AMERICAN JOURNAL OF PREVENTIVE MEDICINE AND PUBLIC HEALTH, 2017
VOL 1, NO. 1: 20-26
10.5455/ajpmph.280307

eJManager

ORIGINAL ARTICLE

Open Access

Health Status Evaluation of mine workers and nearby population around iron ore mines in tribal district of Jharkhand, India

Sarang V Dhatrak, Subroto S Nandi, PrahaladKumar L Sishodiya, Umesh L Dhumne, Shilpa V Ingole, Shweta R Gupta
Occupational Health, National Institute of Miners' Health, Nagpur, MS, India

ABSTRACT

Aim: India is one of the largest producers and exporter of iron; however limited information is available about prevalence of iron ore dust exposure related health problems. Reports from some agencies indicated high prevalence of health disorders among population residing in nearby area of tribal district of West Singhbhum in Jharkhand state. Hence this study was undertaken in the twin township of Meghatiburu and Kiriburu iron ore mining area of West Singbhum district to determine health status evaluation of workers and nearby population.

Method: Cross Sectional Study involving 102 male mine workers, 138 general population and 126 school children from Meghatiburu & Kiriburu mining area of West Singhbhum district of Jharkhand was conducted. The medical examination included general physical examination, chest x-ray, spirometry, audiometry, vision screening and biochemical parameters for Hb (gm%), blood sugar, etc.

Results: The findings of the mine worker group study showed that 3.4% had pneumoconiosis and suspected pneumoconiosis each. Audiometry results showed 23.8% workers having noise induced hearing loss. In general population group 24.2% were undernourished with 85% suffering from anemia of which more than 50% were suffering from moderate to severe anemia with female predominance. Among school children 55% were undernourished and 92.8% had anemia with more than 70% girls suffering from moderate to severe anemia.

Conclusion: Undernutrition and anaemia are prevalent among population residing nearby iron ore mines in West Singbhum district of Jharkhand state.

ARTICLE HISTORY

Received 17 March 2017
Accepted 16 October 2017
Published 21 October 2017

KEYWORDS

Jharkhand; anemia; iron ore; NIHL; siderosis

Introduction

Mining is one of the most hazardous occupations. It not only affects the workers who are actively engaged in mining activities but also the environment which may cause its adverse effects on the health of the population residing in its vicinity. The most common health hazards are caused due to exposure to dust, noise, vibration etc. of these Pneumoconioses and Noise induced hearing loss are notifiable diseases under Mines Act 1952. India is among the leading producer as well as exporter of iron ore in the world. Jharkhand ranks second among all states with 26% of the total iron ore (hematite) reserves in the country [1]. West Singhbhum is largest and one of the tribal district in the Jharkhand state with large deposits of iron. The ore is of high grade with about 90% iron. There were about 41 mines and more than 200 legally and illegally run crusher units in this iron ore mining hub spread over south-west Jharkhand to south-eastern Orissa [2].

There were reports from some agencies indicating that there was high prevalence of health disorders among population residing in nearby area in West Singbhum district. There also had been press reports and complaints from NGOs aboutpeople especially children suffering from various diseases in this area due to prevalent iron ore pollution in surroundings

Contact Subroto Nandi snandi76@rediffmail.com National Institute of Miners' Health, JNARDDC Campus, Wadi, Nagpur - 440023, MS, India.

of iron ore mines [2]. As there is limited information available related to health hazards due to iron ore pollution, this study was undertaken in the twin township of Meghatiburu and Kiriburu iron ore mining area of West Singbhum district to generate information about the health status of mine workers involved in the mining activities and the population residing in the vicinity of the mines.

Materials & Methods

It was a pilot study and mine workers were randomly selected as made available by the mine management. As mining causes environmental pollution in nearby areas where general population and schoolchildren were residing they were included on their voluntary participation. Accordingly, the study included representative samples involving 102 male mine workers, 138 general population and 126 school children from Meghatiburu & Kiriburu mining area of West Singhbhum district of Jharkhand was completed in the year 2014.

Institutional Ethics Committee approved the study. Informed written consent was obtained from each study subject before recruitment to the study. In case of school children <16 yrs, additional consent of their parent was obtained. Sample size of each individual test varies as per participation of the study subject.

The study subjects underwent general physical examination along with following parameters.

Body mass index (BMI)

BMI was included as one of the parameters of health status evaluation for nutrition. Body composition analyzer scale was used for BMImeasurement. The adult study population was classified as Underweight, Normal, Overweight and Obese as per WHO criteria [3]. BMI categorization for school children was done as per the Centers for Disease Control and Prevention recommendations [4].

Chest X-rays (CXR)

A Postero-Anterior (PA) CXR of each person was obtained. School children were excluded. All chest x-rays were evaluated as per ILO Classification 2000 [5].

Spirometry

Spirometry was conducted following standard procedure. Three readings were obtained for each individual and the best reading was taken for reporting and analysis. The results were interpreted as normal, restrictive, obstructive or mixed impairment [6].

Audiometry test

Evaluation for hearing capability was measured for air conduction by audiometric test. The audiometry was conducted in a small closed room having minimal background noise for sound frequencies ranging from 0.5 KHz to 8 KHz and the minimum intensity for measurement was from 15 dB(A). Audiogram of mine workers were evaluated as per WHO recommendations for classification on the basis of pure tone audiogram evaluating the thresholds of hearing for frequencies of 500, 1000, 2000 4000, 6000 and 8000 Hz. The principle criteria for diagnosis of occupational NIHL was (i) History of exposure to excessive noise levels (ii) Bilateral sensorineural hearing loss showing similar pattern in both ears (iii) The difference between two ears should not exceed 15 dB at 500, 1000 and 2000 Hz and 30 dB at 3000, 4000 and 6000 Hz. (iv) Sign of "notching" in the audiogram at high frequencies of 3000, 4000 or 6000 Hz with recovery at 8000 Hz [7].

Biochemical parameters

Auto analyzer was used for estimation of various parameters like Hb (gm%), blood sugar, etc. Grades of anemia were categorized into mild, moderate and severe as per WHO criteria [8].

Statistical analysis

Percentage, mean and standard deviation was calculated. The chi sqaure test and two tailed paired t test was used for statistical analysis.

Results

Normal working hours was 8 hours per day for six days a week. The mean age of mine workers was 45.97 ± 9.66 and the mean age of general population was 39.56 ± 13.79 [Table 1]. In school children group the mean age was 14.37 ± 1.99 [Table 2]. The mean work exposure of mine workers was 18.56 ± 9.70.

Body mass index (BMI)

BMI was calculated to study the nutritional status of the study groups [Table 3]. The mean BMI was compared between mine workers and men from general population, it was observed that there is statistically significant difference ($P < 0.001$) between the groups. However the difference was

Table 1. Distribution of mine workers according to age.

Age (yrs)	Mine Workers (n = 102)	General Population (n = 138)
18-30	9 (8.8)	46 (33.3)
31-40	19 (18.6)	34 (24.6)
41-50	33 (32.3)	34 (24.6)
51-60	40 (39.2)	14 (10.1)
>60	1 (0.9)	10 (7.2)

Figures in parenthesis indicate percentage.

Table 2. Distribution of School Children according to age and sex.

Age (yrs.)	Boys (n = 63)	Girls (n = 63)	Total (n = 126)
8-10	7 (11.1)	3 (4.7)	10 (7.9)
11-13	6 (9.5)	17 (26.9)	23 (18.2)
14-16	50 (79.3)	43 (68.2)	93 (73.8)

Figures in parenthesis indicate percentage.

Table 3. Distribution of study subjects according to BMI.

BMI Category	Mine Workers (n = 97)	General Population Men (n = 60)	General Population Women (n = 76)	School Children Boys (n = 63)	School Children Girls (n = 63)
Underweight	1 (0.9)	16 (26.6)	17 (22.3)	38 (60.3)	31 (49.2)
Normal	4 (42.5)	33 (55.0)	32 (42.1)	23 (36.5)	30 (47.6)
Overweight	48 (47.5)	8 (13.3)	17 (22.3)	1 (1.5)	1 (1.5)
Obese	5 (4.9)	3 (5.0)	10 (13.1)	1 (1.5)	1 (1.5)
Mean BMI	25.4 ± 3.30	21.8 ± 4.09	23.2 ± 6.13	18.5 ± 3.01	18.7 ± 3.04

Figures in parenthesis indicate percentage.

statistically insignificant among male and female from general population and school children group.

Chest X-ray

Chest x-rays of 88 mine workers and 106 general population were evaluated [Table 4]. Among mineworkers, 3 (3.4%) x-rays showed the presence of small opacities with profusion 1/1 i.e category 1 Pneumoconiosis while 3 (3.4%) x-rays showed 1/0 profusion of small opacities i.e. suspected silicosis. The opacities were q/q type. The other x-ray findings include 3 x-rays with thickened interlober fissure i.e. pi and 2 x-rays with cg i.e. calcified non pneumoconiotic nodules. The x-ray findings of the persons from general population showed no evidence of pneumoconiosis. 1 x-ray showed the presence of tubercular shadow while 4 had pi.

Table 4. Findings of chest x-rays among study groups.

	Mine workers (n = 88)	General Population (n = 106)
Normal	82 (93.1)	106 (100)
Suspected Pneumoconiosis (1/0)	3 (3.4)	0
Pneumoconiosis (1/1)	3 (3.4)	0

Figures in parenthesis indicate percentage.

Table 5. Findings of Spirometry among different study groups.

	Mine workers (n = 88)	General Population (n = 113)	School Children (n = 118)
Normal	85 (96.6)	107 (94.6)	117 (99.2)
Mild Restriction	3 (3.3)	6 (5.3)	1 (0.8)

Figures in parenthesis indicate percentage.

Pulmonary function test

The finding of Spirometry showed 3 mine workers, 6 general populations and 1 school children had mild restriction [Table 5].

Audiometry

The finding of the audiometric evaluations is depicted in Table 6. Relation of NIHL to duration of work among mine workers was also studied; the data was analysed using Chi-square test and it was observed that there was statistically significant corelation between duration of exposure and NIHL.

Biochemical parameters

The mean Hb (gm%) of men and women from general population was 10.7 ± 2.0 and 9.0 ± 1.3 respectively. The mean Hb (gm%) in mine workers was

Table 6. Findings of audiometry evaluations among study groups.

	Mine Workers (n = 92)	General Population (n = 119)
Normal	51 (55.4)	93 (78.1)
NIHL	22 (23.8)	0
Bilateral Hearing Loss	9 (9.7)	18 (15.1)
Unilateral Hearing Loss	10 (10.8)	8 (6.7)

Figures in parenthesis indicate percentage.

11.51 ± 1.3. The mean Hb (gm%) of boys and girl students was 10.4 ± 1.5 and 9.3 ± 1.2 respectively. On the basis of hemoglobin gm% study population was classified as mild, moderate and severe anemia. The distribution of anemia among the study groups is shown in Table 7. The grade of anemia was studied with the gender and it was observed that there was statistical significance impact of gender in general population as well as in school children group for occurrence of anemia. The grade of anemia was also studied with the male gender in general population to that of mine worker, however the difference was statistically insignificant.

Discussion

This is probably the first study conducted to study the effect of iron ore mining on the persons residing in nearby areas in tribal district of Jharkhand with the objective to study the adverse health effects of iron pollution both in mine workers and the general population residing nearby.

Anthropometric measurements

The basic objective of anthropometric assessment was to determinethe nutritional statues of study population. The majority of mine workers were in 40+ age group having >20yrs of exposure to the iron ore mining. It was observed that the majority of workers were either overweight (52.4%) or normal weight (42.5%). It can be infered that as these workers had regular source of income and as expected the nutritional status was good. These findings are in line with the studies conducted by NIMH at other PSUs/Private sector mines.

In comparison to the mine workers the overall nutritional status of the general popualtion and the school children was poor with 24.2% of general popualtion and 54.7% of the school children were found to be underweight. Males in both general popualtion and the school children were found to be more undernourished as compared to their female counterparts. With 26.6% men compared to 22.3% women in general popualtion and 60.3% of boys as compared to 49.2% girls in the school children were undernourished. The overall prevalence of overweight in general population was 27.5% which is lower than that of mine workers. These findings are in line with the NFHS-3 survey which showed 43% women and 33% men are underweight in state of Jharkhand [9]. Another survey conducted by National Nutrition Monitoring Bureaus (NNMB) showed that about 35% each of the men and women had chronic energy deficiency (BMI < 18.5) i.e. underweight, also had the similar findings [10].

Chest X-ray

Long term exposure to iron dust results in deposition of iron in the lung which causes condition known as Siderosis which is generally assumed to be a benign condition usually not associated with respiratory symptoms. Few surveys have been conducted to study the effect of iron dust on the lung, which showed the prevalence of pneumoconiosis around 42%, however these studies were conducted in underground mines and the effects may also be attributed to smoking and silica present in the dust [11]. In the present study, x-rays of mine workers showed evidence of 3.4% each for pneumoconiosis and suspected pneumoconiosis which is much lower than the earlier reported studies; it might be attributed to the better mining condition or to smaller sample size. Evaluation of the x-rays of general population did not show evidence of pneumoconiosis.

Pulmonary function test

Exposures to iron dust on longer duration may have effect on respiratory function as that of smoking, iron has also been shown to cause fibrosis in some cases. Small functional changes of restriction and loss of lung compliance are also reported due to iron exposure [12]. The spirometry findings of the mine workers showed 3.3% had mild restriction; however these persons did not have the history of cigarette smoking. The persons detected with suspected pneumoconiosis / pneumoconiosis had normal FVC and FEV1. Spirometric evaluations of the general population revealed 5.3% having mild restrictive impairment; whereas only 1 school children had mild impairment.

Table 7. Distribution of grades of Anemia among study groups.

Variable		Normal	Anaemia			Total	p value (Chi square Test)
			Mild	Moderate	Severe		
Gender (School Children)	Girls	1 (1.5)	17 (27.0)	44 (69.8)	1 (1.6)	63	<0.0001 (HS)
	Boys	8 (12.7)	35 (55.5)	18 (28.5)	2 (3.1)	63	
Gender (General Population)	Female	1 (1.3)	16 (21.0)	55 (72.3)	4 (5.2)	76	<0.0001 (HS)
	Male	18 (29.0)	30 (48.3)	9 (14.5)	5 (8.0)	62	
Mine Worker	Male	38 (37.6)	50 (49.4)	13 (12.8)	0	101	0.3414 (NS)

HS- Highly Significant, NS- Non Significant.
(Figures in parenthesis indicate percentage).

Audiometry

Noise induced hearing loss (NIHL) isone of the common occupational health hazard of mining operations. Surveys conducted by DGMS and other institutions have shown high levels of noise in drilling, blasting, screening, use of heavy earth moving machineries, etc. The present study showed that the about 45% mine workers were having some form of hearing impairment of which 23.8% was attributed to NIHL and remaining 21% were due to the other factors. The prevalence of NIHL was in line with similar trend observed in the studies conducted by NIMH at different mining companies. The studies conducted by NIMH have shown the prevalence of NIHL ranging from 20% to 30% [13-15]. Audiometric findings suggested that the prevalence of NIHL is directly proportional with duration of exposure. The findings showed that 5.2% of workers were having NIHL who had exposure of <10 yrs whereas in 11 to 20 yrs of exposure it was 25.9% and in 21 to 30 yrs exposure it was 27.7% and with exposure >30 yrs it was 30.0% . The association of NIHL with increase in duration of exposure was statistically significant ($p < 0.001$). The audiometric findings of the general population suggested that about 15.2% had bilateral hearing loss mostly age related with 14.7% in age group of 41 to 50, 50% in the age group of 51 to 60 and 62.5% in the age group of >60. 4.1% of subjects had unilateral hearing loss because of various reasons.

Biochemical parameters

The results showed that about 64% of mine workers were suffering from anemia of which 14% had moderate anemia which is serious as the job profile of mine workers requires strenuous physical hard work and this anemia will result in decreased physical output causing tiredness/weakness. The earlier studies conducted by NIMH had shown the prevalence of anemia between 20–25% among mine workers [13-15]. However, there are no other reported studies regarding anemia among mine workers.

The status of anemia was more severe among general population; of 138 persons about 85% of the population was suffering from anemia of which 46% were suffering from moderate and 6.4% from severe anemia. About 72.5% of the women were suffering from moderate and 5.2% from severe anemia. Among the 126 school children, the results showed that 62 girls out of 63 and 55 boys out of 63 had anemia. Overall 96% of the school children had anemia with 69.8% girls and 28.5% boys had moderate anemia. It is being reported by World Health Organization that about 50% of Indian women are suffering from anemia [16]. The National Family Health Survey, India reported that Jharkhand has the highest rate of anaemia among women of 15-49 years (70%) and one of the highest rate of anaemia among adolescent girls of 15-19 years (67%) as compared to the national average of 52% [9]. Rate of anaemia among adolescent boys of 15-19 years is 41% according to the same survey and about 30% suffer from moderate to severe anemia as compared with 17% for India as a whole. Jharkhand Rural Health Society has also depicted that anemia is a major health problem in Jharkhand state and 70 percent of women in Jharkhand are anemic. More than one third of men (37%) are also anemic. Data collected under District Level Household Survey of the Reproductive and Child Health Project showed that prevalence of anemia was observed among 99.9% girls of 15 to 19 years in Jharkhand [17].

The prevalence of anaemia was compared between mine workers and men from general population; it was observed that the findings were

statistically insignificant. However, when the prevalence of anaemia was compared between the gender of general population and school children group, the association was found to be statistically significant thereby indicating the role of gender in causing anaemia.

The present study also showed that the problem of anaemia is much more serious in Jharkhand state. Numerous factors, such as the lack of education, poor exposure to information, limited role of women in decision-making, and last but not least, social stereotypes and social economics contribute being held responsible for the scenario. Along with these factors, the anaemia might be attributed to other causes like prevalent falciparum malaria in the Jharkhand state and may also to sickle cell disease. A detailed study in this matter is required.

Limitation

The study could not conclude any relation between iron ore mining and anaemia due to presence of many confounding factors. Under nutrition is well documented in that area and it may be attributed to nutritional status. Hence further investigation is required.

Conclusion

The study showed NIHL and anaemia as major health effects among mine workers in open cast iron ore mining. The major findings of the study were high prevalence of anemia and under nutrition among general population well above national status but in line with the status of anemia in Jharkhand state. The study being a pilot project for determination of health hazards caused due to iron ore mining included less number of study subjects and thus the findings may not be representative of the real status caused due to iron pollution in West Singhbhum District of Jharkhand. Hence, it is recommended to conduct a large scale epidemiological study for determination of the real health status in the area affected by iron ore mining.

References

[1] Indian Bureau of Mines (IBM). 2014. Indian Minerals Yearbook 2012. http://ibm.gov.in/writereaddata/files/07092014130735IMYB-2012-Prelim_2012.pdf (Accessed on 15 July 2015).

[2] B. Vijay Murty. Red dust brings early death to West Singbhum. Hindustan Times, Gua (Jharkhand). March 18, 2010.

[3] World Health Organization (WHO). 2004, Global data base on Body Mass Index. http://apps.who.int/bmi/index.jsp?introPage=intro_3.html (Accessed 15 July 2015).

[4] Centre for Disease Control. (CDC). 2000. BMI Categorization of children and teens. http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html (Accessed 15 July 2015).

[5] International Labour Office (ILO). 2011. Guidelines for the use of ILO International Classification of Radiographs of Pneumoconioses 2011 edition. Geneva, International LabourOffice.http://www.ilo.org/wcmsp5/groups/public/-ed_protect/-protrav/-safework/documents/publication/wcms_168260.pdf (Accessed 15 July 2015).

[6] American Thoracic Society. Standardization of Spirometry 2005. Eur Respir Jrnl 2005; 26: 319-338.

[7] World Health Organization (WHO). 1997. Prevention of noise induced hearing loss, http://www.who.int/pbd/deafness/en/noise.pdf (Accessed 10 May 2015).

[8] World Health Organization (WHO). 2011. Hemoglobin concentration for the diagnosis of anemia and assessment of severity, Vitamin and Mineral Nutrition System. http://www.who.int/vmnis/indicators/haemoglobin.pdf (Accessed 18 July 2015).

[9] International Institute for Population Sciences (IIPS) and Macro International. 2007. National Family Health Survey (NFHS-3), 2005-06, India: Key Findings. http://www.measuredhs.com/pubs/pdf/SR128/SR128.pdf (Accessed 24 July 2015).

[10] National Nutrition Monitoring Bureau. 2012. Diet And Nutritional Status of Rural Population, Prevalence of Hypertension & Diabetes Among Adults And Infant & Young Child Feeding Practices-Report of Third Repeat Survey, NNMB Technical Report No. 26. http://nnmbindia.org/1_NNMB_Third_Repeat_Rural_Survey_Technicl_Report_26.pdf (Accessed 20 July 2015).

[11] Chen SY, Hayes RB, Liang SR, Li QG, Stewart PA, Blair A. Mortality experience of haematite workers in China. Br J Ind Med 1990; 47 (3): 175 – 181.

[12] Billings CG, Howard P. Occupational Siderosis and welders' lung: a review. Arch Chest Dis. 1993 Aug;48(4):304-14.

[13] National Institute of Miners' Health. 2011. Technical report on Medical examinations of Mine Workers from M/s Rajasthan State Mines and Minerals Limited. Nagpur, India

[14] National Institute of Miners' Health. 2012. Technical report on Medical examinations of Mine Workers from M/s Gujarat Minerals Development Corporation. Nagpur, India.

[15] National Institute of Miners' Health. 2013. Technical report on Health Surveillance Programme at M/s Andhra Pradesh Mineral Development Corporation Limited. Nagpur, India.
[16] World Health Organization (WHO). 2008. Global database on anaemia. Worldwide prevalence of anaemia, 1993–2005. http://www.who.int/nutrition/publications/micronutrients/anaemia_iron_deficiency/9789241596657/en/ (Accessed 24 July 2015).
[17] International Institute for Population Sciences (IIPS). 2006. National status of children and prevalence of anaemia among children, adolescent girls and pregnant women. 2002-04. Available from http://www.iipsindia.org/research.htm (Accessed 24 July 2015).