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STUDY OF THE HEALTH EFFECTS OF COAL MINING ON COAL MINE WORKERS OF BALUCHISTAN

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ABSTRACT

The average emission and prevalence of Methane (CH4), Carbon monoxide (CO), and Oxygen (O2)measured as 11.8m3/ton, 36ppm and 14% respectively which exceeds the permissible limits of 1-10m3/ton, 30ppm and 18 %(Standardized by National institute of occupational safety and health (NIOSH U.S.A)and are the sources of higher death ratio. The higher concentration of coal dust (Carbon and Quartz) have been measured as 4-5mg/m3 and 0.35mg/m3 against the threshold limits (Recommended by NIOSH) of 2mg/m3 and 0.05-0.1 mg/m3 for 8hours daily and 40hours/week. Due to high concentration of coal dust the coal workers of Baluchistan are experiencing the diseases like Routine headache, irritation in throat ,nose, and eyes drowsiness, shortness of breath, Nausea,pneumoconiosis, tuberculosis, chronic obstructive bronchitis, heart problems, Impacts on genetic integrity of workers i.e. reproductive and fertility problems, respiratory irritation, asthmatic and even lung impairment and lung cancer problem. The coal water and slurry being the residual of coal mining are disposed off in an unconfined area which becomes the source of water contamination which is used by coal workers and has several health impactslike Ulcer, Diarrhea, cholera, Hepatitis B and C etcon coal workers of Baluchistan.

Keywords: Environmental protection agency (Department of labor), Chronic obstructive pulmonary disease (COPD) Threshold limit values (TLVS), Coal workers pneumoconiosis (CWP), Pulmonary function test (PFT), Permissible exposure limit(PEL), Car boxy hemoglobin(COHB),

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Tuberculosis(T.B), National institute of occupational safety and health(NIOSH), Occupational safety and health administration(OSHA), Mine safety and health Administrative(MSHA)

1. INTRODUCTION

The basic reason to declare the coal mining as the harmful profession in Baluchistan is the uncontrolled emission and exposure to carbon monoxide and methane both being greenhouse gases and are harmful not to the environment but to coal workers as well. Theover exposure of methane gas (Greenhouse Gas) causes the sudden death whichis quite frequent in Baluchistan.The accidents due to roof collapse inside the mine because of old mining techniques are quite common, and it has become overburden on Government of Baluchistan in the shape of compensation and treatment expenditures. Exposure to over emission of coal dust is another phenomenon which has given rise to numerous health problems. In Balochistanthere is no concept of disposal of coal effluents atconfined place,so it has become not only the source of air,water and soil degradation but has posed numerous waterborne health problems

2. MATERIAL AND METHODS

It describes the procedure adopted for the conduct of research work in the field, collection of data, experimental material used in the field, study area, Medical and Laboratory services and statistical tools practiced to identify the problem areas due to coal mining in Baluchistan. Studies to determine occupational health impacts on coal mine workers of Baluchistan were conducted in the coal fields in Mach, Sorangedegari and chamalong. It was quite difficult to conduct the research work in Baluchistan due to the unrest and security situation; therefore the Military services were sought in the field as shown in (Figure; 1)

2.1. Methods Used to Identify the Health Impacts of Coal Workers

To carry out the research in the field, a comprehensive plan was made in which three coal mines were selected for study purpose. A comprehensive Questionnaire, covering all the details, was formulated to get the qualitative and quantitative data about the coal mine workers health impacts in selected coal mine fields and a W.H.O based Quality of life (QOL) questionnaire was also used to ascertain the quality of life and health effects of coal workers in Baluchistan. The high quality analytical equipment of Baluchistan Environmental Protection (BEPA) was mobilized and used on all three selected coal mine sites to find out the effects of coal dust, coal waste and coal gases exposure on the health of coal mine workers. To ascertain the specific and precise harmful impacts such as common clinical problems, like respiratory irritation, pulmonary tuberculosis, pneumoconiosis(black lung), obstructive bronchitis, allergy, male infertility and heart diseases etc being related to physical and biological hazards of work environment, the selected coal workers were taken to Combined Military Hospital for the medical examination like X-ray, sputum, blood and urine routine examination, semen analysis, CT scan, biopsy, and ultrasound etc.

3. DATA COLLECTION

For the collection of secondary data, different departments of Government of Baluchistan were approached (Table1).

3.1. Types of Equipment Used to Identify the Health Effects

During the field work, the data on the mentioned parameters that could havethe health impactson coal miners were collected with the help of apparatus given in the table(2)

3.2. Research Area and Sample Size

Keeping in view the security situation, total no of mines selected and allowed to visit by authority, Geographical location, types of mining carried out, the three coal mine fields named as Mach, So-range-Degari, and Chamalong coal fields were selected for study purpose. For the simplicity and to be more specific three sub-mines from each selected coal fields were selected and marked as M1,M2,andM3 at Mach coal field, SD1, SD2 and SD3 at So-range-Degari and C1, C2 and C3 at Chamalong coal fields. Approximate 10% strength of coal workers out of sample size 228 was selected for further analysis. The strength of coal workers selected from respective mines is given in table 3;

Mach (M1, M2, M3) = 65 coal workers. So-range -Degari (SD1, SD2, SD3) =77Coal Workers and Chamalong (C1, C2, C3) =86.In this way total strength of coal workers selected n= 228 coal workers for study purpose, so this figure can be denoted (n=228) Moreover a total of 120 Non coal workers 30, 40, and 50 respectively from living areas near to each selected coal field were selected for comparison purpose. The idea was to ascertain whether the population adjacent to coal fields approximately within one kilometer is affected due to coal mining or not. The data was collected by face to face interviews, coal workers were read out the Questionnaireeven the questionnaire was translated into the language which they can understand/ read out. The average timing for the completion of questionnaire was 36 minutes. For coal dust workers and non coal workers the age ranges between 15-45 and above with medium age of 32 years old.Percentage of coal drillers, helpers, coal loaders (Labors) and coal transporters were 60%, 15%, 20% and 5% respectively. The total strength of coal workers was further divided into four age group table 4

3.3. Methods of Investigation Through Questionnaire

The reliability of the QOL – Brief scales was calculated, usingcronbach'sX-coefficient. (Cronbach, 2003),Alpha co-efficient of magnitudes 0.70 or greater were sought as evidence of adequate scale, reliability for use at the level of group comparison. (Cronbach, 2003).Person's correlation coefficient was used to examine the correlation between the scales (Cronbach, 2003).To examine the Impact of Socio-demographic, working, and health factors on health related QOL, the multiple stepwise regression analysis was used in which the dependent variables were the scores of the physical, psychological social and environmental domains of the QOL – Brief and the independent variables. For all analysis, a two sided P- value of less than 0.05 was considered to be statistically significant , statistical description and hypothesis testing were performed by using the statistical software (SPSS)version (11.5).Regression analysis was performed using SAS (version 8.2).

3.4. Methods of Investigation in the Field

The services of Environmental Protection Agency (Department of labor)were requested for the provision of Equipment and staff in the field. The coal dust samples at all selected coal mines

were collected with the help of Particulate Matter Andersons Samplers (PM10 and PM2.5)for the Evaluation of coal dust Exposure limits and to ascertain the sizes of inhaled dust particles.(Figure2).The gas detection appliances were used to detect the percentage of Carbon monoxide CO),Methane (CH4) and presence of Oxygen (O2).The coal mine water, coal slurry and coal dust samples were Collected and analyzed in the Laboratory to detect the presence and percentage of trace elements in the sample.(Figure3).Vitalo-graph peek flow meter; A manual apparatus was used in the field to ascertain the respiratory problems of coal workers (Figure 4). The coal dust samples, coal slurry, coal mine water and drinking water collected in the field were brought to Environmental protection Agency's laboratory for further analysis. Whereas the selected coal workers from all age groups were brought to CMH and Air Force Hospital Quetta for detail medical tests/examination like Sputum AFB, Liver function test, Blood and Urine complete picture and, Chest X-ray poster anterior single back to front, Spiro metric analysis, Siemens analysis, CT scan, Biopsy, Hepatitis B and C, to ascertain the impacts related to occupational health exposure. Yearly health analysis report regarding coal workers was gathered from different Hospitals/Health units where the coal workers normally report with diseases.

3.5. Criteria to investigate QOL of Coal workers

To evaluate the MultidimensionalQOL of coal dust workers and to investigate the impact of socio-demographic, working, and health factors on their QOL A minimumservice criterion for coal workers was one year. The workersage range between 15 to 45 years based on the common age range of the coal workers.The coal dust workers were categorized as mainly coal drillers, helpers, loader,transporters, loading/unloading workers and non dust workers as maintenance workers and technician. The workers with chronic diseases, such as Hypertension, diabetes or other cardio disease were excluded.

4. DISCUSSION ON QOL RESULT

The QOL analysais of above tables (5, 6,7 and 8) show thatthereis no tendency of Physical/ Medicalexamination of coalworkersatany stage of theirstay as Coal workers.They Works day and night irrespective of allowabledaily/weeklyhours and shifts. They are not aware of the harmful impacts of overexposure of gases and Coal dust and thusthey are more prone to most of the diseases. The over all Picture of quality of life and life style of Coal workers of Balûchistân Can bé describedwith the help of (Figure 5)

The graph shows that the coal workers of Baluchistan are illiterate and belongs to below poverty line family. Their living conditions at coal fields are worse than they live at their home. They don't care their health and use to work more than their capacity for the sake of earning small petty amount. They are helpless to work under the similar conditions because of poverty and joblessness in the country. They are not provided with the good living conditions like Medical facilities, living, food, water and other recreational facilities by the coal mine owners and government agencies. They don't go for initial or periodic medical examination at the time of induction as coal workers or during the service so they don't come to about the clinical hazards of coal mining. They don't know the impacts of coal mining like exposure to harmful gases or

environmental degradation and latest trends in coal mining other than to earn some money for their family.

4.1. Effects of over-exposure of Gases on Baluchistan coal workers

The table-9 shows that the gas exposure limits are more than the permissible exposure limits given by health safety agencies like National institute of occupational safety and health (NIOSH),Occupational safety and health administration(OSHA),Mine and safety health administration(MSHA).The higher concentration of methane reacts with air (CH4+2O2= CO2+2HO) and displaces the prevalence of oxygen Petsonk (2007) as it has been highlighted, higher the concentration of CH4, lower the percentage of oxygen (Min 18%) and thus it results in suffocation and ultimately sudden death (Jrof, 2004).One of the reason of sudden death due to over emission of CH4 in Baluchistan coal workers is the weak cardiac sensitizers in human following inhalation exposures to high concentration (greater than 5%isobutene and greater than 10% for propane)cardiac sensitizers causes the sudden onset of irregular heart beat and sudden death (Megrran, 2001).In some cases due to high concentration and oxygen deprivation damage to some or all organs including the nervous system and the brain has also been observed in Baluchistan coal workers. In some casesOccupational or accidental exposure to CO has caused acute decrements in lung function because of high level car boxy hemoglobin**.** During medical examination headaches**,** dizziness, drowsiness, unconsciousness, nausea, vomiting, shortness of breath has been found common in Baluchistan coal workers. Problemsof aging and illness due toCO induced neurobehavioral effects have been observed, because, under normal circumstances, the brain can increase blood flow to tissue, oxygen extraction to compensate for the hypoxia caused by exposure to CO. (Xiao, 2003)Tissues of highly active oxygen metabolism, such as heart, brain, liver, kidney and muscle may be particularly sensitive to CO poisoning (Wei-Lung, 2006).When car boxy-hemoglobin levels are higher than 50% convulsion and cardio pulmonary arrest have been observed. Complications have been observed frequently in CO poisoning like immediate, death, myocardial impairment, hypotension, arrhythmias, and pulmonary edema (Gabe Wells, 2008).Perhaps the most insidious effect of CO poisoning observed is the delayed development of neuron psychiatric Impairment and the neurobehavioral consequences (Richard, 2005).Impact onthe central nervous system, causing hallucination and a heightened emotional state has also been observed. This is very unfortunate that no stake holder is having such awareness

4.2. Effects of over-exposure of Coal dust

During the underground coal mining whichever the method used for mining, the coal dust is generated whose particles that are small enough to penetrate into the nose(Figure 6), upper respiratory system and deep into the lungs (Hong, 2007). These particles that penetrate deep into the respiratory system are generally beyond the body natural clearance mechanism of cilia and mucous and are more likely to be retained. This can cause severe lungs problems, infection in eyes, nose and throat etc (John and Kirk, 2007). Initially the MSHA and NIOSH of U.S.A had recommended 6-8mg/m3. Under the conditions of time weighted average (TWA) 8hours work/day and 40 hours/week but later on these limits have been revised as 1-2 mg/m3 for carbon contents and 0.05-0.1mg/m3 for quartz. Keeping these criteria and conditions in mind, the exposure limits

verification tests at all the three selected coal sites for coal dust and quartz contents were conducted. The samples were collected in the field with the help of PM10 and PM2.5 Anderson apparatus and analyzed in the EPA laboratory (Figure-7).To evaluate the coal dust exposure limits in comparison with international standards, three sites So- range -Degari, Mach, and Chamalong coal field were selected and marked as siteSD, M and C respectively. To get the concentration limits during all three shifts and to avoid the error due to just single reading, the selected coal sites were further sub divided as mines SD1,SD2,SD3,M1,M2,M3and similarlyC1,C2,C3so that the aggregate reading can be obtained.

The tabulated values (Table-10) received as a result from analysis in EPA laboratory have exceeded the recommended exposure limits The most obvious reason of higher concentrations of coal dust in Baluchistan coal fields is the lack of monitoring by EPA, mine and mineral department and implementation of environmental laws. This has given rise to numerous of health problems like, respiratory Problems, Impairment of long tissues, pneumoconiosis, Impact on brain, kidneys and other organs, itching and irritation problems, Tuberculosis, Asthmatic problem are most common due to overexposure of coal dust in Baluchistan. The few of the pictures as shown in Figure-1 of the lungs taken during the X-ray at CMH Quetta of coal workers of all three sites clearly Indicates the presence of all symptoms of lung impairment, changing color of lungs from pink to black is the indications of dusty lung. During medical examination the maximum strength of coal workers was diagnosed with T.B.The concentration of quartz contents in the coal was also found higher than the threshold exposure limits prescribed internationally by health safety agencies like NIOSH, OSHA and ACGIH(Table-11) .The reasons of high concentration of quartz are the same as that of coal dust (Carbon contents).Adverse health effects of over exposure of quartz on coal mine workers of Baluchistan have been reported during medical examination like chronic obstructive pulmonary disease,lungimpairmenttuberculosis(T.B),shortness of breath, asthma etc

4.3. Coal Dust Particle Sizes

The analysis of dust particles with respect to the sizes as in the table-12 shows the presence of all sizes of particles.The basic reason to measure the sizes of particles is to know how and where the quantity of dust particles is entrapped and causes the damage**.** Dust particle were measured in microns and varies between 1.1- 10 (um) .The particle that is small enough to penetrate the nose and upper respiratory system and deep into the lung (Figure-7). Particularly penetrate deep into the respiratory system are beyond the body natural clearance mechanism of cilia and mucous and more likely to be retained. The particles having bigger diameter can be trapped into the upper respiratory tract (Derikson, 2000) due to which following problems were noticed in coal mine workers of Baluchistan: - Irritation in lungs, throat and nasal infection, wheezing and Asthmatic problem. The particle sizes found in Baluchistan coal field are bigger in diameter and more in concentration, which attribute toward severe throat and lung problems whereas the particles less in diameter could not be trapped by cilia and mucous of the respiratory system and enter into the lung airways and causes damage to lung(Figure-8).

4.4. Impacts of Coal Waste

During coal mining no doubt the coal mine waste water and coal waste(coal slurry) come out as the product waste and spread out into unconfined place at Baluchistan coal fields. It contaminates the nearby source of drinking water that water is used by coal mine workers and they are suffering from numerous waterborne diseases, this was investigated by taking the water sample and testing it into laboratory, the results in comparison of WHO prescribed limits have been tabulated in table-13.

The comparison shows the concentration limits of TSS and TDS in Baluchistan coal fields are higher than prescribed by W.H.O. The higher concentration of these effluents makes the water heavier and unsuitable until unless it is purified and the lower PH value shows that the water is acidic. The less BOD and COD demand shows that either the microorganisms are less in numbers or mostly dead due presence of higher concentration of TDS and TSS. Moreover the non-availability of facility to purify the water has become one of the reasons of no of health impacts in coal workers of Baluchistan. Common diseases were registered amongst the coal workers like, viral diseases, Diarrhea cholera, Hepatitis, Ulcer, Headache, nausea, tiredness chest and muscular pain etc.

4.5. Noise Impact Due to Coal Mining

Though in the underground mines the Noise Impact is not as pronounced as it is in the surface mining where lot of heavy equipment is used for the coal mining, the mining operation like drilling, collection, transportation and handling of coal, sizing and segregation units are the major source of noise pollution, results have been given in table-14. Noise in coal mining is obvious and is displeasing for coal workers that disrupt the activating and life as well (Whispers Barry Robinson, 2006).In underground coal mining the blasting, compression, and transportation of coal, has certain noise impacts like., impaired hearing, damage to hearing system, deafness, permanent hearing loss caused by damage to the sensory cell in the inner ear.sleeplessness, muscular pain, itching, unpleasant feeling, hard in taking

4.6. Yearly Health Analysis of Coal Workers of Baluchistan

The year wise figures in the table-15 show very alarming health conditions of coal workers of Baluchistan. Since No pronouncedmedical facilities are offered to coal workers therefore significance rise in yearly health statics has been observed. Namely Poverty, Illiteracy, unemployment is the main contributing factors towards the rising trends of health problems of coal workers because they don't find any alternate except to work as coal worker

4.7. Assessment of Occupational Health Impacts of Coal Mining in Baluchistan

The coal mining in Baluchistan is having many severe occupational health impacts due to omission of Gases, coal dust and coal effluents. To investigate these problems into the coal mine workers of Baluchistan the selected coal workers from all age groups were brought to Combined Military Hospital and Air force Hospital Quetta to conduct the requisite tests. The symptoms observed and the tests results have been summarized in tables from 16 to 18.The tabulated values present the comprehensive breakdown of all possible occupational impacts and illnesses by

covering all the age group of coal workers, right from the induction into coal industry till the retirement. The picture painted in the tabulated form depicts the actual situation and conditions of coal workers of Baluchistan (Pak). Due to over exposure of methane gas **(Greenhouse Gas**) the incidents of sudden deaths are quite frequent in Baluchistan whereas the CO poisoning has severe health implications on coal workers as shown in above table. The accumulation of methane and carbon monoxide causes sudden death and health problems whereas the accidents due to roof collapse inside the mine because of old mining techniques are quite common, and it has become overburden on Government of Baluchistan in the shape of compensation and treatment. Exposure to over emission of coal dust has given rise to numerous health problems which are either faced by coal workers or Government of Baluchistan but not the coal mine owners. In Balochistancoal mining, there is no concept of disposal of coal effluents at some confined place,so it has become not only the source of air,water and soil degradation but has posed numerous waterborne health problems which is directly or indirectly is the burden on the economy of the Province. it is quite evident that the %age of no of death/injuries and diseases because of exposure to gases, coal dust and coal effluents are more than the requisite and not compatible with the quantity of coal extracted, which pose an alarming situation and give the significant message to the Government of Baluchistan and other stake holders that they must take the immediate measures to reduce it.

5. CONCLUSION

Though many research are being conducted all over the coal mining countries for the improvement in coal extraction techniques, to overcome the emission rate of methane and carbon and thus to reduce the death and injury rate and environmental degradation. Efforts have also been instituted to overcome and reduce the toxicity of coal effluents on the health of the coal workers. The wages, compensation, disability rate, pension, insurance policies and other allied facilities have also been reviewed with the passage of time to uplift the quality of life of coal workers and their families all over the world, but in Pakistan especially in Baluchistan no such measures have been taken by Government and mine owners. The mitigation measures as adopted in the rest of the mining world in the shape of new mining techniques, methodology to reduce the emission of gases and other coal effluents, use of personnel and mine safety equipment, disposal techniques of coal effluents and other allied facilities have neither been adopted by Government of Baluchistan nor appreciated by the coal mine owners.

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List of Tables

Table-1. Collection of data about occupational health

S/NO	Name of department	Types of data collected
1	Mine and Mineral Department Quetta	➢ Total no of mines and their location in Baluchistan ➢ Registered/unregistered coal mine workers in Baluchistan ➢ Types of coal produced, Equipment and Methods of extraction of coal used ➢ Types of Facilities provided to coal workers ➢ No of mine inspectors, Frequency of inspection, Observations reported, Types of inspection equipment used for inspection, Precautions advised by inspectors to coal mine owners to implement etc ➢ Types of Medical Facilities available to coal workers at coal fields ➢ Record of injuries/deaths available with the department. ➢ Reasons for injuries/deaths of coal workers ➢ Types of Exposures observed due to coal mining ➢ Other impacts observed due to coal mining.
2	Environmental Protection Agency of Baluchistan	➢ Types of Equipment available ➢ No of visits to coal mines to assess the impacts of coal mining, like exposure limits of carbon and Methane, health, air, water, Noise and soil degradation. ➢ Visits to check the implementation of Mine act, imposition of taxes and penalty, Visits to monitor the implementation of International standards of Environment protection ➢ Type of equipment used by EPA officials if at all moved in the field to conduct the tests.
3	Hospitals/ Health facilities in Baluchistan	➢ Monthly records of injuries/deaths reported from coal mines fields ➢ Types of diseases reported from coal fields ➢ Record of coal mine workers diagnosed with diseases ➢ Record of tests conducted and treatment provided to coal workers ➢ Types of Medical facilities available and authorized to coal

	workers of Baluchistan. ➢ Yearly health analysis of coal mine workers available with hospitals/health units ➢ Types of Medical tests of coal workers conduced at the time of induction as coal worker or during any stage of service as coal workers.

Source: Field work

Table-2. Type of Equipment used to perform the test

S/ No	Type of exposure	Type of equipment used to perform the test	Make and Type of equipment	Model No	Calibration
1	Coal dust concentration	Gravimeter	Made in UK	Gravimetric G-1023NF	Before using it was calibrated
2	Coal particles sizes	Particulate Matter Anderson apparatus	Made in U.S.A	PM10and PM2.5 instruments motor no 1542 and0452	Before using it was calibrated
3	Types and Quantity of coal effluents	Atomic Absorption Method	Jaeca Japan	AAM instrument serial no 4568-23sd-2A-234	Before using it was calibrated
4	Noise level	Noise level measuring equipment	Made in Japan	Equipment serial no 234-1a-34	Before using it was calibrated
5	1PH 2.Turbidity 3.BOD 4.COD 5.TSS 6.TDS	1.PH meter 2.Turbidity meter 3.Hatch BOD Track 4.Hatch COD Reactor 5.Vacuum pump filter system for TSS 6.Ion sense meter hatch TDS-EC Salinity	1.Made in Japan 2.Made in Japan 3.Made in U.S.A 4.Made in love land colo U.S.A 5.Japan 6.Japan	1.PH meters no 558272 HM 25r,TKK-TOA 2.Turbidity meter NOF412R-05NBNippon Dashiki 3.Hatch BOD Track ser/no 26197-01/0104103 4.Hatch COD Reactor ser/no021200010120p/n45600-02 5.Vacuum pump filter system for TSS 6.Ion sense meter hatch TDS-EC salinity	Before using it was calibrated

6	Presence and concentrations of gases(CH-4,CO and O2),	Gas Measuring devices	Mine safety appliance mining detector Meotro NICs serial no 045MEo6101	Made in UK	Before using it was calibrated

Source: Field and laboratory work

Table-3. Selection of sample size

S/ No	Name of mine field	Name of sub mine field	No of miners selected
1	Mach coal field	M1,M2,M3	65
2	So-range Degari coal field	SD1,SD2,SD3	77
3	Chama-long Coal field	C1,C2,C3	86

Source: Field work

Table- 4. The distribution of selected coal workers into age Group (n=228)

Age group of coal workers (years)	No of coal workers(No)	Percentage of sample size (%)
Under-15	15	6.5
15-24	37	16.2
25-35	121	53.2
36-49	39	17 .1
50 & above	16	7
Total	228	100

Source: Field work

Table-5. Subjective feeling about General QOL-brief and health for Coal dust workers (%age)

Items	Very Poor	Poor	Average	Good	Very Good
General QOL-brief	72.7%	17.3%	5.9%	2.5%	1.6%
General Health	64.2%	27.3%	3.6%	3.4%	1.5%

Source: Field Work

Table- 6. Association between Socio-demographic Variables and WHO QOL- Brief

Variable	NO	Physical	Psychological	Social	Environment
Gender	180	12.56+2.13	12.7+2.17	12.02+2.95	9.92+2.95
Age (Year)					
< 30	86	12.89+2.15	12.89+2.10	12.15+2.56	10.39+2.89
> 30	108	12.43+2.56	12.65+2.13	12.11+3.21	9.94+3.04
Martial Status					
Single	69	13.28+2.35	13.12+2.16	12.37+2.57	10.69+2.47
Married	124	12.5+2.18	12.74+2.07	12.20+2.86	10.01+3.05
Educational Level					
Illiterate	186	15.49+2.03	15.78+2.12	14.67+2.14	12.13+2.14
Primary	8	12.07+2.37	12.67+2.08	12.33+2.44	11.06+2.43
Junior School	Nil	-	-	-	-
Senior School	Nil	-	-	-	-
Diploma	Nil	-	-	-	-
College	Nil	-	-	-	-

Monthly Income					
<5000	44	12.64+2.39	12.69+2.41	12.42+3.38	10.27+3.12
6000-7000	131	12.58+2.18	12.74+1.98	11.95+2.75	9.96+2.96
7000-8000	16	13.25+1.97	13.12+2.44	12.32+2.78	10.98+2.79
>8000	3	15.81+2.01	12.89+1.54	16.00+1.33	9.5+1.32
Recreational Activities					
Few	25	12.37+1.72	11.79+2.11	11.86+1.98	9.81+2.01
Some	135	12.53+2.56	12.75+1.91	12.11+2.93	10.06+3.15
Many	34	13.30+2.16	13.53+2.59	12.4+3.45	10.56+2.85

Source: Field Works

Table-7. Association between Working Variables and WHO QOL-Brief

Variables	NO	Physical	Psychological	Social	Environmental
Working Years					
≤ 5	82	12.99+2.22	12.75+2.26	12.03+2.87	9.95+2.89
> 5	112	12.39+2.18	12.77+2.01	12.19+2.97	10.24+3.04
Types of Job					
Surface Mining	-	-	-	-	-
Underground Mining	194	12.19+2.26	12.25+2.29	11.51+3.07	9.01+2.80
Working Hours					
≤ 8 hours	92	13.32+1.98	13.28+1.88	13.59+2.52	11.59+2.62
> 8 hours	102	12.03+2.24	12.33+2.23	11.19+2.95	8.78+2.63
Working Shift					
Long Night Shift	6	12.95+1.51	13.70+1.11	13.93+2.01	11.78+1.82
Long Day Shift	35	13.21+1.28	13.21+2.08	13.14+2.47	11.35+2.58
Often working shifts	153	12.51+2.21	12.63+2.13	11.83+2.98	9.77+3.0
Work Danger					
No	59	13.47+1.81	13.67+1.48	13.22+2.13	11.95+2.13
Yes	135	12.29+2.29	12.36+2.23	11.66+3.01	9.3+2.94

Source: Field Works

Table-8. Association between health variables and WHO QOL-Brief

Variables	NO	Physical	Psychological	Social	Environmental
Smoking Edict					
No	57	12.83+2.10	12.73+2.15	12.09+3.28	10.76+3.07
Yes	137	12.57+2.26	12.78+2.11	12.14+2.77	9.85+2.90
Physical Examination					
Once a Year	Nil	-	-	-	-
Once every 2 Year	Nil	-	-	-	-
Once every 3 Year	Nil	-	-	-	-
At Your Own or at time of Severe Disease	194	13.03+1.83	13.01+1.84	12.88+2.45	11.64+2.4

Source: Field work

Table- 9. Emission of Methane (CH4), Carbon Monoxide (CO) and presence of Oxygen O2 at all three Selected Sites of Baluchistan

S/No	Mine Location	Time Weighted HRS	Average Emission of CH4 m3/ton		Concentration of		Method of Measurement
			During Mining	Post Mining	CO PPM/ HR	O2 %age	
1.	Mach coal fields A1,A2,A3	8	11.2	5.43	37	13.5	Mine safety Appliances Mining Detector Meotro NICs serial No 045 MEO 6101 Made in UK
2.	Sorange degori coal fields B1,B2,B3	8	8.7	5.46	35	16.2	"
3.	Chamalong coal fields C1, C2, C3	8	12.5	4.5	37	12.4	"

Source: Field work

Table-10. Summary of field results of Coal dust exposure at selected sites (Ambient air monitoring TWA 8 hours, 40hours/Week results)

S/NO	Mine ID	Location of Reading	Average Dust Concentration mg/m3	Threshold Limit Value mg/m3	Difference mg/m3
1.	Mach (Abe-gum) M1,M2,M3	At the face of mine	5.26	2	+3.26
2.	Mach (Abe-gum) M1,M2,M3	At the loading place	4.25	1-2	+2.25
3.	Mach (Abe-gum) M1,M2,M3	At Ventilation / Exhaust	3.47	2	+1.47
4.	Sorange degari SD1,SD2,SD3	At the face of the mine	3.54	2	+1.54
5.	Sorange degori SD1,SD2,SD3	At the loading point	3.05	1-2	+1.05
6.	Sorange degori SD1,SD2,SD3	At Ventilation / Exhaust	2.75	2	+0.75
7.	Chamalong C1,C2,C3	At the face of mine	5.2	2	+2.2
8.	Chamalong C1,C2,C3	At loading place	4.35	1-2	+2.35
9.	Chamalong C1,C2,C3	At Ventilation / Exhaust	4.05	2	+2.05

Source: Field Work

Table- 11. Summary of the field results of quartz exposure at selected sites (Ambient air monitoring 8 Hours, 40 hours/week result

S/NO	Mine ID	Location of Reading	Average Dust Concentration mg/m3	Threshold Limit Value mg/m3	Difference mg/m3
1.	Mach (Abe-gum) M1,M2,M3	At the face of mine	0.67	0.1	0.57
2.	Mach (Abe-gum) M1,M2,M3	At the loading place	0.55	0.05-0.1	0.45

3.	Mach (Abe-gum) M1,M2,M3	At Ventilation /Exhaust	o.44	0.1	0.34
4.	Sorange degori SD1,SD2,SD3	At the face of the mine	0.45	0.1	0.35
5.	Soange degori SD1,SD2,SD3	At the loading point	0.39	0.05-0.1	0.29
6.	Sorange degori SD1,SD2,SD3	At Ventilation / Exhaust	0.35	0.1	0.25
7.	Chamalong C1,C2,C3	At the face of mine	0.67	0.1	0.57
8	Chamalong C1,C2,C3	At loading point	0.58	0.05-0.1	0.45
9	Chamalong C1,C2,C3	At Ventilation / Exhaust	0.52	0.1	0.42

Source: Field work

Table-12. Measurement of Particulate Size of Coal dust

S/NO	Mine Location	Time Weighted Average/HR	Particle Size Range (micro meter)	Method Used
1.	Mach coal field	8	2.0 -10	PM 10 and 2.5 Anderson Instruments U.S.A, Sr/Motor No. 1542
2.	So range coal field	8	2.1 – 10	“
3.	Chamalong	8	1.1 – 10	“

Source: Field work

Table -13. Concentrations of suspended solid in coal mine waste of Baluchistan

S/NO	Mine location	Type of effluent	Measured quantity in mg/L except Ph	WHO Standards in mg/L except Ph	Measuring Principle
1.	Mach coal field	PH	4.9	6.9	AAS Method
		BOD	220	250	“
		COD	370	400	“
		TSS	425	400	“
		TDS	3720	3500	“
2.	So range coal field	PH	5.0	“	“
		BOD	215	“	“
		COD	350	“	“
		TSS	430	“	“
		TDS	3600		“
3.	Chamalong coal fie	PH	4.98	“	“
		BOD	225	“	“
		COD	360	“	“
		TSS	435	“	“
		TDS	3650	“	“

Source: Field work

Note- BOD - Bio-available oxygen demand

COD - Chemical oxygen demand

TSS - Total suspended solid

TDS - Total dissolved solid

Table-14. Noise level standards at coal mines of Baluchistan

S/NO	Mine Location	Maximum Allowable Leq hourly in dB/A			Measure Method
		0700 - 2200		2200 - 0700	
1.	Mack coal field	71	70	70	Noise level measuring equipment ser/234-1a-34 of Japan
2.	So range coal field	70	70	70	do
3.	Chamalong coal field	71	70	70	do

Source: Field work

Table-15. Yearly health analyses of coal workers of Baluchistan

S/NO	Types of Occupational Illnesses	No of patients / year				
		2005	2006	2007	2008	2009
1.	T.B	204	289	319	307	379
2.	Post T.B	348	372	412	407	389
3.	Bronchitis	396	422	453	392	512
4.	Asthmatic problems	423	447	492	398	307
5.	Skin and other infection	729	597	612	707	779
6.	Hypertension	837	714	745	810	823
7.	Lung C.A	149	112	132	79	93
8.	Death in hospital due to injury	119	139	122	98	109

Source: Data collected from different hospital at Quetta

Table-16. The health Impacts due to coal dust exposure

Age Group	Service as Coal worker	Daily/ weekly working hours	Types of Mining	Types of Exposure	Tests conducted		Test Results		Health impacts observed
					Field Test	Pathology test	EPA Labs	Pathology Labs	
15-45	Max 39	12/84	Underground	Coal Dust (Carbon and Silica Contents)	➢ Exposure limits of coal dust with help of PM10 ➢ Vitalo Graph Peek flow meter cat no 43615 of Ireland was used to determine the respiratory problems of coal workers ➢ Carried out the interviews of coal workers	➢ L.F.T ➢ Sputum Smear ➢ Chest X-ray Blood & Urine R.E ➢ Spiro metric Analysis ➢ Blood pressure noted and ECG ➢ Ultra sound ➢ CT scan	Higher Coal Dust exposure limits in comparison of PEL were found	➢ LFT positive ➢ Sputum positive ➢ Chest X-ray showed spots on lung. ➢ Spirometry showed variation	➢ 98%Irritation in eyes, throat , Nose and skin ➢ 88%Chest pain due to(Musculoskeletal and non specific and evens cardiac cases) ➢ 97%Respiratory problems Like, Coughing, Wheezing ,T.B ,CWP,COPD, .asthma and few Spot on lungs ➢ 86%Depression ➢ 12% cases Kidney problems through ultra sound were observed ➢ 7%CA lung cases ➢ 8%Hypertension problems

Source: Field Work

Note:

➢ The allowable working hours daily/weekly as per international standers =

- Permissible exposure limits of coal dust as per international standers = 2 mg / m3
- Coal Dust exposure limits obtained in the field during research = 4-5mg /m3
- Permissible limits of silica as per international standers = .05 – 0.1 mg .m3
- Silica dust exposure limits obtained in the field during research = 0.35 mg /m3

Table-17. The health Impacts due to CH4 and CO exposure

Age Group	Service as Coal worker	Daily/ weekly working hours	Types of Mining	Types of Exposure	Tests conducted		Test Results		Health impacts observed
					Field Test	Pathology test	EPA Labs	Pathology Labs	
Under15-Above45	Max 39	12/84	undergro und	Methane (CH4 & Carbon Mono Oxide (CO	➢ Exposure limits of CH4 & CO were measured through Gas detection appliances ➢ Vitalo Graph Peek flow meter cat no 43615 of ire land was used to determine the respiratory problems of coal workers ➢ Carried out the interviews of coal workers	➢ L.F.T ➢ Sputum smear ➢ Spiro metric analysis Blood & Urine R.E ➢ Chest X-ray ➢ Blood pressure noted and ECG ➢ CT scan ➢ Ultra sound	Higher CH4 & CO Concentration in comparison of PEL were found	➢ X-ray ➢ Spiro metric variation ➢ Sputum positive ➢ LFT in some cases positive	➢ 88%Respiratory problems ➢ 93% Headache ➢ 91%Tiredness 92%Due to CO poisoning drowsiness Dizziness etc were observed. High death toll due to suffocation of CH4 87% cases of shortness of breath, 75%Chest Pain due to muscle and cardiac reasons 66%Anxiety /Stress 9%Hypertension problems

Source: Field Work

Note:

- The minimum allowable oxygen limit in underground coal mines as per international standers = 18 %
- Average Percentage of Oxygen in underground coal mines found during research = 14 %
- CO-carbon monoxide,CH4-Methane,PEL-permissible exposure limits

Table-18. The health Impacts due to coal waste

Age Group	Service as Coal worker	Daily/weekly working hours	Types of Mining	Types of Exposure	Tests conducted		Test Results		Health impacts observed
					Field Test	Pathology test	EPA Labs	Pathology Labs	
15-45	Max 39	12/84	undergro und	Coal Wastes (Coal Mine water and slurry)	➢ Sample of Coal waste Water and coal slurry were collected ➢ Interviews of coal workers were conducted	➢ LFT ➢ Sputum smear ➢ Blood & Urine R.E ➢ Chest-ray	Samples collected were analysis in the field	LFT and blood showed positive symptom of Hepatitis Spiro metric variation	➢ 76%Stoma tic problems ,like diarrhea ,vomiting, Ulcer ,Cholera ➢ 54%Hepatitis B&C ➢ 83%Hypertension ➢ 46%Anxiety

Source: Field Work

Figure-1. The Security arrangement made to carry out the field work

Figure-2. The PM10 and PM2.5 Andersen apparatus used to collect the coal dust during Field work

Figure- 3. Collection of coal mine and drinking water samples in the field to carry out the field test

Figure- 4. The Vitalo-graph peek flow meter

Figure-5. Quality of Life of Coal Workers

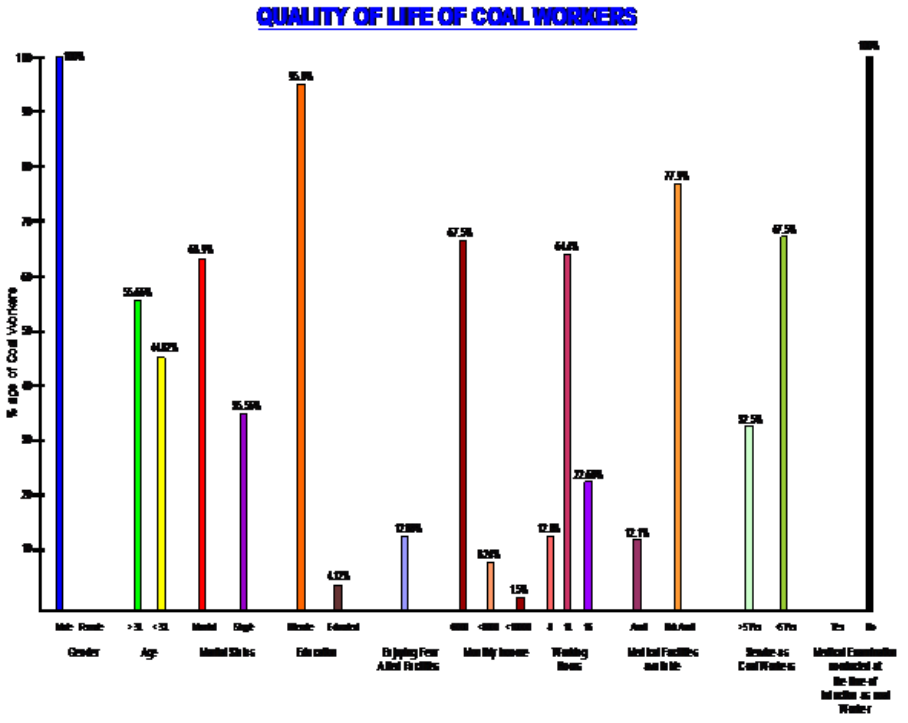

Fig-6. Human Respiratory system

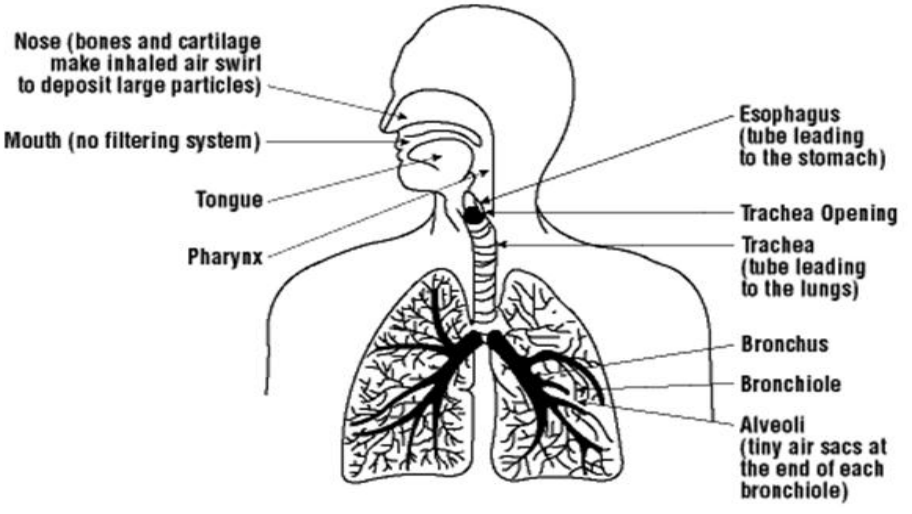

Figure-7. Collection and Analysis of coal dust sample in the field and EPA laboratory

Fig-8. The pictures of damaged lungs of coal workers of so-range Degari taken during medical examination at CMH Quetta