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Original Article

Health Issues of Coal Mine Workers in Pakistan

Salahuddin Din Azad[1], Maqsood A Khan[1], Muhammad Ishaque Ghaznavi[2], Shereen Khan[3]

[1]Department of Environmental Management and Policy Baluchistan University of Information Technology, Quetta

[2]Department of Geology Haripur

[3]Bolan Medical College, Quetta

Corresponding Author:
Salahuddin Din Azad
Email: 477asge@gmail.com

Abstract:

Background: The data on coal mine workers was collected from May 2009 to April 2010.**Objective:**To study the health issues of coal mine workers. **Methods:** Two types of data were collected. Primary data was obtained through topographic survey and questionnaire while Secondary data about the health issues, medical facilities and other allied facilities of coal mine workers of Baluchistan (pakistan) were collected from; Mine& Mineral department of Quetta, hospitals and medicals facilities in coal mine fields. Three mine fields i.e. Mach, So-range-Degari, and Chamalong coal fields were selected and further subdivided as M1,M2,andM3 at Mach coal field, SD1, SD2 and SD3 at So-range-Degari and C1, C2 and C3 at Chamalong coal field. **Results:** The average emission of Methane (CH4), Carbon monoxide (CO), and Oxygen (O2) in coal mine fields was 11.8m3/ton, 36ppm and 14% respectively which, exceeded the permissible limits of 1-10m3/ton, 30ppm and 18%. The concentration of coal dust (Carbon and Quartz) was 4-5mg/m3 and 0.35mg/m3 respectively as against the threshold limits of 2mg/m3 and 0.05-0.1 mg/m3 for 8 hours daily and 40 hours/week. Due to high concentration of coal dust the miners experienced headache, irritation in throat, nose and eyes, drowsiness, shortness of breath, nausea, pneumoconiosis, tuberculosis, chronic obstructive bronchitis, heart problems, and other respiratory illnesses. The coal water and slurry was disposed off in an unconfined area causing contamination of drinking water leading to symptoms of indigestion and diarrhea to the miners. **Conclusion:** Government of Baluchistan and coal mine owners should take concrete steps to improve the adverse health impacts of coal miners.

Key Words: Chronic obstructive pulmonary disease, threshold limit values, coal workers pneumoconiosis, permissible exposure limit, tuberculosis.

Introduction

Coal mining is taken as the harmful profession in Baluchistan due to its uncontrolled emission and exposure to carbon monoxide and methane both being harmful not only to the environment but also to coal workers. Prolonged exposure to methane gas (Greenhouse Gas) causes the sudden death [1] which is quite frequent in Baluchistan (Pakistan) [2]. The accidents of roof collapse inside the mine are also quite common causing a huge spending on the Government of Baluchistan as compensation or treatment [3]. Exposure to coal dust is another issue peculiar to coal mining which causes numerous health problems [4] while, improper disposal of coal effluents causes air, water and soil degradation but has poses waterborne health problems [5].

Methods

The study was conducted on Coal mine workers of Baluchistan from May 2009 to April 2010. Two types of data were collected. Primary data was collected through topographic survey and questionnaire while, Secondary data about the health issues, medical facilities and other allied facilities of coal miners were collected from; Mine & Mineral department of Quetta, hospitals and medicals facilities in the coal mine field areas. Three coal mine fields were selected which included Mach, So range Degari, and Chamalong. These fields were further subdivided as M1, M2, and M3 at Mach coal field, SD1, SD2 and SD3 at So range Degari and C1, C2 and C3 at Chamalong coal field.

A WHO based Quality of life (QOL) questionnaire was used to ascertain the quality of life and health impacts of coal miners. The high quality analytical equipment which included gravimeter, particulate matter Anderson apparatus, noise level measuring equipment, gas measuring devices, pH and turbidity meter etc from Baluchistan Environmental Protection (BEPA) was mobilized and used at all three sites to find out the effects of exposure of coal dust, coal waste and coal gases on the health of coal mine workers.

To ascertain the specific and precise harmful impacts such as respiratory irritation, pulmonary tuberculosis, pneumoconiosis (black lung), obstructive bronchitis, allergy and heart diseases the selected coal workers were taken to Combined Military Hospital and Air Force Hospital Quetta for detailed medical tests/examination like Sputum AFB, liver function test, blood and urine complete picture, Chest X-ray, Spirometry, lung biopsy (where indicated), Hepatitis B and C, CT scan and

ultrasound. Selected coal workers were divided into following age group.

Age Group	% (N)
Up to 15	15(6.5)
15-24	37(16.2)
25-35	121(53.2)
36-45	39(17.1)
45 & above	16(7)
Total	228(100)

Results

The allowable working hours daily/weekly as per international standards are 8/40 while, permissible exposure to coal dust is 2 mg/m3 but in our miners the coal dust exposure was twice high i.e. 4-5mg/m3. Similarly the permissible limits of silica as per international standards is 0.05-0.1 mg/m3 while, in the present study it was 0.35 mg/m3 which is again twice higher.

The Presence of Methane, Carbon monoxide and Oxygen was measured in selected coal mine fields and the results are shown in Table I. The table shows that gas exposure limits are more than the permissible limits given by health safety agencies like National Institute of Occupational Safety and Health (NIOSH) [6], Occupational Safety and Health Administration (OSHA) [7] and Mine Safety Health Administration (MSHA) USA [8].

Table I Measurement of Gases at all three selected coal sites

Sl. No.	Mine Location	Time Weighted hours	Average Emission of CH4 m3/ton		Concentration of	
			During Mining	Post Mining	CO PPM/ HR	O2 % age
1	Mach coal fields A1,A2,A3	8	11.2	5.43	37	13.5
2	Sorangede-gori 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

The minimum allowable oxygen in underground coal mines as per international standards is 18% while in this study it was 14%. Allowable carbon monoxide levels are 30-33 ppm/hour while, observed levels were 35-37 ppm/hour, similarly methane should be 1-10 m3/ton during mining with a maximum level of 3.5 m3/ton during post mining phase but these values were 12 and 5.5 respectively (Table I).

The health problems due to exposure to these gases included headache in 93%, drowsiness or dizziness in 92%, tiredness in 91%, respiratory problems in 88%, shortness of breath, in 87%, chest pain in 75%, anxiety/stress in 66% and hypertension in 9% cases.

The Coal dust exposure at selected sites is shown in Table II and its health related problems included irritation in eyes, throat, nose and skin in 98%, respiratory problems like, cough, wheeze, T.B, obstructive pulmonary disease, asthma in 97%, chest pain in 88%, depression in 86%, kidney problem as seen on ultra sound in 12%, hypertension in 8% and lung cancer in 7% cases.

The coal dust particle sizes also play a deleterious role in the health of coal mine workers. All sizes of dust particles are shown in Table III.

During mining, coal mine waste water and coal waste (Coal slurry) come out as the product wastes which are thrown without confinement. These contaminate the nearby source of drinking water. Water samples were taken and tested it the laboratory and the results were compared with WHO prescribed limits (Table IV). The concentration limits of TSS and TDS were higher than permissible limits. Health impact of this contamination was seen as diarrhea, vomiting, and symptoms of acid peptic disease in 76%, hypertension in 83% and anxiety in 46% and other water borne diseases in 54%. Most of the symptoms that were seen at early age i.e. soon after induction in the coal mining were mild and these grew in severity in those who stayed for a longer duration in this job i.e. over 35 years of age when they became more profound.

Discussion

The present study shows higher concentration of methane and Carbon monoxide gases, coal dust and coal particles in our environment which are causing health hazards in the coal miners. Methane reacts with air and displaces oxygen [9] resulting in suffocation and sudden death[10] occur due to weakening of cardiac sensitizers [11]. In some cases due to oxygen deprivation, damage occurs to some or all organs including the nervous system and the brain causing headaches, dizziness, drowsiness, unconsciousness, nausea, vomiting, and shortness of breath and early aging [12]. Tissues having highly active oxygen metabolism, such as heart, brain, liver, kidney and muscle are particularly sensitive to CO poisoning [13] leading to immediate, death, myocardial impairment, hypotension, arrhythmias, and pulmonary edema [14]. The most insidious effect of CO poisoning is the delayed development of neuropsychiatric impairment and neurobehavioral consequences [15]. In the present study many of the workers had similar symptoms but unfortunately neither the Provincial government nor any stake holder is showing any concern.

Small dust particles penetrate the nose and upper respiratory system and reach the depth of lungs where they cannot be removed by the cilia and mucous and are thus more likely to be retained. The particles with bigger diameter are trapped in the upper respiratory tract[16] where they cause irritation in lungs, throat causing nasal infection, wheezing and asthma. Due to higher concentration of mercury in coal, there is reduction in the

Table II Measurement of Coal dust exposure at selected sites (Ambient air monitoring TWA 8 hours, 40hours/week results)

Sl 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	1. PH 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 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

Table III Selection of sample size

Sl. 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

Table IV 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

production of hormones, which cause early aging, stress, decreased sex drive and aggravation of menopausal symptoms and reduction in the male productivity. All these were observed in few cases only in the present study. Though exposure to sulfur contents in the coal are not as pronounced due to the type of coal but its health impacts like aggravation of pre-existing respiratory, heart problem pulmonary diseases, asthmatics problems, poor visibility and irritation etc. are known. The higher concentration of coal effluents in drinking water makes water heavier and unsuitable for human consumption causing multiple GI problems

There is a need to improve the standards of coal mining in Pakistan so that coal miners who are the back bone for generating revenue for the mine owners are satisfied and healthy and are able to deliver better and longer.

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