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ASSESSMENT OF THE RESPIRATORY SYMPTOMS AMONG THE WORKERS OF CEMENT FACTORY

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Abstract:

Background:

Even in the twenty-first century, millions of people are working daily in a dusty environment. They are exposed to different types of health hazards i.e. fume, gases and dust, which are risk factors in developing occupational disease. Cement industry is involved in the development of structure of this advanced and modern world but generates dust during its production. Cement dust causes lung function impairment, chronic obstructive lung disease, restrictive lung disease, pneumoconiosis and carcinoma of the lungs, stomach and colon.

Objective:

To assess the respiratory symptoms among the workers of cement factory.

Methodology:

A cross sectional study was conducted in Cement factory. Data and peak expiratory rate was collected from 100 factory workers regarding their respiratory symptoms. The data was analyzed on SPSS version 18.

Conclusion: *Total cement dust exposure was related to acute respiratory symptoms and acute ventilatory effects. Implementing measures to control dust and providing adequate personal respiratory protective equipment for the Production workers are highly recommended*

Keywords: *Portland cement dust, exposure, Lung function impairment*

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INTRODUCTION:

In the most general sense of the word, cement is a binder, a substance that sets and hardens independently, and can bind other materials together. The word "cement" traces to the Romans, who used the term *opus caementicium* to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick additives that were added to the burnt lime to obtain a hydraulic binder were later referred to as *cementum*, *cimentum*, *cäment*, and *cement*.

Usage: The most important use of cement is the production of mortar and concrete—the bonding of natural or artificial aggregates to form a strong building material that is durable in the face of normal environmental effect.

Types of modern cement

- **Portland cement**
- **Non-Portland hydraulic cements**

Portland cement:

Cement is made by heating limestone (calcium carbonate) with small quantities of other materials (such as clay) to 1450 °C in a kiln, in a process known as calcination, whereby a molecule of carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quicklime, which is then blended with the other materials that have been included in the mix. The resulting hard substance, called 'clinker', is then ground with a small amount of gypsum into a powder to make 'Ordinary Portland Cement', the most commonly used type of cement (often referred to as OPC).

Portland cement is a basic ingredient of concrete, mortar and most non-specialty grout. The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate (gravel and sand), cement, and water. As a construction material, concrete can be cast in almost any shape desired, and once hardened, can become a structural (load bearing) element. Portland cement may be grey or white.

Non-Portland hydraulic cements:

Non-Portland cements include:-

- Pozzolan-lime cements
- Slag-lime cements
- Supersulfated cements
- Calcium aluminate cements
- Calcium sulfoaluminate cements
- Natural cementsGeopolymer cements

Environmental impacts:

Cement manufacture causes environmental impacts at all stages of the process. These include emissions of airborne pollution in the form of

- Dust
- Gases
- Noise and vibration

CO_2 emissions:

Cement manufacturing releases CO_2 in the atmosphere both directly when calcium carbonate is heated, producing lime and carbon dioxide,[1] and also indirectly through the use of energy if its production involves the emission of CO_2. The cement industry produces about 5% of global man-made CO_2 emissions, of which 50% is from the chemical process, and 40% from burning fuel.[2]

The amount of CO_2 emitted by the cement industry is nearly 900 kg of CO_2 for every 1000 kg of cement produced.[3]

Heavy Metal Emissions in the Air

In some circumstances, mainly depending on the origin and the composition of the raw materials used, the high-temperature calcination process of limestone and clay minerals can release in the atmosphere gases and dust rich in volatile heavy metals, a.o, thallium, cadmium and mercury are the most toxic. Heavy metals (Tl, Cd, Hg, ...) are often found as trace elements in common metal sulfides (pyrite (FeS_2), zinc blend (ZnS), galena (PbS), ...) present as secondary minerals in most of the raw materials. Environmental regulations exist in many countries to limit these emissions. As of 2011 in the United States, cement kilns are "legally allowed to pump more toxins into the air than are hazardous-waste incinerators."[4]

Cement Dust Emission

The major pollution problem in the cement industry is dust, which is emitted from various parts of the production process such as the raw material crusher, rotary kiln, cranes, mills, storage silos and packing sections[5] Airborne respirable dust levels from less than 5 to more than 40 mg/m3 have been recorded in the workplace air of cement factories(6) The aerodynamic diameter of the cement dust ranges from 0.05 to 20 lm, making the whole respiratory tract a target for cement deposition(7) The essential constituents of Portland cement are tricalcium silicate

and dicalcium silicates, with varying amounts of alumina, tricalcium aluminate and iron oxide and low concentrations of hexavalent chromium(8) Workers exposed to cement dust have chronic respiratory symptoms(9), chronic impairment of ventilatory function(10) and chronic lung and pleural abnormalities on chest radiography(11Occupationally related respiratory cancer has also been reported(12)

Pathogenesis:

The aerodynamic diameter of cement particles range from 0.05 to 5.0 micrometer in diameter. These particles are respirable in size hence Portland cement is important as a potential cause of occupational lung disease 2. This particle size distribution would make the tracheobronchial respiratory zone, the primary target of cement deposition4. The main route of entry of cement dust particles in the body is the respiratory tract and / or the gastrointestinal tract by inhalation or swallowing respectively. Both routes, especially the respiratory tract are exposed to numerous potentially harmful substances in the cement mill environment10. The physical properties that are of importance include particle size and density, shape and penetrability, surface area, electrostatic charge, and hygroscopicity. Among the more important chemical properties influencing the respiratory tract response is the acidity or alkalinity of the inhaled agent. The deposition of inhaled material is primarily dependent on particle size and is best described in forms of an aerodynamic diameter. All particles with an aerodynamic diameter in excess of 10 m are deposited on the mucous membrane in the nose and pharynx and particles between 3 and 10 m in diameter can be deposited throughout the tracheobronchial tree. Particles between 0.1 and 3 m in diameterare mostly deposited within the alveoli and particles smaller than 0.1 m remain in the air stream and are exhaled 12. The pathogenesis is most probably due to its irritating, sensitizing and pneumoconiotic properties. Deposition of cement dust in the respiratory tract causes a strong basic reaction leading to increased pH values (12.5–13.0) that irritate the exposed mucoumembranes[13] Furthermore, calcium and aluminum found in cementdust have been shown to irritate mucous membranes[14] Crystalline silica exposure is associatedwith the development of respiratory health effects[15] however in cement dust theconcentration of airborne respirable silica has been reported to be low[16].

Apart from that, Maestrelli*et al.* (1979) reported radiographic changes of pneumoconiosis among 7.2% in Italian cement mill workers. In addition, Herrera *et al.* (1984) found (1.6%) of pneumoconiosis in cement mill workers in Venezuela. Similarly, Popovic (1984) identified pneumoconiosis in 17.4% in Yugoslavian cement workers.

Cement industry in the world

In 2010, the world production of hydraulic cement was 3,300 million tonnes. The top three producers were China with 1,800, India with 220, and USA with 63.5 million tonnes for a combined total of over half the world total by the world's three most populated states.[17]For the world capacity to produce cement in 2010, the situation was similar with the top three states (China, India, and USA) accounting for just under half the world total capacity.

Cement Industry in Pakistan:

Pakistan is a country that is wealthy in cement raw material. Cement, being one of Pakistan's major industries, has been playing an essential role in the socio-economic growth of the country. While the industry has seen its highs and lows in the recent past, it has improved during the last couple of years. The growth in current years is the result of the development of export markets and an increase in production ability.

History

- In 1921 the first cement plant was established in the city of Wah.
- During its independence in 1947, Pakistan acquired four cement plants.
- In 1972 the cement industry was nationalized and the State Cement Corporation of Pakistan was established. 11. Kazmi, S. The cement industry was privatized in 1990 which led to the setting up of new plants.

Cement Market

Pakistan's cement market, which at present consists of 29 cement plants, is divided into two separate regions, North and South.

The northern region consists of the provinces of Punjab and NWFP.

- Some of the major cement manufacturers in this region are:
  - *D.G. Khan*
  - *Lucky Cement*
  - *Maple Leap*

The southern region consists of the province of Sindh and lower parts of Balochistan.

- Some of the major cement manufacturers in this region are:
  - *Attock*
  - *Zeal Pak*
  - *Thatta*

Cement production capacity in the North is 35.18 million tons {80 percent} while in the South it is only 8.89 million tons {20 percent}. Rohail, M.[19]

AIMS AND OBJECTIVES:

Our aims and objectives were to :-

1.To study the respiratory symptoms of the cement factory workers

2.Factors responsible for respiratory symptoms

3.The impact of hazardous gaseous emission on the health of the workers

4.How to prevent these respiratory symptoms among the workers

5.To propose better preventive measures other than the conventional face masks

METHODOLOGY:

Study Design:

Descriptive Cross- Sectional

Setting:

D.G Khan Cement Factory

Duration of Study:

June 2018 – August 2018

Population:

Target Population : Pakistan

Study Population: District D.G.Khan

Sampling Method:

Purposive (Non-random)

Inclusion Criteria:

Cement Industry workers working in the dusty environment.

Exclusion Criteria:

Cement Industry workers having the age more than 45.

Workers having asthma before the appointment.

Workers having any Chronic respiratory disease before the appiontment.

Study instruments:

Questionnaire

Peak flow meter

Data analysis:

Descriptive Statistics

Ethical Considerations:

University approval:

The study instruments and protocols for doing an authentic research was approved by the respective department of the university

Confidentiality:

The confidentiality of the workers was maintained

Information provided to participants:

Sufficient information regarding the data collection,statistical analysis and research layout were provided to the participants

Right to withdraw:

Each worker has his right to participate or to withdraw from the evaluation.

RESULTS:

Our research was conducted on 100 cement industry workers. Questionnaire and peak flow meter was our study instrument. They were directed to collect information about the factors associated with respiratory symptoms and to assess the peak expiratory rate among cement factory workers respectively.

Results are as follows:-

Out of 100 workers, all were males. The workers having asthma and chronic respiratory diseases before the appointment were excluded. Moreover the workers with age more than 45yrs were also put under exclusion criteria.

- 47% of workers have cough positive, while 53% of workers were not suffering from it.
- 53% of workers have positive sputum and 47% of workers have not.
- 60% of workers suffered from production of excessive nasal secretions while 40% are free from this symptom
- 56% of workers are suffering from dyspnea (difficulty in breathing) and 44% are normal.
- 53% of workers use masks during working and 47% are not.
- 54% of workers have symptom of wheezing while 46% have not.
- 71% of workers are complaining of throat irritation and 29% workers have no complaints.
- Out of 100 workers, 11% of workers works for 11hrs, 75% workers works for 12hrs and 14% works for more than 12hrs in a day.
- 45% of workers have normal expiratory peak flow ranging from 400-600, 26% of workers have slightly effected expiratory peak flow between 300-400, and 29% have highly effected peak flow, which is below 300.
- 35% of workers are working in cement factory from less than 3 yrs,33% are working from less than 5 yrs and 32% are working from less than 10 yrs in factory.
- 53% patients were non-educated.35% had done matriculation & only 12% were

intermediate pass.

4.2 TABULATED AND GRAPHICAL PRESENTATION OF DATA

TABLE-1:

Cough

	Frequency	Percent
1	43	43.0
2	57	57.0
Total	100	100.0

GRAPH-1:

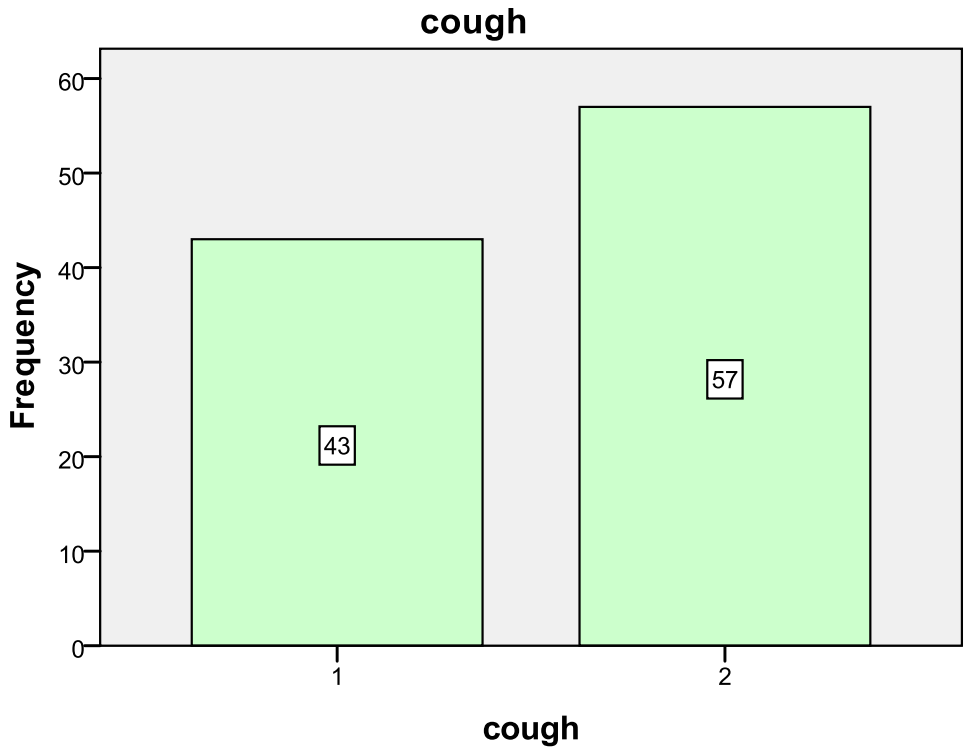


TABLE-2:

PRESENCE OF SPUTUM

	Frequency	Percent
SPUTUM POSITIVE	53	53.0
SPUTUM NEGATIVE	47	47.0
Total	100	100.0

GRAPH#2

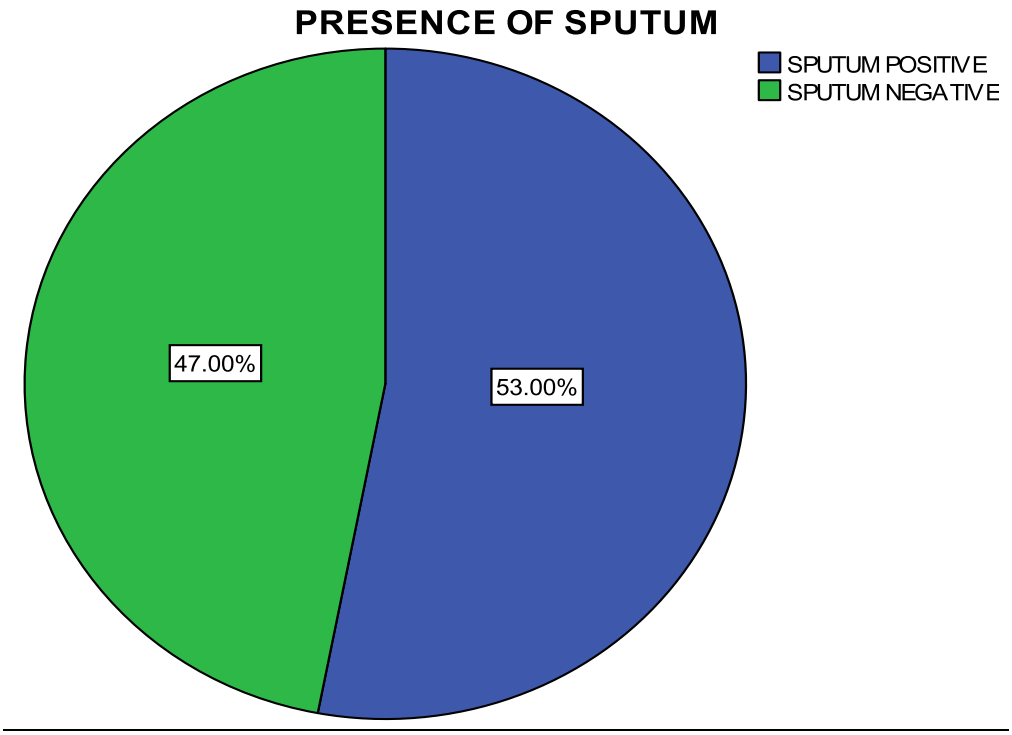


TABLE-3:

NASAL SECRETIONS

	Frequency	Percent
PRESENT	60	60.0
ABSENT	40	40.0
Total	100	100.0

GRAPHS-3:

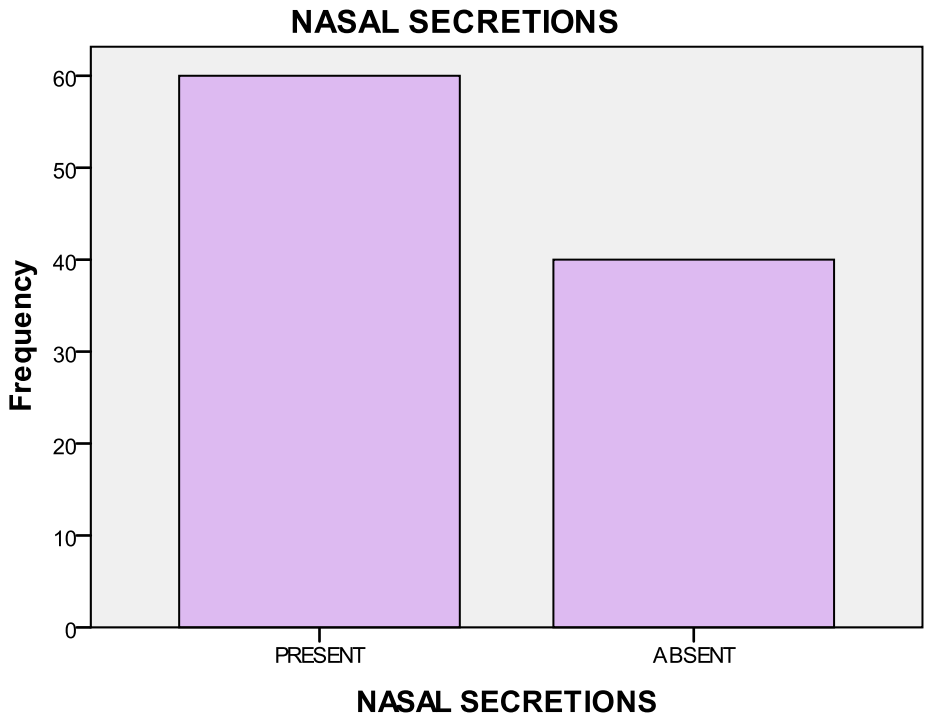


TABLE-4:

STATUS OF DYSPNEA

	Frequency	Percent
DYSPNEA POSITIVE	56	56.0
DYSPNEA NEGATIVE	44	44.0
Total	100	100.0

GRAPH-4:

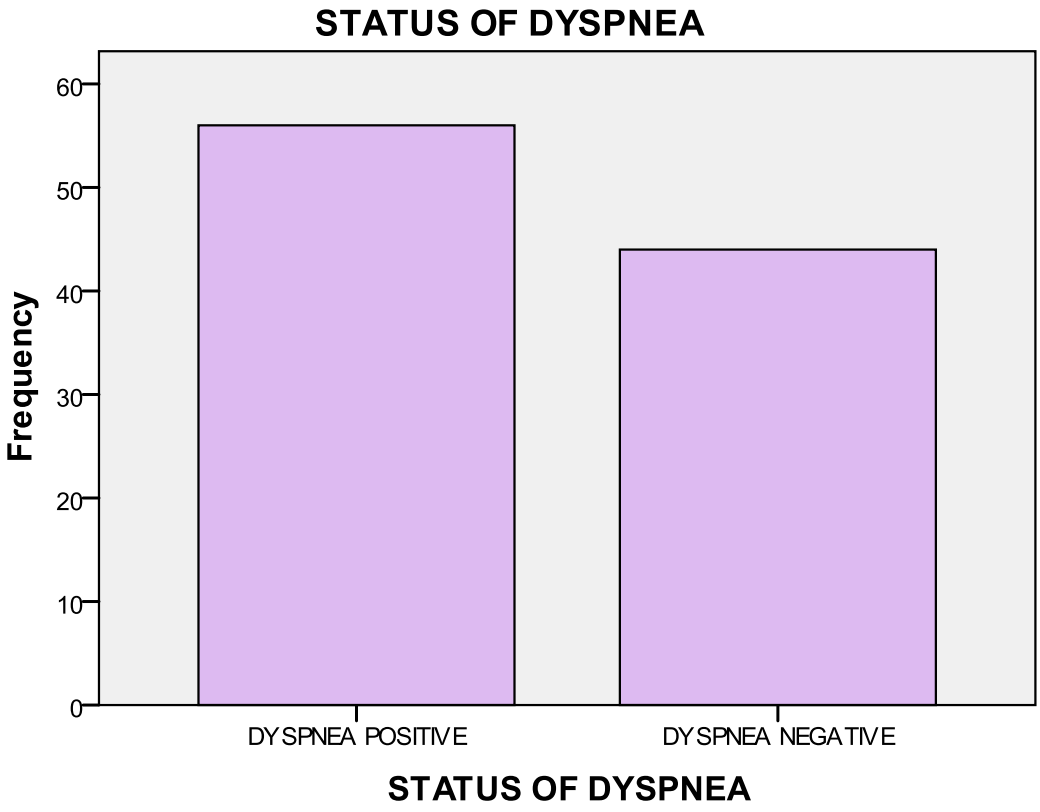


TABLE-5:

Use of face mask during work

	Frequency	Percent
No	71	71.0
Yes	29	29.0
Total	100	100.0

GRAPH-5:

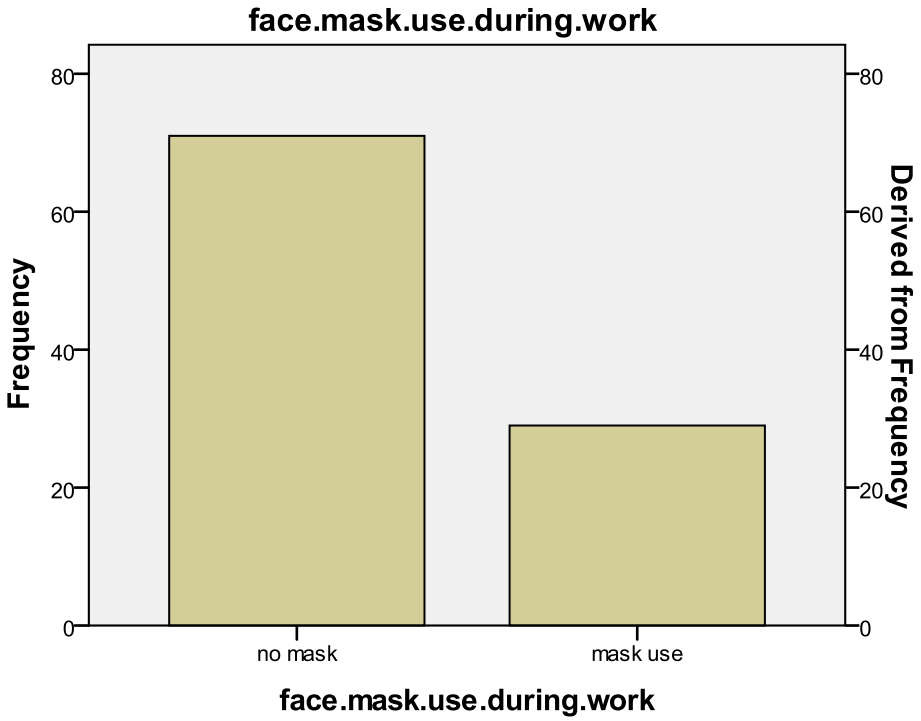


TABLE-6:

STATUS OF WHEEZE

	Frequency	Percent
POSITIVE	54	54.0
NEGATIVE	46	46.0
Total	100	100.0

GRAPH-6:

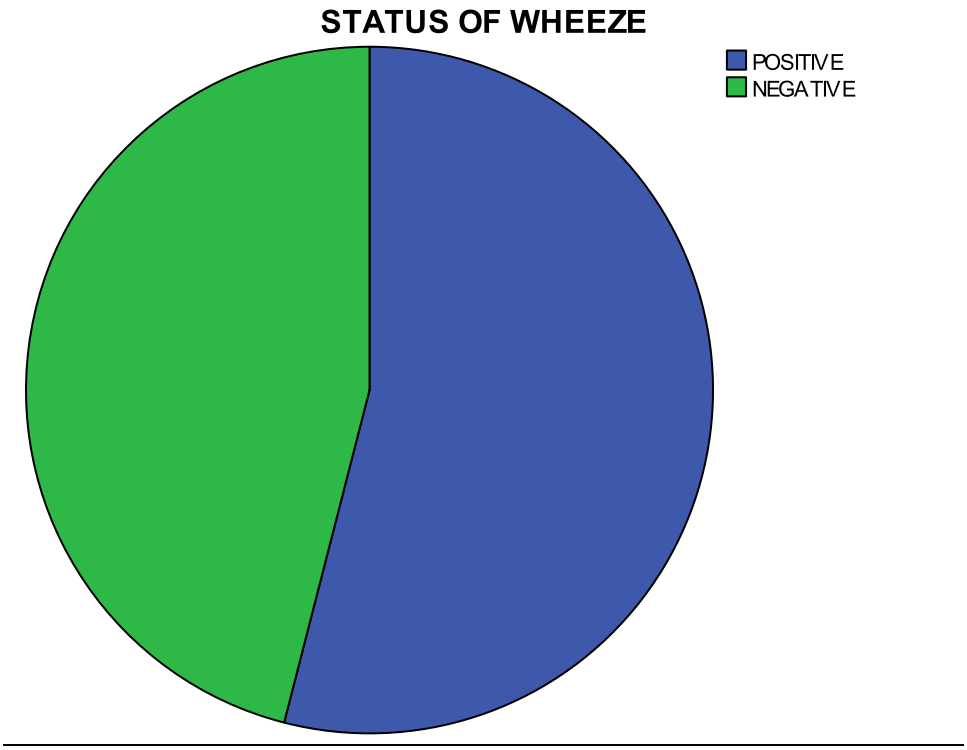


TABLE-7:

THROAT IRRITATION

	Frequency	Percent
PRESENT	71	71.0
ABSENT	29	29.0
Total	100	100.0

GRAPH-7:

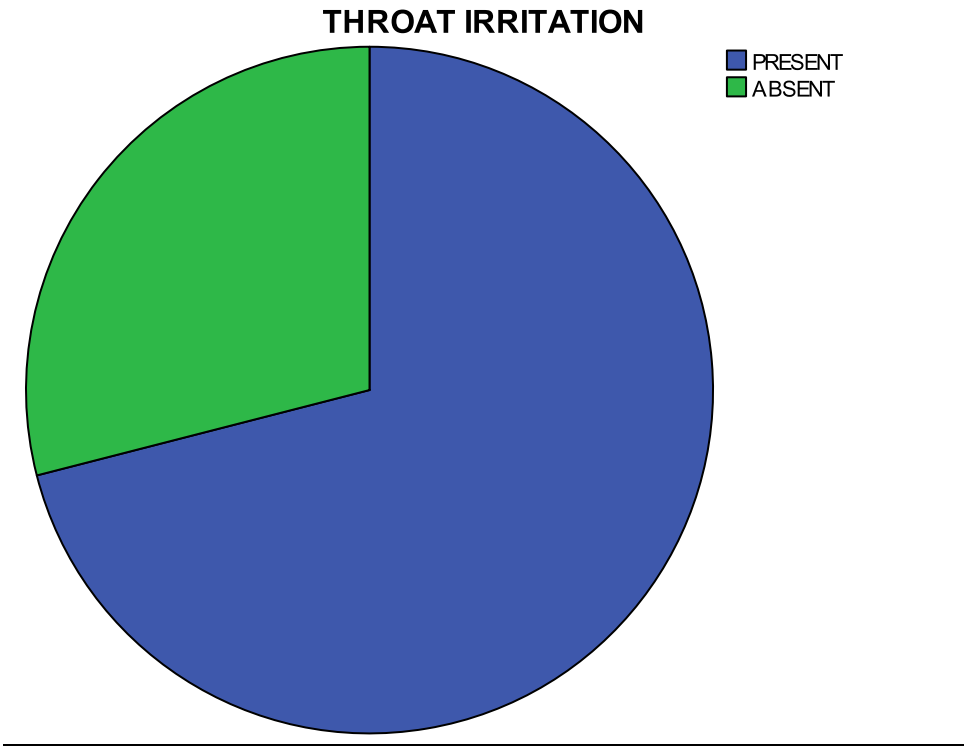


TABLE-8:

STATUS OF WHEEZE

	Frequency	Percent
POSITIVE	54	54.0
NEGATIVE	46	46.0
Total	100	100.0

GRAPHS-8:

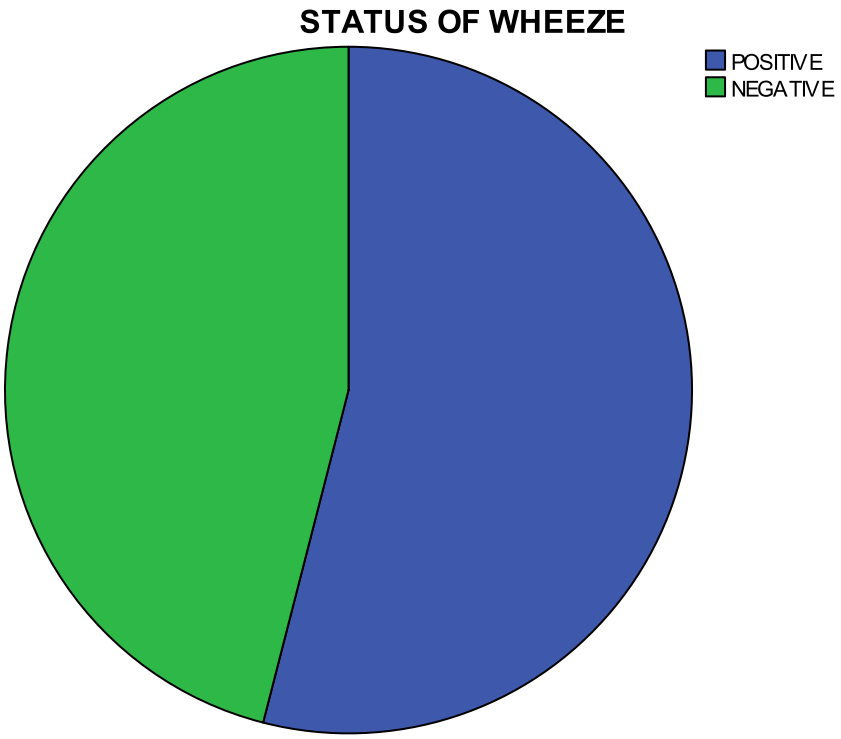


TABLE-9:

WORKING HOURS

	Frequency	Percent
EIGHT HOURS	11	11.0
TWELVE HORS	75	75.0
MORE THEN TWELVE HOURS	14	14.0
Total	100	100.0

GRAPHS-9:

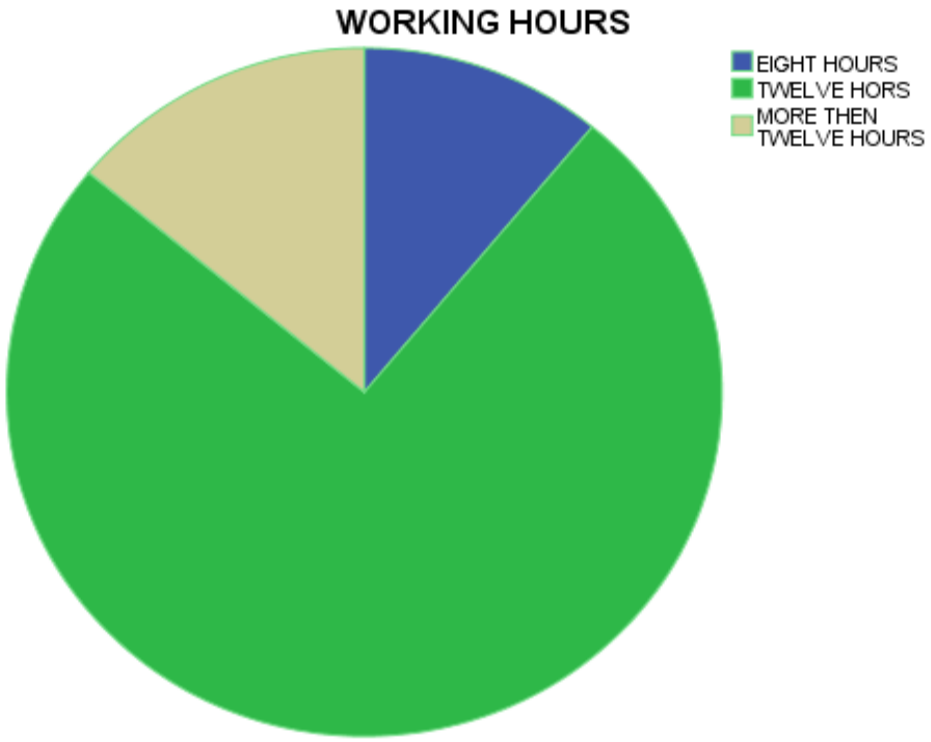


TABLE-10:

PEAK EXPIRATORY FLOW

	Frequency	Percent
normal range 400-600	45	45.0
slightly affected range between300-400	26	26.0
highly affected below 300	29	29.0
Total	100	100.0

GRAPH-10:

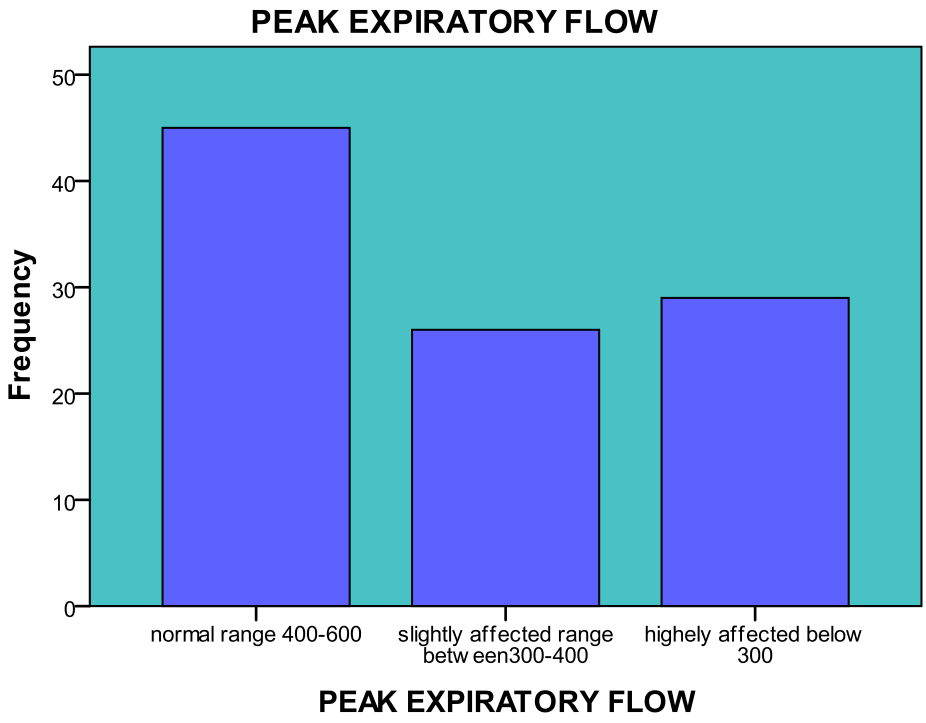


TABLE-11:

WORKING DURATION

	Frequency	Percent
LESS THAN THREE YEARS	35	35.0
LESS THAN FIVE YEARS	33	33.0
LESS THAN TEN YEARS	32	32.0
Total	100	100.0

GRAPH-11:

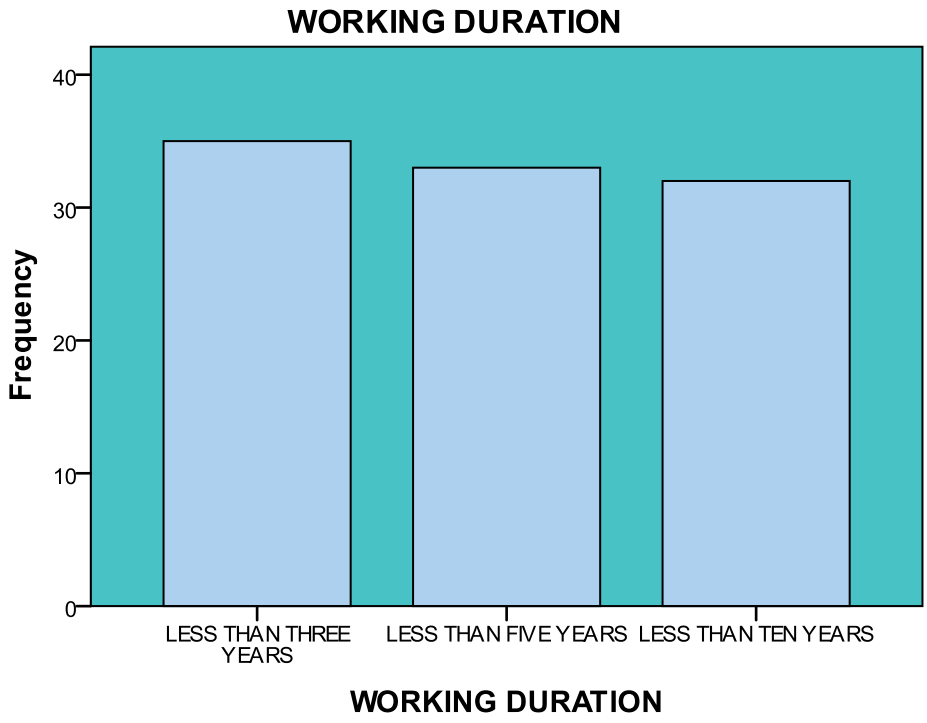
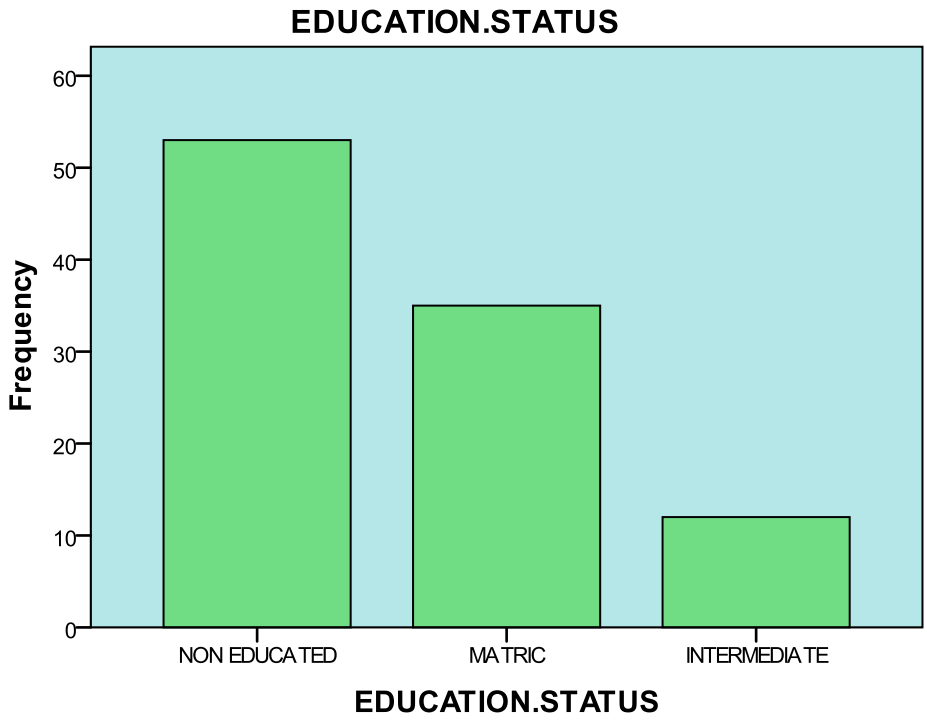


Table-12:

EDUCATION.STATUS

	Frequency	Percent
NON EDUCATED	53	53.0
MATRIC	35	35.0
INTERMEDIATE	12	12.0
Total	100	100.0

Graph-12:



DISCUSSION:

Respiratory tract diseases are the most important group of occupational diseases in cement industry and are the result of inhalation of airborne dust.[35]

This cross-sectional study was conducted in D.G Khan Cement factory, at Dera Ghazi Khan Districtover the period from June till August 2012. It was conducted todetermine the impact of cement dust on the respiratory systemof the exposed workers, and to propose a plan to reduce therespiratory hazards related to cement dust exposure.

100 male workers at D.G Cement factory were involved inthis study. The workers having asthma and diagnosed chronic respiratory diseases were excluded. Moreover the workers with the age more than 45 were also excluded so that the result of the study may not be affected by age related respiratory symptoms and only pure occupational symptoms may be achieved.

The workers were subjected to questionnaire and their peak expiratory flow rate was taken by a simple peak flow meter.

The incidence of cough in our study was 47%, sputum present was 53%, nasal secretions 60%, dyspnea 56%, wheezing 54%, throat irritation 71%. When peak flow meter reading was taken from the workers to calculate their peak expiratory rate flow 45% of the workers were having normal peak expiratory rate flow, 26% of the workers were slightly affected and 29% were highly affected as their expiratory rate flow was markedly reduced. The percentage of uneducated workers was 53%.

On the other hand, a research was conducted in El-Minia cement factory, Cairo which shows the symptoms of dry cough 29.2%, productive cough 26.6%, dyspnea 25.3% and incidence of wheezing was 17.5%.[36]

A research conducted in Tanzania which shows the incidence of cough was 41.2%, shortness of breath 43.1%, nasal secretions were among 39.2% and sneezing was present among 33.3%.

A study conducted in cement factory in UAE to assess the relationship between the cement dust and respiratory symptoms among workers. It showed the incidence of cough was 19.5%, sputum 14.8%, wheezing 2%, shortness of breath 4.7%, Dyspnea 10.7%

The cough and sputum is basically related to the dust exposure of the worker. In our study, cough and sputum is markedly high which shows immediate measures should be taken to provide the workers with extra and effective preventive measures. The environment in which the workers are working must be extremely dusty with fine dust more in proportion.

The present results also show thatthe peak expiratory flow rates were significantlyreduced in workers exposed to cement dust. These resultssuggest that chronic exposure to cement dust impairslung function. Since protective gears were provided,the

impaired lung function suggests that the gears were either ineffective or the workers did not usethem.
In this study, high percentage of uneducated workers shows that the workers may not use the protective measures regularly and they were less conscious about taking the medicine and visiting the doctor.
In the present study, it was found that all respiratory symptoms (cough, sputum, nasal secretions, dyspnea and wheeze) were increased significantly with duration of exposure to the dust. This suggests that chronic cement dust exposure impairslung function. It agrees with the findings of Alakijaet al (1990) who first reported "Cement factory lungdisease" in Nigeria and those of others elsewhere.[37]

The readings taken by the peak flow meter were not satisfactory either regarding the respiratory health of the workers. Only 45% workers had satisfactory peak expiratory flow rate. The workers having low peak expiratory flow rate suffer from mild to moderate airway obstructions which may lead to other occupations respiratory diseases.

Recommendations and preventive Measures:
1: Keeping in view the hazards of cement dust it is advisable therefore, the cement industry management, their workers and health officials should work together to adopt technical preventive measures, such as well ventilated work areas.
2: Workers should wear appropriate apparel, mask, and safety goggles.
3:It is also suggested that cement mill workers must undergo pre-employment and periodic medical surveillance tests. These measures would help to identify susceptible workers in due time and improve the technical preventive measures that will decrease the risk of occupational hazards in the cement industrial workers.
4: Equipment to reduce dust emissions during quarrying and manufacture of cement should be widely used.
5: Equipment to trap and separate exhaust gases should be installed.
6:Proper age limit criteria should be maintained so that elderly workers are ruled out from areas under heavy dust.
7: On duty shifts should be of shorter duration in heavy dusty areas.
8:The proper working of electrostatic precipitator should be monitored at all times.

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