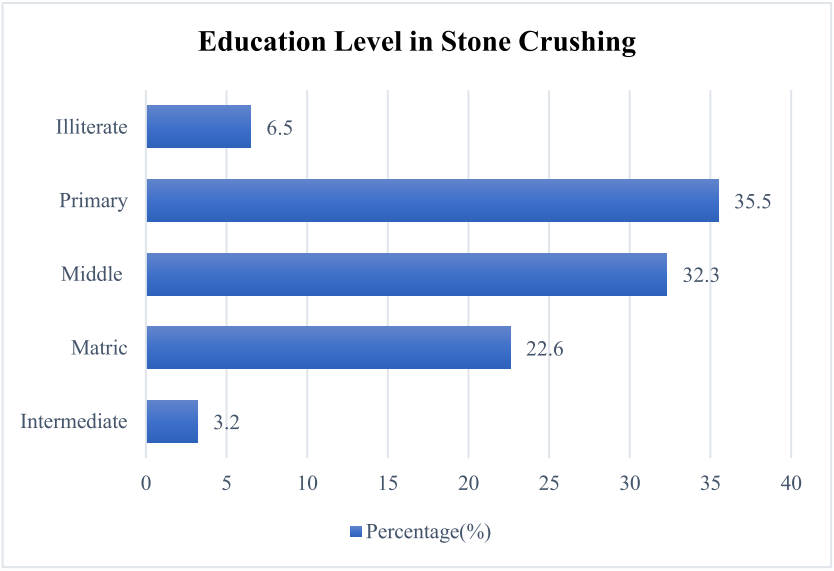


Figure 3(b)

4.1.4 Insurance Details of the Workers

28.9% of workers had the facility of insurance claims in the cement sector. 6.6% & 3.2% had government aid, and 60.5% & 96.8% spent their own money for medical assistance in both sectors, i.e., cement & stone crushing units, respectively, as shown in Figure 4.

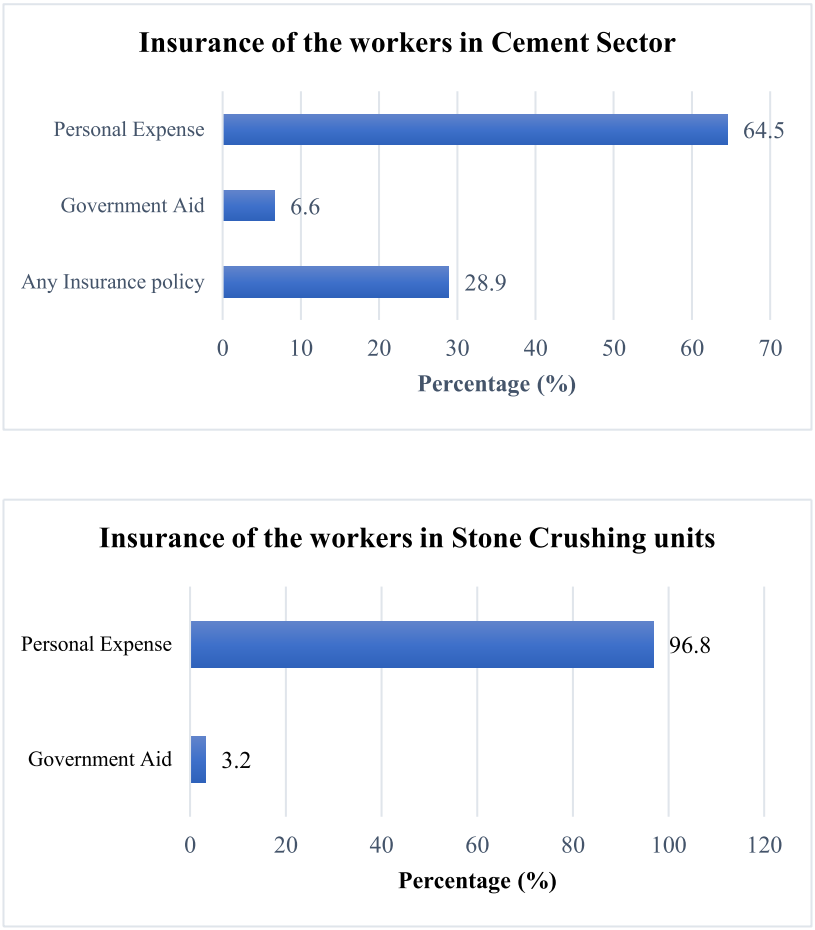
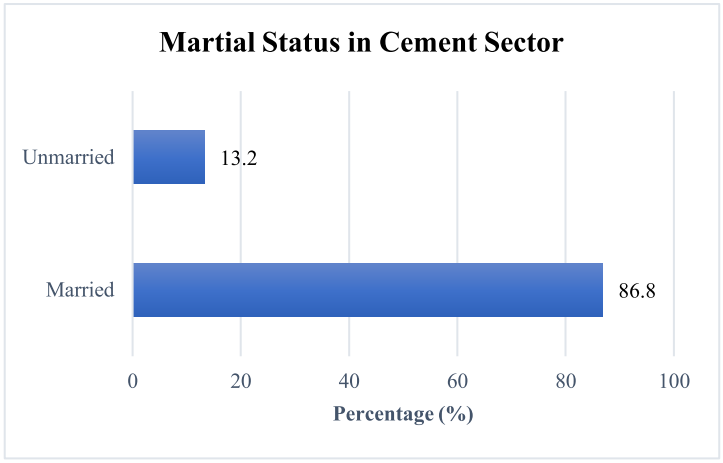


Figure 4: - Insurance facility for the workers

4.1.5 Marital Status of the Workers

As far as marital status of the workers is concerned, 86.8% were married, and 13.2% were unmarried in the cement sector, while 74.2% were married and 25.8% were unmarried in stone crushing units, as shown in Figure 5.



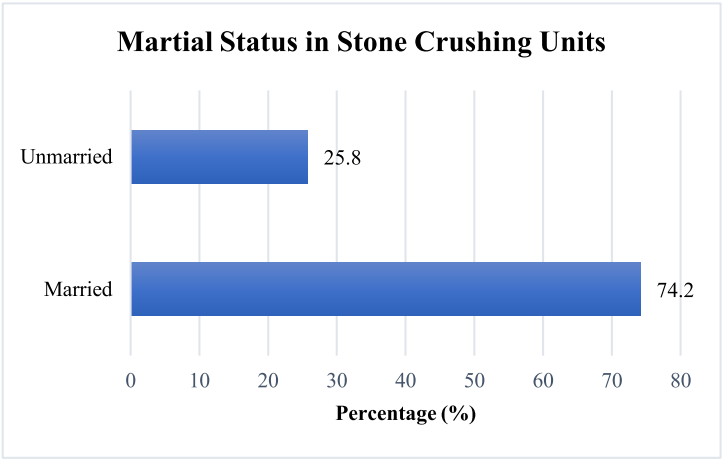


Figure 5: - Marital status of the workers

4.1.6 Employment Status of the Workers

In the Cement sector, 57.9% of the workers were permanent, 22.4% were temporary, 9.2% part-time, and 10.5% worked contractually.

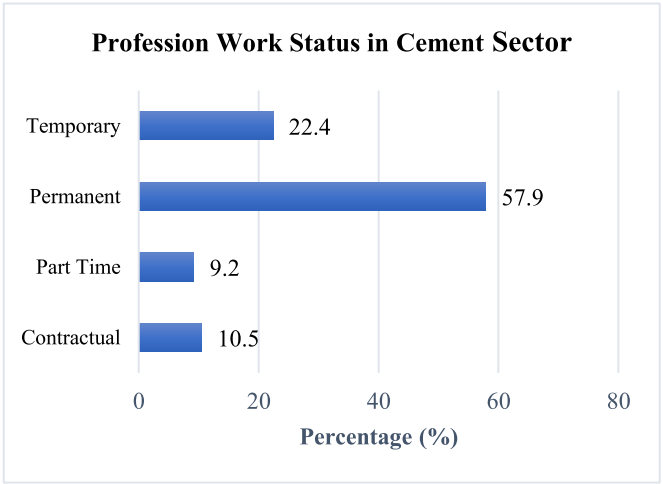


Figure 6(a): Employment status of workers in Cement Sector

In contrast, 28.7% of workers in the stone crushing sector were temporary, 32.3% permanent, 25.8% part-time, and 3.2% employees worked contractually.

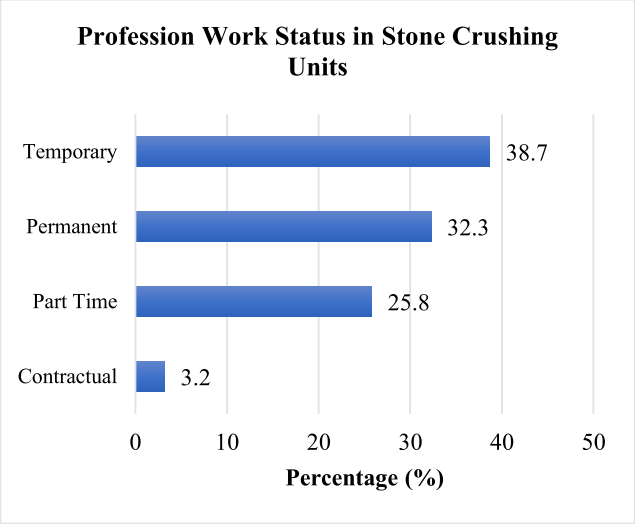


Figure 6(b): Employment status of the workers in Stone Crushing Sector

4.1.7 Residential Status of the Workers

In the cement sector, Figure 7(a) shows around 72.4% of the workers had their residence, 21.1% lived on rent, while 6.6% of the workers lived with their families.

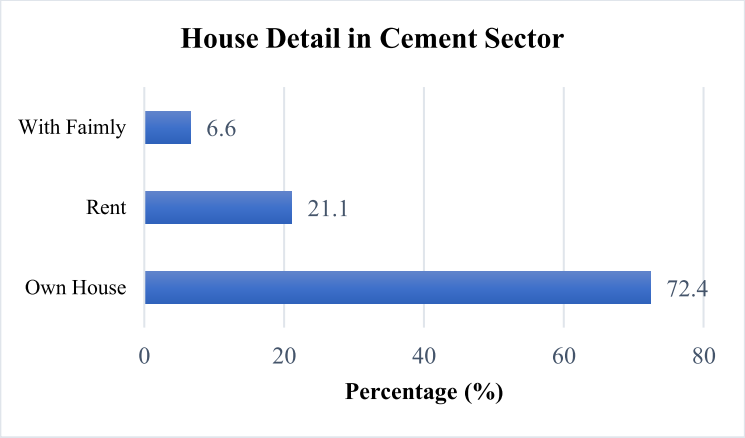


Figure 7(a): Housing details of workers in the Cement Sector

In contrast, as shown in Figure 7(b), 58.1% of the workers in the stone crushing sector had their own house, 29% lived on rent, while 12.9% lived with their families.

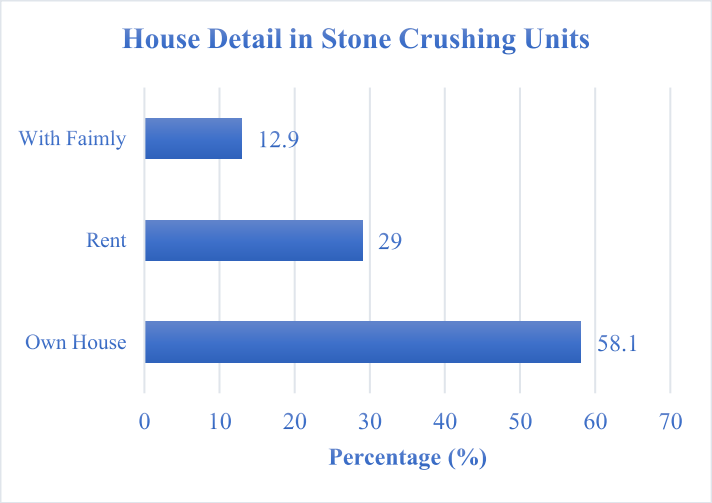


Figure 7(b): - Housing status of the workers in Stone Crushing Sector

4.1.8 Other sociodemographic data of workers:

Other sociodemographic data of workers showed that workers' minimum and maximum age ranged between 22 to 63 years. In comparison, the weight and height of workers vary from 45 kg to 118 kg and 156 cm to 190 cm, respectively. Moreover, the total no. of family members fluctuates from 2 to 14 persons whereas no. of children and young persons are 0 to 8 and 0 to 9 correspondingly. Still, the total no. of earning hands were 1 to 5 persons per family. In contrast, in the stone crushing units, the minimum and maximum age of workers range between 20 to 57 years. While weight and height of workers vary from 40 kg to 105 kg and 147 cm to 177 cm, respectively. Moreover, the total no. of family members fluctuates from 2 to 12 persons whereas, total no. of children and young persons were 0 to 5 and 2 to 7 correspondingly. In addition, the total no. of earning hands were 1 to 4 persons per family in both sectors respectively, as shown in **Table 1**.

Table-1: Descriptive Statistics of Cement & Stone Industries

Descriptive Statistics of Cement Industries				
Sr. No.	**Category**	**Min**	**Max**	**Mean**
1	Age of Employee (year)	22	63	35.12
2	Weight (kg)	45	118	75.97
3	Height (cm)	156	190	171.93
4	Total No. of Family Members	2	14	5.64
5	Total No. of Children	0	8	2.09
6	Total No. of Young Persons	0	9	3.09
7	No. of earning hands	1	5	1.50

Descriptive Statistics of Stone Crushing Units				
Sr. No.	**Category**	**Min**	**Max**	**Mean**
1	Age of Employee (year)	20	57	34.81
2	Weight (kg)	40	105	66.06
3	Height (cm)	147	177	165.61
4	Total No. of Family Members	2	12	6.94
5	Total No. of Children	0	5	2.42
6	Total No. of Young Persons	2	7	4.00
7	Number of earning hands	1	4	1.74

4.2 Physical Hazards

4.2.1 Noise:

A high noise level was observed in most of the cement and stone crushing units, i.e., ≥ **85 dB(A),** which might affect the hearing capacity of the workers, as shown in **Table 2**. As there is no threshold limit value for workplace noise level, we used Occupational Safety and Health Administration (OSHA) as a reference which recommends an 85 dB(A) standard for noise pollution in industries.

Figure 8: - Noise monitoring

Table 2: OSHA standard for industrial noise is **85 dB(A)**

Noise monitoring in the cement industry			Noise monitoring in stone crushing units		
Sr. No.	**Departments/ Sections**	**Noise Level dB (A)**	**Sr. No.**	**Departments/Sections**	**Noise Level dB (A)**
1.	Near power plant	86.4	1.	Near Main Gate	68.1
2.	Coal Mill	89.0	2.	Lifter workshop	71.0
3.	Powerhouse	98.1	3.	Sand screen machine	70.3
4.	Near boiler	88.2	4.	Near drill machine	83.5
5.	Kiln	92.2	5.	Backside of building	66.9
6.	Raw Mill	97.2	6.	Mechanical workshop	83.5
7.	Near power plant	86.4	7.	Near Masa machine	117.6
8.	Coal Mill	89.0	8.	Earthmoving machine	90.1
9.	Mechanical Workshop	76.1	9.	Crusher Machine	83.2
10.	Electrical Workshop	76.3	10.	Generator	103.2
11.	RDF Shed	84.1	11.	Drill machine	105.2
12.	CCR	87.9	12.	Crusher-01	100.02
13.	Cooler No. 2	82.1	13.	Crusher-02	92.06

4.2.2 Audiometry Testing

Audiometry tests of workers indicate that some workers have slight to severe hypoacusia during their ear testing. **Table 3** shows that 12.06% of overall tested workers had normal audiometry, 51.72% had slight hypoacusia, 32.75% moderate and 3.44% with severe hypoacusia in the cement sector whereas, 5.35% of overall tested workers had normal audiometry, 42.85% of overall tested workers had slight hypoacusia, 41.07% moderate hypoacusia and 10.71% with severe hypoacusia in stone crushing units. *According to Section 11 of the "Punjab Occupational Safety & Health Act 2019", it is the employer's legal responsibility, to provide biannual medical examination regarding precautions against contagious, occupational or infectious disease at the workplace.*

Figure 9: Audiometry testing

A Sibelmed audiometer carried out audiometry testing. The results are summarized below in

Table 3: Audiometric Results

Sr. No.	Unit Type (Cement)	Total Number of Employees	Normal	Slight hypoacusia	Moderate hypoacusia	Severe hypoacusia
1	Unit-1(F)	21	05	13	03	0
2	Unit-2 (D.G)	20	01	07	10	2
3	Unit-3 (A)	17	01	10	06	0
Total		58	07	30	19	2
Unit Type (Stone Crushing Units)						
1	Unit-1(I)	21	01	06	14	0
2	Unit-2 (M)	20	0	08	09	3
3	Unit-3 (G)	15	02	10	0	3
Total		56	03	24	23	6

4.2.4 Poor Housekeeping

Poor housekeeping was observed in some sections, such as maintenance and raw material areas, including passageways, storerooms, and service areas in the cement sector. At the same time, there is no concept of safety in stone crushing units, which may lead to serious ill health and accidents of the workers. The carcinogenic dust at both places is a serious threat to the workers' health, and this concern must be addressed on a priority basis.

4.2.5 Temperature/Humidity/Ventilation

Poor ventilation was observed in some areas of the cement sector, which in case of high temperature and humidity in the industry can cause heat stress, heat illness, sweating, dehydration, deficiency of salts in the body, headache and heat stroke. There was also respirable carcinogenic dust present in the workplace environment, affecting lung efficiency and developing cancer over time. In the stone crushing units, these environmental conditions were deplorable, leading to ill health such as heat stroke, asthma, chest illness, cancer, musculoskeletal disorders, which may increase the accidents ratio.

4.2.6 Stack Emission Testing

The stack emission monitoring was carried out during the general shift using calibrated Flue Gas Analyzer Testo 350. The results of all cement industries and stone crushing units are summarized in **Table 4** below. All the values are within permissible limits of Punjab Environmental Quality Standards except H2S values.

Table-4: Stack Emission Results (Boiler)

Parameters	Unit	PEQS	Raw Mill EP Stack (Line-2)	Coal Mill (Line-2)
Capacity	Tons/day	--	7200	1200
Load	--	--	Normal	Normal
Fuel	--	--	Coal	Coal
O_2	%	NGVS	8.85	6.40
CO	mg/Nm^3	800	168.8	166.2
NO_x	mg/Nm^3	1200	461.9	562.1
NO	mg/Nm^3	NGVS	449.6	547.2
NO_2	mg/Nm^3	NGVS	12.3	14.9
CO_2	%	NGVS	10.3	12.8
SO_2	mg/Nm^3	1700	0	0
H_2S	mg/Nm^3	10	87.2	110.9
Eff. N	%	--	95.1	96.3
Eff. G	%	--	91.2	88.1
Final Temp	°C	--	96.6	88.1
Smoke	% or Ringlemann Scale	40% or 2	20% or 1	20% or 1

*The sum of NO and NO_2 values used for the calculation of NOx value.
**The mixed fuel is used for boiler ***NGVS: No guideline value set
****PEQS: Punjab Environmental Quality Standards

Table-5: Stack Emission Results (Generator)

On the other hand, the stack emission values monitored on stone crushing units were within the permissible limits of PEQS, as depicted in **Table V** below.

Parameters	Unit	PEQS	Generator - I
Capacity	kVA	-	-
Load	-	-	Normal
Fuel	-	-	Diesel
O_2	%	-	16.49
CO	mg/Nm^3	800	226.2
NO_x	mg/Nm^3	600	268.7
NO	mg/Nm^3	-	224.8
NO_2	mg/Nm^3	-	43.9
CO_2	%	-	3.85
SO_2	mg/Nm^3	1700	0
H_2S	mg/Nm^3	10	2.1
Eff. N	%	-	50.5
Eff. G	%	-	48.3
Final Temp	°C	-	200
Smoke	% or Ringlemann Scale	40% or 2	20% or 1

*The sum of NO and NO_2 values used for the calculation of NOx value.
**NGVS: No guideline value set ***PEQS: Punjab Environmental Quality Standards

4.3. Use of Personal Protection

Usually, there is no practice to provide and use special PPE's while working on machines except basic ones in the cement sector. Before procurement of the safety equipment, there must be size, fitness and quality evaluation. So it was recommended to provide workers with suitable, reasonable fitness and quality-wise best PPEs. In contrast, a worker must ensure their compliance with safety rules by using such personal safety equipment. In contrast, there is no concept of safety in the stone crushing units or even use of PPEs. Such alarming situations may lead to ill health, especially asthma and cancer, due to carcinogenic dust, which has silica sand. Such severe conditions may also lead to accidents and deaths of the workers. Figure 11 shows that PPE'S had been provided to 100% of the employees, which doesn't necessarily mean they are offered job-specific PPE's (helmets, masks, safety shoes). While on the other hand, in the stone crushing units, 25.8% of workers were provided with PPE's which were not specific, while 74.2% of workers were without any safety equipment. However, the Apex Court of Pakistan has already, in its ruling, raised the issue of carcinogenicity of the silica-containing dust in both sectors, which depicted an alarming situation of workers health and safety.

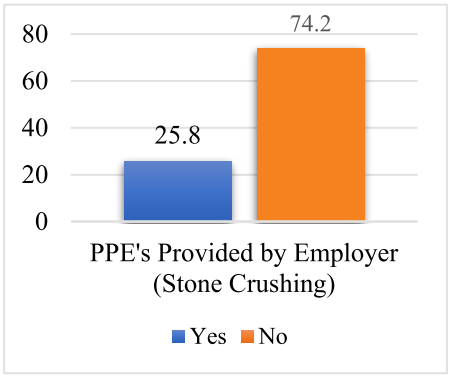


Figure 10: Use of Personal Protection

4.4 Fire Hazards

Fire hazards were observed in coal mill, processing, chemical storage areas, welding, mechanical and electrical workshop, and some of the fire extinguishers were found expired. But there was no arrangement of a fire emergency in the stone crushing units, and workers are untrained concerning their safety.

4.4.1 First Aid Facilities/Equipment

The first aid box was found empty or with insufficient material during risk assessment of the enterprises. The Health and Safety (First-Aid) regulations require all employers to provide adequate

and appropriate first aid equipment, facilities, and qualified people so that employees can receive immediate help in case they are injured or ill at work. But on the other hand, in the stone crushing units, such facilities were missing.

4.5 Mechanical Hazards

At some points, the observed mechanical hazards were unguarded machinery, disarrangement of tools in the electrical/mechanical store. For example, the mechanical saw machine blade was not guarded that may cause serious injury. In the Machine shop area, improper stacking of metal plates in the plant area may cause cut, slip, trip & fall hazards. In addition, safety guards of machines were missing at some points.

4.6 Chemical Hazards

The main chemical hazards observed in cement units were the poorly maintained storage and mixing of chemicals and carcinogenic cement dust in the premises. Toxic chemicals handling and mixing without proper PPE's is a primary concern, along with no reasonable precautions against carcinogenic dust hazardous to human health. In the stone crushing units, the primary health concern was carcinogenic dust and poorly stored fuel tanks.

4.6.1 Chemical Exposure

Figure 15 depicts that 6.5% and 5.3% of the workers were exposed to the chemical gas hazard in the stone crushing and cement sectors, respectively.

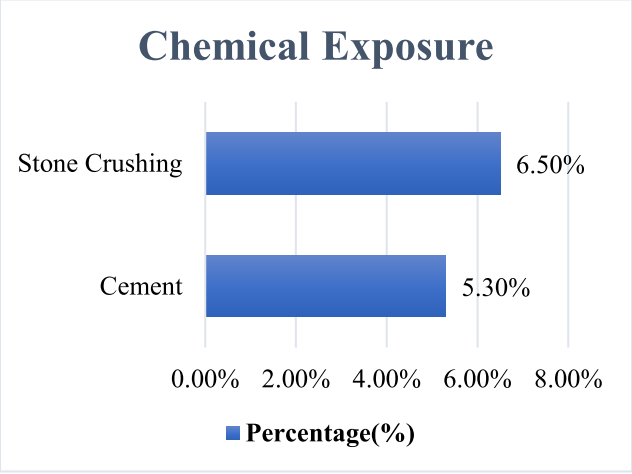


Figure11 : - Chemical Exposure at the workplace

4.6.2 Total Dust Exposure

The maximum concentration value of total dust was observed in the labour raw mill area (cement sector) with avg of 11.37 mg/m^3, which is greater than the threshold limit of 10mg/m^3 as per ACGIH standards. Whereas 4.032 mg/m^3 was the maximum concentration value observed on stone crushing units, as shown in **Table 6.**

Table 6: Total dust concentration (mg/m^3) in cement industries		
Sr. No.	**Location / Machine**	**Total dust concentration (mg/m^3)**
1.	Mech -Pyro	0.48
2.	Pyro Process	1.66
3.	Planning and Process	0.46
4.	Planning Office	0.49
5.	Production	2.34
6.	gardening/nursery	2.00
7.	cleaner /housekeeping	1.48
8.	Milling	3.92
9.	Crusher	1.27
10.	coal mill	0.84
11.	cement kiln	2.02
12.	labor raw mill	11.37
13.	kilner yard	4.55
14.	packing plant	0.82
15.	Raw-Mech	0.79
16.	WHR	0.95
17.	AM Raw Mill	0.47
18.	Electrical	0.47
19.	Quality Control	0.89
20.	Maintenance	6.54
21.	Drawing	0.85
22.	Admin	1.21
Total dust concentration (mg/m^3) in stone crushing units		
Sr. No.	**Location / Machine**	**Total dust concentration (mg/m^3)**
1.	Section A	4.032
2.	Section B	4.23
3.	Section C	1.52
4.	Mass plant area	1.22
5.	Loader area	1.66
6.	Security Guard	1.30

The dust present at both sites is carcinogenic as it has silica sand. Moreover, the prolonged exposure of the workers may result in the development of cancer, as were also highlighted in the Apex Court of Pakistan's ruling a few years back.

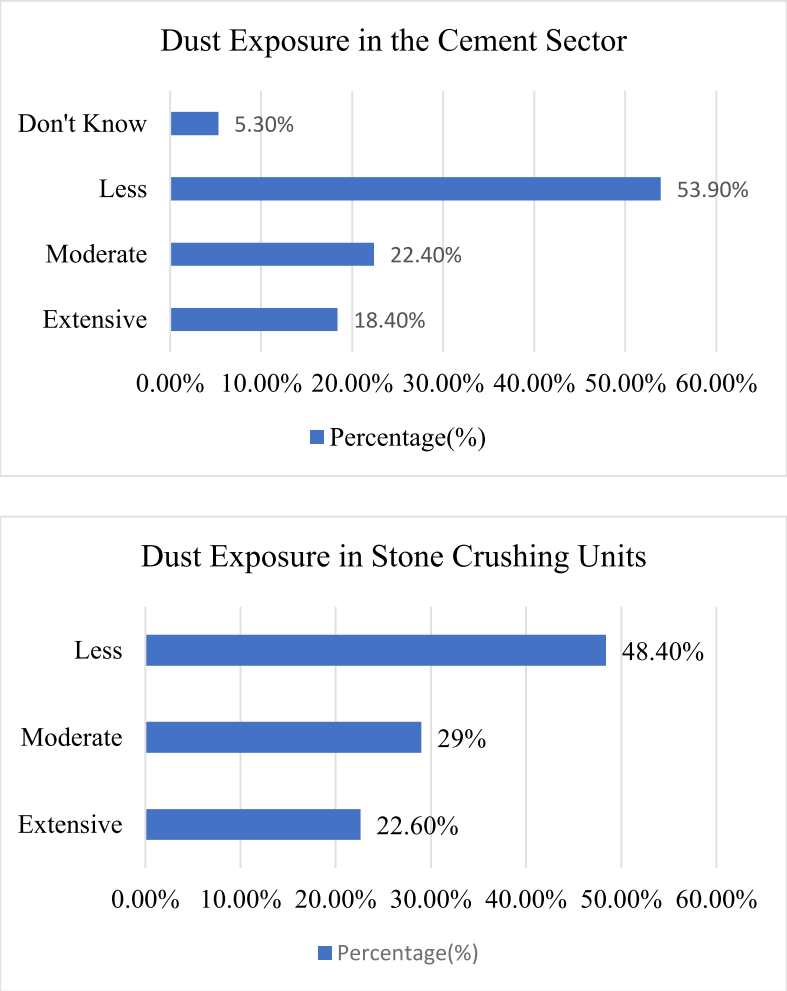


Figure12: -Dust Exposure at the workplace

As far as the awareness level is concerned, workers are usually unaware of such risks or do not have such competence level to protect themselves by reducing their exposure to such risks or using PPE's. As shown in above **Figure 16**, 18.4% & 22.6% were extensively exposed, 22.4% & 29% moderately vulnerable, 53.9% & 48.4% less exposed to such conditions in both sectors respectively. Interestingly, there were 5.3% workers population in the cement sector did not know about this hazard due to the lack of knowledge and basic skills.

Figure 13: Total Dust Exposure at Workplace

4.6.3 Spirometry Testing

107workers

Spirometry testing of 65 and 56 randomly selected employees from various enterprise sections in the cement and stone crushing units, respectively, were performed by using MIR Spirodoc to diagnose occupational asthma, chronic obstructive pulmonary disease (COPD) other conditions that affect the respiratory system**.** The details are summarized below:

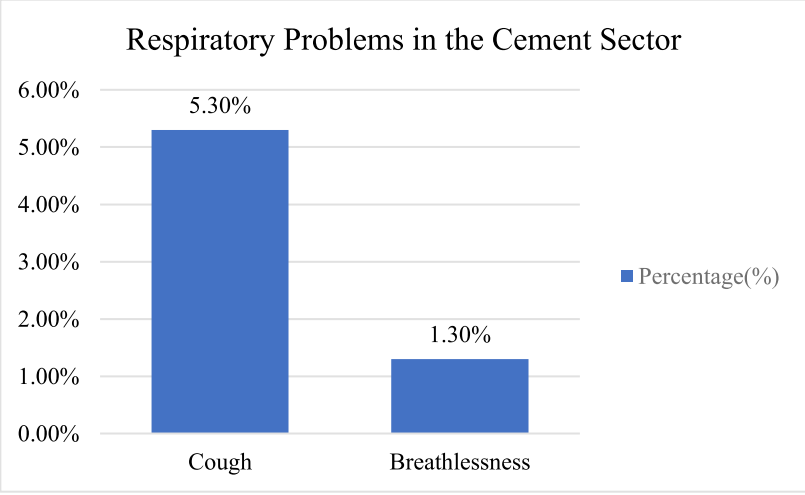
Figure 14: Spirometry test of Workers

4.6.2 Spirometry Testing Results

The details of the spirometry results are shown in the given **Table 7** below.

Sr. No.	Unit Type (Cement)	Total Number of Employees	Normal	Mild-Moderate Restriction	Moderate Severe Restriction	Severe Restriction
1	Unit-1(F)	23	15	06	01	01
2	Unit-2 (D)	21	10	06	04	01
3	Unit-4 (K-W & D)	21	07	10	04	01
Total		**65**	**32**	**22**	**09**	**03**
Unit Type Stone Crushing Units)						
1	Unit-1(S)	22	10	06	03	03
2	Unit-2 (G)	14	05	35	08	01
3	Unit-4 (I)	20	09	08	0	03
Total		**56**	**24**	**49**	**11**	**07**

As shown in **Table 7**, Spirometry tests of workers indicate that 49.23% & 42.85% of the workers had normal spirometry, whereas 33.84% & 87.5% had mild to moderate respiratory problems. Moreover, 13.84% & 19.64% showed moderate to severe and 4.61% & 12.5% severe respiratory restrictions respectively in both sectors, due to workplace carcinogenic dust/chemical exposures or smoking. Therefore, a pulmonologist should properly check such workers.



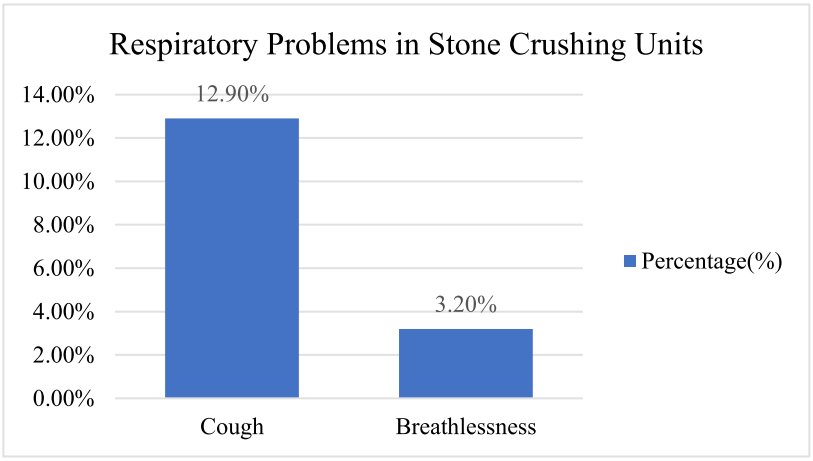


Figure 15: - Respiratory problems to the workers in cement & Stone Crushing Units

In **Figure 19**, it was revealed that workers had 1.3% & 3.2% breathlessness problem, 5.3% & 12.9% had cough symptoms, and no symptoms were reported for phlegm, wheezy problems, and Chest illness in both sectors, i.e., cement and stone crushing and grinding respectively.

4.7 Electrical Hazards

It was found at some points that wet and dirty switch sockets were connected to the machines. Grounding was not according to the standard, and wires hung without cable trays. Main power cables for stone crushing machines contained joints. These joints were made by twisting of wires. Conduits of wires were broken, which increased the chances of electrical shock. Earthing of electrical equipment was not properly maintained. Electrical fire hazard in different sections was present due to naked electrical wires. If this situation persists, it will lead to fire hazards due to an electrical short circuit.

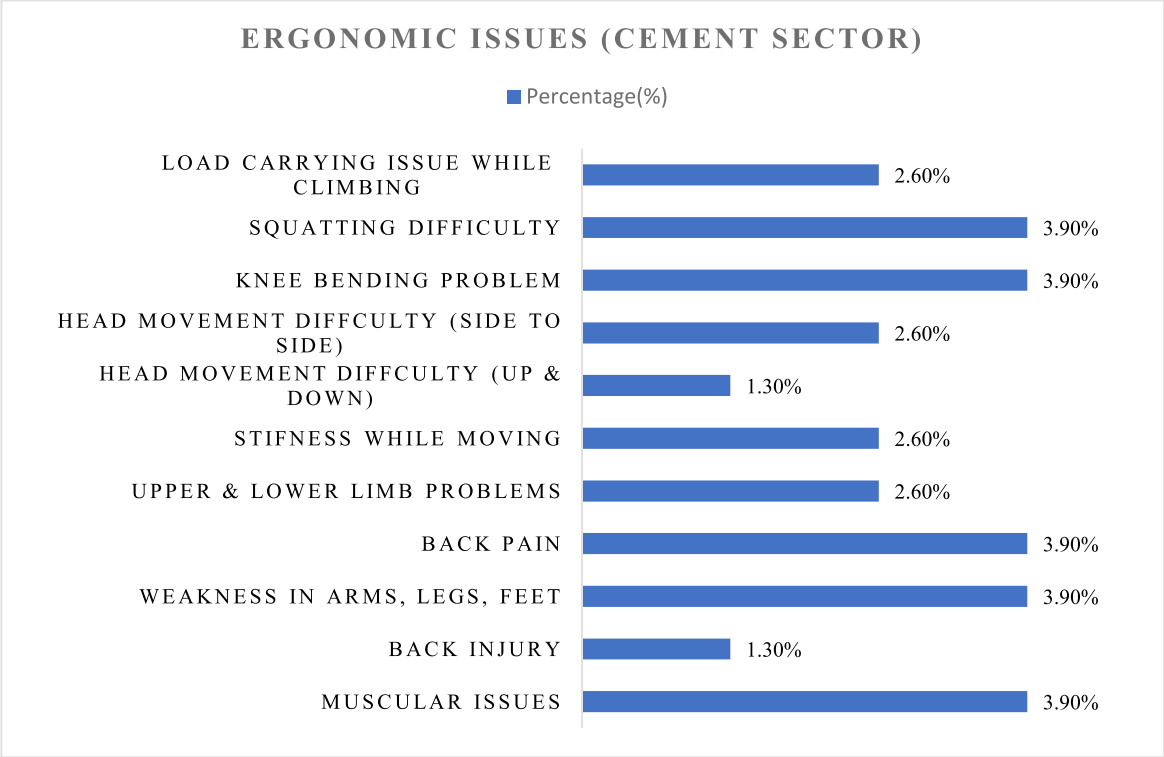
4.8 Ergonomics Hazards

The most neglected part of the hazards which needs more attention from the employer are ergonomic hazards. Awkward body movements and postures while performing tasks such as forcing, kneeling, overreaching, bending, repetition of work & body twisting most of the workplaces in the cement sector while stone crushing sites were full of such hazards. Most of the workers in both industries were unaware of ergonomics hazards as well as training. The most common hazards were either personal, task-related due to equipment or environmental risk factors. However, it is need of the hour to educate employees through training and safety signs. In addition, user-friendly hand tools must be incorporated into the system to prevent musculoskeletal disorders. Similarly, it was also observed that there were outdated stools and outdated technologies/machinery in different locations, as clearly depicted in figure 20.

Figure 16 : - Awkward body posture and movement at workplace

4.8.1 Musculoskeletal Disorders

According to the assessment, as revealed in **Figure 22**, 3.9% & 9.7% of the workers had muscular problems, 1.3% & 9.7% had back injuries, 3.9% & 12.9% had weakness in arm/leg and feet, 3.9% & 6.5% had back pain, 2.6% & 12.9% had upper & lower limb problems, 2.5% & 12.9% had stiffness lean forward and backward, 1.3%, 2.6% and 9.7% & 6.5% had difficulty in head movement (up-down & side by side), 3.9% & 6.5% felt difficulty in knee bending, 3.9% & 9.7% had difficulty in squatting and 2.5% & 6.5% workers feeling difficulty while carrying loads (12kg). Employees must be educated regarding ergonomic hazards through training and counseling. The ergonomic diseases develop over the period of time in poor workplace conditions.



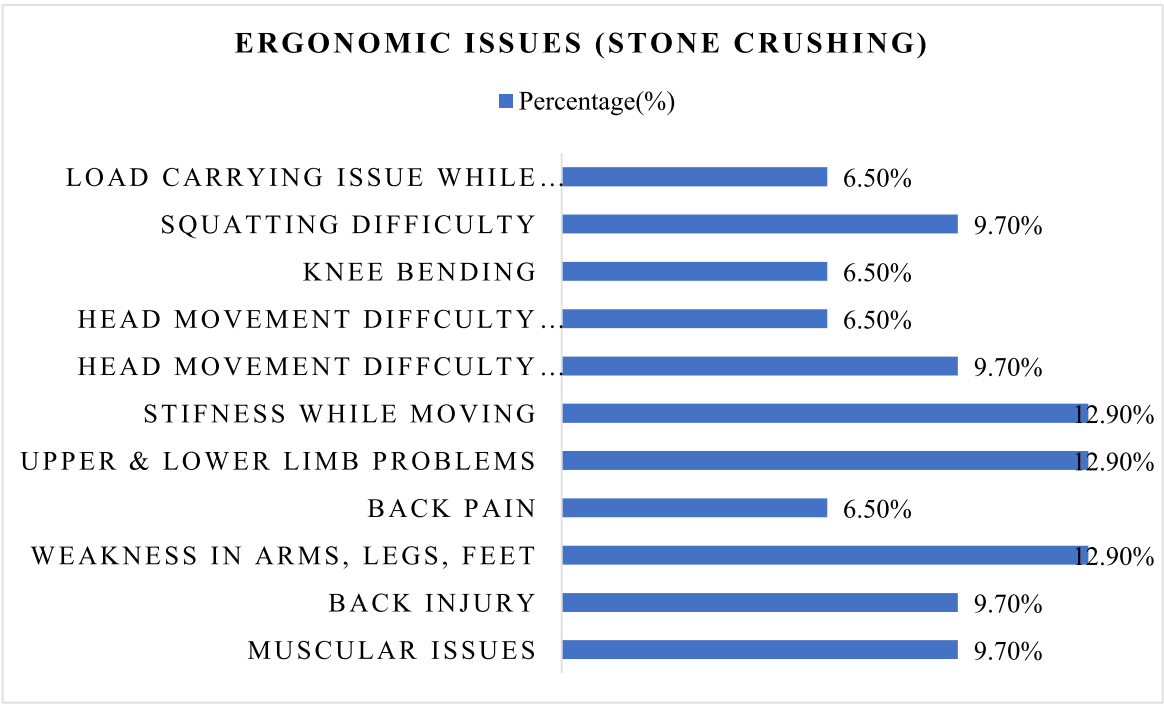


Figure 17: - Ergonomics Issues at workplace (Cement & Stone Crushing Units)

4.8.2 Smoking

As stated in Figure 23, the ratio of the employees in the cement and stone crushing sector that around 41.9% & 19.7% had smoking habits, respectively. Such personal factors may also enhance the risks of musculoskeletal issues for the workers.

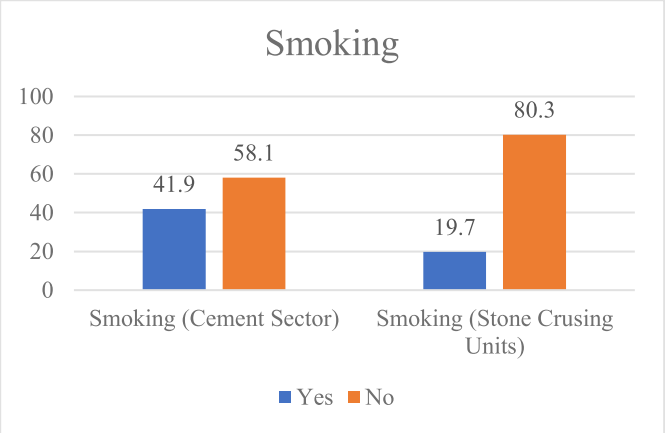


Figure 18: Smoking habits of the Workers at the Workplace

4.9 Biological Hazards:

There were poor conditions of restrooms, kitchen, and some workplace areas used by the workers, which may lead to the workers' ill health, as shown in **Figure 24**. On the other hand, the workers' conditions in stone crushing units were deplorable. Proper facilities such as clean drinking water and other basic amenities weren't provided for workers. Workers must be provided medical checkups twice a year, precautions against contagious or infectious disease and compulsory vaccination and inoculation according to Sections 23, 23-A and 47 of The Factories Act 1934 and The Punjab Factories Rules 1978, respectively.

About Covid-19

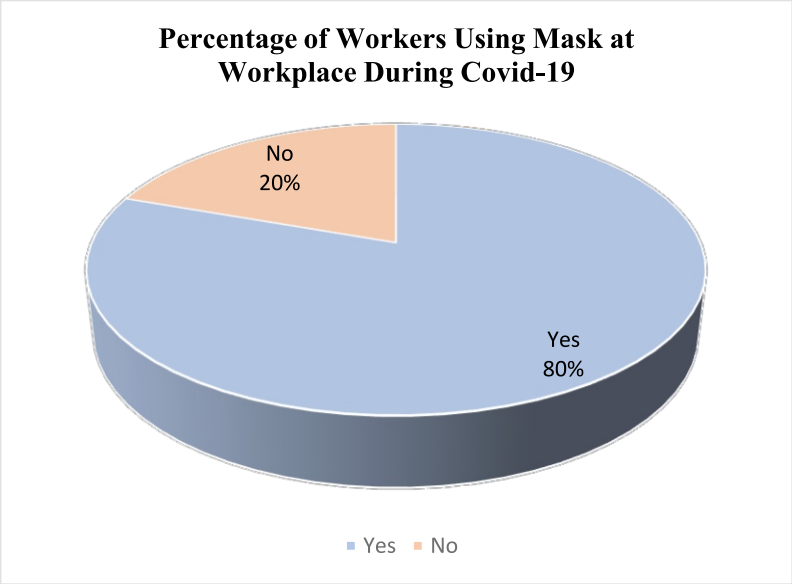
The COVID-19 pandemic has changed the world. As the science revealed that the COVID-19 virus was spreading via airborne droplets, public health and safety and health experts recommended the use of face coverings or respirators when around other people. COVID-19, which started in 2020 and is continuing into 2021, the SAA Centre for the Improvement of Working Conditions & Environment (SAACIWCE), Directorate General Labour Welfare Punjab, Labour & Human Resource Department received multiple requests for COVID-19 related trainings and follow-ups of standard operating procedures and performed several compliance assistance activities on respiratory protection at workplaces. As a result, SAACIWCE provided valuable information about occupational safety and health, risk assessment activities and personal protection to groups of employers, workers, and future workers during the pandemic.

It is the obligation of the employers, workers, and their organizations to collaborate with health authorities to prevent and control COVID-19. Cooperation between management and workers and their representatives is essential for workplace-related prevention measures. Workers are responsible for following measures for occupational safety and health, infection prevention and control

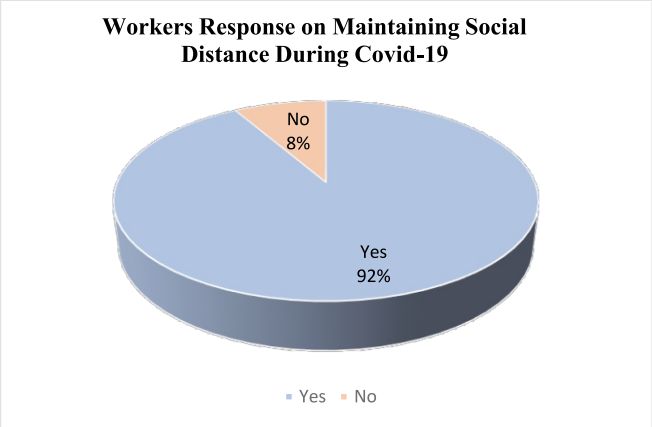
established for their workplace, and participating in training provided by the employer. Workers should immediately report to their supervisor any situation which may present an imminent and severe danger to their life or health. Even workers have the right to remove themselves from any workplace that they reasonably believe presents an imminent and serious threat to their life or health and should be protected from any undue consequences as a result of exercising this right (POSH Act 2019).

The pandemic has severely hampered the risk assessment activities on OSH during the field visits while maintaining the day-to-day guidelines issued by the Primary and Secondary Health Care Department, Government of the Punjab in accordance with the National Command Operation Centre (NCOC). During the OSH risk assessment activity, some questions related to the COVID-19 were also incorporated into the questionnaire. Analysis of the data showed that in the Cement & Stone Crushing sector, as handwashing facilities were provided to the workers, on average, every worker washed their hands eight times daily. In these times of the pandemic, wearing a mask at the workplace is mandatory.

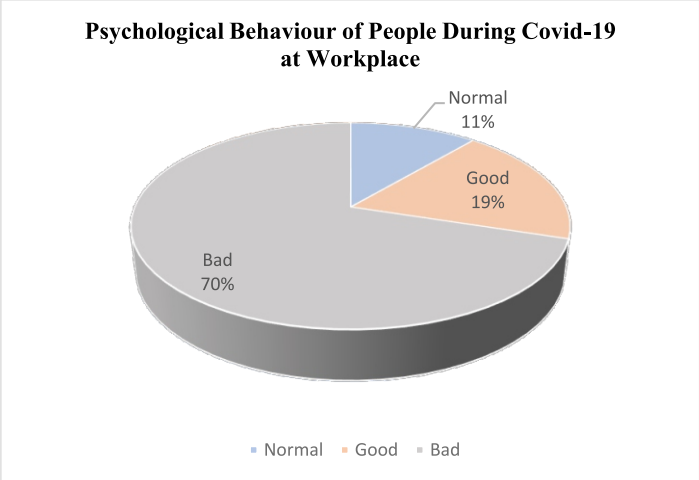
Around 80% of workers responded they were using a mask at the workplace. An average of Rs.550/- per month was being spent on purchasing them by the employer.



The data showed that around 92% of the workers and their co-workers maintained social distancing while at work. By applying statistical tools on the data, it was evident that the respiratory problems among the workers were more who were repeatedly using the mask due to non-availability of sufficient financial resources or carelessness in using them. These results are in agreement with the research studies conducted by the University of Health Sciences Lahore.



Workers were asked about the psychological behaviour during the covid-19 times. 19% of the workers responded to the behaviour as good, 11% normal, while 70% bad.



Challenges During Study

Pandemic

Several challenges were faced during these activities, but one of the significant challenges was the pandemic. It slowed down the field activities of the risk assessment in the field. Still, whenever the Government (National Command and Operation Center) granted the ease in the restrictive guidelines to cope with Novel Corona Virus, the field activities were resumed to meet the targets. Most of the activities were completed by the SAACIWCE OSH team during the peak of the disease.

Other Challenges

Employers' management didn't allow the OSH team to conduct their activities freely and steadily for the wellbeing of the workers. Employees worked for many years without a standard job letter with proper terms and conditions written in the local legislation and the difference in the minimum wage (employers record and actual salary).

Recommendations

1. Noise levels in most of the areas in both sectors were above the permissible limits of the OSHA standard (85dB(A). OSHA standard was followed as local legislation regarding noise does not exist. The administration needs to reduce sound produced by providing administrative controls and personnel protection to concerned employees. It must be ensured that proper size and type of ear protectors are provided to the workers for maximum effectiveness. Workers in high noise areas must be rotated and allowed to work in less noisy areas for at least half of their shift. Machines must be well maintained and lubricated to stem the unnecessary noises.
2. Audiometry tests indicate that maximum workers in both sectors had mild to moderate hypoacusia than severe ailments during their ear testing. Nevertheless, a medical doctor must properly check those workers for further medical treatment.
3. Spirometry tests showed that most of the workers had mild to moderate respiratory problems. In contrast, some had severe respiratory problems due to smoking or exposure to carcinogenic dust in both sectors. Therefore, a pulmonologist must properly check such workers. The maximum number of the workers had normal spirometry.
4. The maximum concentration value of total dust was observed in the raw labour mill with avg of 11.37 $mg/m^{3,}$ whereas the minimum value was 0.46 mg/m^3 in the cement sector. In contrast, in the stone crushing units, an average of 4.23 mg/m^3 concentration was observed, and the lowest value was 1.22 $mg/m^{3,}$ which is less than the threshold limit of 10 mg/m^3 except in the cement sector as per ACIGH standards as no local legislation is present to address this. However, dust exposure must be prevented with dust control mechanisms, PPE's and good housekeeping.
5. A comprehensive fire risk assessment and check fire system vigilantly. When working with flammable and combustible liquids, eliminate ignition sources (sparks, smoking, flames, hot surfaces). Use less amount of flammable liquid necessary in the work area. Keep storage areas cool and dry. Store flammable and combustible liquids away from incompatible materials. All workers, visitors and staff members must be aware of the escape routes. Make sure that emergency exit doors are not wedged open. Combustible material must not be stored near emergency exit doors/escape routes. Minimum fire protection requirements such as fire alarm, fire extinguishers, emergency response plans and fire drills must be in place. Stone crushing units need special attention from both employer, employee's representation and government side for the safety and health of the workers. All SOPs concerning OSH must be prepared and implemented.
6. At the workplace, material/tools/machinery must be appropriately stacked. All components of mechanical systems that transmit energy must be guarded. Machines must be adequately

safeguarded to avoid entanglement/draw in / cut/ crushing hazards. Moreover, ensure maintenance of forklift and other such machinery. During service/maintenance activity of machines or equipment, a Lockout/Tagout (LOTO) system must be implemented in the stone crushing units to prevent the workers from accidents.

7. The hazard communication program must be developed and implemented accordingly. Activity-based suitable and clean PPE's must be available to the workers with proper training refers to the subject matter. Fume hoods must be installed in the welding section to prevent ill health effects in both sectors.
8. Short rest breaks must reduce awkward body movement and postures in some sections to prevent musculoskeletal disorders in both sectors.
9. Working platforms and stools quality must be enhanced for the said purposes. Moreover, environmental conditions and intra-space between working platforms must be improved for the workers' comfort in both sectors.
10. There must be a proper inspection and checking system to prevent electric shocks and fire, especially stone-crushing units.
11. A suitable dust control mechanism with a proper exhaust and ventilation system should be installed, give rest breaks, ensure isotonic cold drinks, and provide heat-resistant clothing to the worker. Moreover, build cold refugees and resting and health surveillance facilities for the workers, especially in stone crushing units.
12. To prevent workers from biological hazards, areas must be disinfected and cleaned using suitable PPEs. Special care is required for low-level workers in both sectors.

ATS-DLD-78-A

ADULT QUESTIONNAIRE - SELF COMPLETION

(for those 13 years of age and older)

Thank you for your willingness to participate. You were selected by a scientific sampling procedure, and your cooperation is very important to the success of this study.

This is a questionnaire you are asked to fill out. Please answer the questions as frankly and accurately as possible. ALL INFORMATION OBTAINED IN THE STUDY WILL BE KEPT CONFIDENTIAL AND USED FOR MEDICAL RESEARCH ONLY. Your personal physician will be informed about the test results if you desire.

IDENTIFICATION

IDENTIFICATION NUMBER: #####

NAME:_____ _____ ___
(Last) (First) (MI)

STREET _____

CITY _____ STATE ____ ZIP _____

PHONE NUMBER: ( ) _____-_____

INTERVIEWER: ###

DATE: _____
MO DAY YR

1. BIRTHDATE: _____ ____ _____
Month Day Year

2. Place of Birth: _____

3. Sex:
1. Male ____
2. Female ____

4. What is your marital status?
1. Single ____
2. Married ____
3. Widowed ____
4. Separated/Divorced ____

5. Race:
1. White ____
2. Black ____
3. Oriental ____
4. Other ____

6. What is the highest grade completed in school? _____
(For example: 12 years is completion of high school)

SYMPTOMS

These questions pertain mainly to your chest. Please answer yes or no if possible. If a question does not appear to be applicable to you, check the does not apply space. If you are in doubt about whether your answer is yes or no, record no.

COUGH

7A. Do you usually have a cough? 1. Yes ___ 2. No ___
(Count a cough with first smoke or on first going out-of-doors. Exclude clearing of throat.)[If no, skip to question 7C.]

B. Do you usually cough as much as 4 to 6 times a 1. Yes ___ 2. No ___

day, 4 or more days out of the week?

C. Do you usually cough at all on getting up, or first thing in the morning? — 1. Yes ___ 2. No ___

D. Do you usually cough at all during the rest of the day or at night? — 1. Yes ___ 2. No ___

IF YES TO ANY OF THE ABOVE(7A,7B,7C, OR 7D), ANSWER THE FOLLOWING:
IF NO TO ALL, CHECK DOES NOT APPLY AND SKIP TO 8A.

E. Do you usually cough like this on most days for 5 consecutive months or more during the year? — 1. Yes ___ 2. No ___
8. Does not apply __

F. For how many years have you had this cough? — _____ Number of years
88. Does not apply __

==========

PHLEGM

8A. Do you usually bring up phlegm from your chest? (Count phlegm with the first smoke or on first going out-of-doors. Exclude phlegm from the nose. Count swallowed phlegm) [If no, skip to 8C.] — 1. Yes ___ 2. No ___

B. Do you usually bring up phlegm like this as much as twice a day, 4 or more days out of the week? — 1. Yes ___ 2. No ___

C. Do you usually bring up phlegm at all on getting up or first thing in the morning? — 1. Yes ___ 2. No ___

D. Do you usually bring up phlegm at all during the rest of the day or at night? — 1. Yes ___ 2. No ___

IF YES TO ANY OF THE ABOVE (8A, B, C, OR D), ANSWER THE FOLLOWING:
IF NO TO ALL, CHECK DOES NOT APPLY AND SKIP TO 9A.

E. Do you bring up phlegm like this on most days for 3 consecutive months or more during the year? — 1. Yes ___ 2. No ___
8. Does not apply __

F. For how many years have you had trouble with phlegm? — _____ Number of years
88. Does not apply __

==========

EPISODES OF COUGH AND PHLEGM

9A. Have you had periods or episodes of (increased*) cough and phelgm lasting for 3 weeks or more each year? *(For individuals who usually have cough and/or phlegm) — 1. Yes ___ 2. No ___

IF YES TO 9A:

B. For how long have you had at least 1 such episode per year? — _____ Number of years
88. Does not apply __

==========

WHEEZING

10A. Does your chest ever sound wheezy or whistling:

1. When you have a cold?	1. Yes ___ 2. No ___
2. Occaisonally apart from colds?	1. Yes ___ 2. No ___
3. Most days or nights?	1. Yes ___ 2. No ___

IF YES TO 1, 2, OR 3 IN 10A:

B. For how many years has this been present? _____ Number of years
88. Does not apply __

11A. Have you ever had an ATTACK of wheezing that has made you feel short of breath? 1. Yes ___ 2. No ___

IF YES TO 11A:

B. How old were you when you had your first such attack? _____ Age in years
88. Does not apply __

C. Have you had 2 or more such episodes? 1. Yes ___ 2. No ___
8. Does not apply __

D. Have you ever required medicine or treatment for the(se) attack(s)? 1. Yes ___ 2. No ___
8. Does not apply __

==========

BREATHLESSNESS

12. If disabled from walking by any condition other than heart or lung disease, please describe and proceed to Question 14A.

Nature of condition(s):_____

13A. Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill? 1. Yes ___ 2. No ___

IF YES TO 13A:

B. Do you have to walk slower than people of your age on level because of breathlessness? 1. Yes ___ 2. No ___
8. Does not apply __

C. Do you ever have to stop for breath when walking at your own pace on the level? 1. Yes ___ 2. No ___
8. Does not apply __

D. Do you ever have to stop for breath after walking about 100 yards(or after a few minutes) on the level? 1. Yes ___ 2. No ___
8. Does not apply __

E. Are you too breathless to leave the house or breathless on dressing or undressing? 1. Yes ___ 2. No ___
8. Does not apply __

==========

CHEST COLDS AND CHEST ILLNESSES

14A. If you get a cold, does it usually go to your chest? (Usually means more than 1/2 the time) 1. Yes ___ 2. No ___
8. Don't get colds__

15A. During the past 3 years, have you had any chest illnesses that have kept you off work, indoors at home, or in bed? 1. Yes ___ 2. No ___

IF YES TO 15A:

B. Did you produce phlegm with any of these chest illnesses? 1. Yes ___ 2. No ___ 8. Does not apply __

C. In the last 3 years, how many such illnesses, with (increased) phlegm, did you have which lasted a week or more? _____Number of illnesses _____No such illnesses _____Does not apply

==========

PAST ILLNESSES

16. Did you have any lung trouble before the age of 16? 1. Yes ___ 2. No ___

17. Have you ever had any of the following:
1A. Attacks of Bronchitis? 1. Yes ___ 2. No ___

IF YES TO 1A:
B. Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply __

C. At what age was your first attack? _____ Age in years 88. Does not apply __

2A. Pneumonia (include bronchopneumonia)? 1. Yes ___ 2. No ___

IF YES TO 2A:
B. Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply __

C. At what age did you first have it? _____ Age in years 88. Does not apply __

3A. Hayfever? 1. Yes ___ 2. No ___

IF YES TO 3A:
B. Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply __

C. At what age did it start? _____ Age in years 88. Does not apply __

18A. Have you ever had chronic bronchitis? 1. Yes ___ 2. No ___

IF YES TO 18A:
B. Do you still have it? 1. Yes ___ 2. No ___ 8. Does not apply __

C. Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply __

D. At what age did it start? _____ Age in years 88. Does not apply __

19A. Have you ever had emphysema? 1. Yes ___ 2. No ___

IF YES TO 19A:
B. Do you still have it? 1. Yes ___ 2. No ___ 8. Does not apply __

C. Was it confirmed by a doctor? 1. Yes ___ 2. No ___ 8. Does not apply __

D. At what age did it start? _____ Age in years 88. Does not apply __

20A. Have you ever had asthma? 1. Yes ___ 2. No ___

IF YES TO 20A:

B. Do you still have it? 1. Yes ___ 2. No ___
8. Does not apply __

C. Was it confirmed by a doctor? 1. Yes ___ 2. No ___
8. Does not apply __

D. At what age did it start? _____ Age in years
88. Does not apply __

E. If you no longer have it, at what age did it stop? _____ Age stopped
88. Does not apply __

21. Have you ever had:

A. Any other chest illnesses? 1. Yes ___ 2. No ___
If yes, please specify _____

B. Any chest operations? 1. Yes ___ 2. No ___
If yes, please specify _____

C. Any chest injuries? 1. Yes ___ 2. No ___
If yes, please specify _____

22A. Has doctor ever told you that you had heart trouble? 1. Yes ___ 2. No ___

IF YES to 22A:

B. Have you ever had treatment for heart trouble in the past 10 years? 1. Yes ___ 2. No ___
8. Does not apply __

23A. Has a doctor ever told you that you have high blood pressure? 1. Yes ___ 2. No ___

IF YES to 23A:

B. Have you had any treatment for high blood pressure (hypertension) in the past 10 years? 1. Yes ___ 2. No ___
8. Does not apply __

==========

OCCUPATIONAL HISTORY

24A. Have you ever worked full time (30 hours per week or more) for 6 months or more? 1. Yes ___ 2. No ___

IF YES to 24A:

B. Have you ever worked for a year or more in any dusty job? 1. Yes ___ 2. No ___
8. Does not apply __

Specify job/industry: _____ Total years worked __
Was dust exposure 1. Mild ___ 2. Moderate ___ 3. Severe ___ ?

C. Have you ever been exposed to gas or chemical fumes in your work? 1. Yes ___ 2. No ___
8. Does not apply __

Specify job/industry: _____ Total years worked __
Was dust exposure 1. Mild ___ 2. Moderate ___ 3. Severe ___ ?

D. What has been your usual occupation or job -- the one you have worked at the longest?

1. Job-occupation: _____
2. Number of years employed in this occupation: _____
3. Position-job title: _____
4. Business, field, or industry: _____

TOBACCO SMOKING

25A. Have you ever smoked cigarettes? (NO means less than 20 packs of cigarettes or 12 oz. of tobacco in a lifetime or less than 1 cigarette a day for 1 year. — 1. Yes ___ 2. No ___

IF YES to 25A:

B. Do you now smoke cigarettes (as of 1 month ago)? — 1. Yes ___ 2. No ___ 8. Does not apply __

C. How old were you when you first started regular cigarette smoking? — ____ Age in Years 88. Does not apply __

D. If you have stopped smoking cigarettes completely, how old were you when you stopped? — ____ Age stopped Check if still smoking ___ 88. Does not apply __

E. How many cigarettes do you smoke per day now? — ___ Cigarettes/day 88. Does not apply __

F. On the average of the entire time you smoked, how many cigarettes did you smoke per day? — ___ Cigarettes/day 88. Does not apply __

G. Do or did you inhale the cigarette smoke? — 1. Does not apply __ 2. Not at all _____ 3. Slightly _____ 4. Moderately _____ 5. Deeply _____

26A. Have you ever smoked a pipe regularly? (YES means more than 12 oz tobacco in a lifetime.) — 1. Yes ___ 2. No ___

IF YES to 26A:

B1. How old were you when you started to smoke a pipe regularly? — ____ Age

2. If you have stopped smoking a pipe completely, how old were you when you stopped? — ____ Age stopped Check if still smoking pipe ____ 88. Does not apply __

C. On the average over the entire time you smoked a pipe, how much pipe tobacco did you smoke per week ? — ____ oz per week (a standard pouch of tobacco contains 1 1/2 oz) 88. Does not apply __

D. How much pipe tobacco are you smoking now? — ___ oz per week 88. Not currently smoking a pipe ___

E. Do or did you inhale the pipe smoke? — 1. Never smoked ____ 2. Not at all _____ 3. Slightly _____ 4. Moderately _____ 5. Deeply _____

27A. Have you ever smoked cigars regularly? (Yes means more than 1 cigar a week for a year). — 1. Yes ___ 2. No ___

IF YES to 27A:

B1. How old were you when you started smoking cigars regularly? ____ Age

2. If you have stopped smoking cigars completely, how old were you when you stopped? ____ Age stopped
Check if still smoking cigars___
88.Does not apply __

C. On the average over the entire time you smoked cigars, how many cigars did you smoke per week ? ___ Cigars per week
88.Does not apply __

D. How many cigars are you smoking per week now? ___ Cigars per week
88. Check if not smoking cigars currently __

E. Do or did you inhale the cigar smoke?
1. Never smoked ____
2. Not at all _____
3. Slightly _____
4. Moderately _____
5. Deeply _____

==========

FAMILY HISTORY

28. Were either of your natural parents ever told by a doctor that they had a chronic lung condition such as:

	FATHER			MOTHER		
	1. YES	2. NO	3. DON'T KNOW	1. YES	2. NO	3. DON'T KNOW
A. Chronic brochitis?	_____	_____	_____	_____	_____	_____
B. Emphysema?	_____	_____	_____	_____	_____	_____
C. Asthma?	_____	_____	_____	_____	_____	_____
D. Lung cancer?	_____	_____	_____	_____	_____	_____
E. Other chest conditions?	_____	_____	_____	_____	_____	_____

29A. Is parent currently alive?

	_____	_____	_____	_____	_____	_____

B. Please Specify:

_____ Age if living	_____ Age if living
_____ Age at death	_____ Age at death
8. Don't know _____	8. Don't know _____

C. Please specify cause of death.

_____ _____

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Under ADP Scheme "Capacity Building of Occupational Safety and Health (OSH) Regime to Promote Safer Working Conditions at Workplaces"

Centre for the Improvement of Working Conditions & Environment

Directorate General Labour Welfare Punjab

Labour & Human Resource Department Government of the Punjab

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