



## Health Issues of Rat Hole Coal Mine Workers of Meghalaya *A Logit Regression Analysis*

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**Abstract.** *Most of the coal mines in Meghalaya are controlled by private individuals and companies. The Garo Hills district has the highest coal reserve of 390 million tonnes. Locally the mining of coal is done by making small pit holes commonly known as Rat Hole mines. These coal mines are illegal and the owners of the mine exploit the poor workers as they have no other means of livelihood to support them. This study intends to highlight the various health problems faced by the coal mine workers who are mostly migrants. The study was carried out in South Garo Hills which is one of the 11 districts of Meghalaya, by interacting with 110 workers of different private coal mines. A logit regression model is used to find the significance of various independent variables which are broadly classified as individual habits, demographic factors, work environment, and the fuel used for cooking. Certain factors come under these broad categories like working hours, age, gender, leisure time. The dependent variables include certain health problems like skin problems, hearing problems, Respiratory problems. The result of the logit regression reveals that for most of the health issues suffered by the coal mine workers, the individual habits and work environment are more significant than the other independent variables.*

**Key words:** Rat-hole Mines, Coal Mine Workers, Health Problems, Working Conditions.

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**Introduction.** The extraction of coal in Meghalaya took place during the British period in 1815, but due to geographical constraints the extraction process could not be continued as the cost of coal could not meet the production cost. Later on, around the period of 1970s coal mining revived in the Jaintia hills part of Meghalaya, then the mining was done by the local people mainly by the family members of the coal mine owner. Gradually with the increasing demand, the coal mining business started to flourish in the area. Since then the locality was exposed to huge extraction of coal, the local people started leasing their agricultural land to local and non-local coal miners. Coal mining became the main course of livelihood for the people. In Meghalaya as per the sixth schedule of the Indian constitution, the government has little power compared to other states of India who are not under the sixth schedule of the constitution. So the prevailing landholding system gives enough liberty to the landowner to extract the coal haphazardly without any concern for environmental degradation. Moreover, the extraction process of coal in the area is very unscientific and the government has no say in this matter as the mining activities in this state do not come under the purview of the Mines Act 1952. This prevailing scenario of coal mining activities in Meghalaya poses immense problems for the health & safety of the workforce and as well as for the future generation, (Annual Report on Mining, 2011-2012).

Coal is one of the valuable minerals found in Meghalaya. Meghalaya has an estimated coal reserve of 559 million tonnes, which are spread over in an area of 213.9 sq. km covering approximately 1% of the total geographical area of the state. The Garo Hills district has the highest coal reserve of 390 million tons, followed by West Khasi Hills 98 million tonnes, Jaintia Hills 39 million tonnes, and East Khasi Hills districts 31 million tonnes (Indian Minerals Yearbook 2013). The entire production is of ungraded coal mined from the large number of small-scale mines operated mostly by the local tribal in the unorganized private sector. Therefore the number of coal mines for the state is not available, (Keith, S. 2014). Most of the coal is of sub-bituminous type with low ash and high sulphur contents and has high calorific value and hydrogen content (1.5-2.8%). Since the industrial demand within the state is quite low, a major portion of the coal produced in the state is exported to Bangladesh and outside the north-eastern region. The local industries using coal include cement plants, lime kilns, brick-burning, and pottery industries.

In Meghalaya, most of the coal mining is controlled by private companies. Locally the mining of coal is known by making small pit holes commonly known as Rat Hole mines, as the mouth opening of the pit is hardly a one-meter opening through which the miners excavate coal. South Garo Hills is one of the districts in Meghalaya, which is known for Rathole coal mining. The South Garo Hills district lies in the southern part of the state of Meghalaya and was created on 18th June 1992. The district is hilly with difficult terrain with headquarter at Baghmara, the only town in the district. It covers an area of 1887 sq. km. It is bounded in the north by East Garo Hills, in the East by West Khasi Hills, in the West by West Garo Hills, and in the South by Bangladesh.

**Coal mines and Workers Health Issues.** Good health of the employee is an instrument for efficient productivity in any sector of the economy. Various studies have been directed toward the health both the physical and mental health of the workers of different economic activities and helped the policymakers to formulate policies relating to human resource development and increase productivity along with maintaining a healthy life of the workers. Among the various sectors mining sector has been one of the sectors where many studies have been carried out to highlight the health issue of workers as they are made to expose themselves to various harmful chemicals during the extraction process, some of those studies are discussed in the following paragraph.

The study of Elisa (2011), stated that it is not only physical injury that the miners commonly face but there is another risk to health like respiratory disorder due to the constant exposure of the workers to a high level of dust and other harmful chemical particulates present in coal mines. Apart from respiratory diseases, another problem commonly found among the miners is the loss of hearing power at an early age, the presence of heavy noise in the coal mine gradually decrease the hearing capacity among the workers in coal mines, it has been estimated that around 40% of the workers faced the hearing problem, Tak (2004) and Joy (2007).

Avidapu (2016) examined the oral health among the coal mine workers in Adilabad District of Telangana and the result is found to be not satisfactory, they have high periodontal diseases and traumatic injuries, the author pointed out that the habit of consumption of tobacco is one of the significant factor contributing to the poor oral health of the coal mine workers. Ghosh and Aggarwal (2020) pointed out that in case of deep mining or underground mining where various techniques are used to access ores and valuable minerals in the ground by digging into the ground to extract them poses a great threat to health in the form of lung cancer, respiratory disease, and low birth weight not only to the workers but also to the people residing in the neighbouring area.

As pointed by Basu (2015) it is the crowded living condition and poor housing infrastructure of the coal mine workers who are mostly migrant workers, is also a significant factor contributing to the poor health status of the workers. Like the study of Basu (2015) another study by Wilson et al. (2015) also pointed that

poor living conditions have a major impact on the health of the miners. The author explains it with a vicious cycle of poverty as to how the workers get trapped under poverty and remain poor. The study stated that the limited investment funding leads to dependence on foreign equipment, low productivity, and sponsor dependence, which in turn leads to low earnings, exacerbating poverty and unemployment with resulting limited investment funding this is how the cycle continues.

According to the study of Forero (2015), the ergonomic hazards are generally low in the case of large scale mining where the mining process is carried out with high-level machines, but in small scale mining where the process of mining is mainly manual, problems like back pain, upper and lower limb pain are some common health issues among the miners.

Bloch et al. (2018) examined the mortality rate among the miners of the gold mine, platinum mines, and coal mines, the study states that the overall mortality rate in ex-miners is 20% higher than that of the general population. A comparison of mortality rates among the three types of mine reveals that gold mine workers have the highest mortality rate compared to platinum and coal mine workers. Corbett et al. (2000) and Churchyard et al. (2000) stated that the combination of silicosis and HIV infection is known to be a potent risk factor for incident tuberculosis among gold miners while miners with silicosis have been shown to have higher mortality rates while on tuberculosis treatment than miners without silicosis.

The present study also attempts to highlight the health issues of the coal mine workers, but the difference is that the coal mines under consideration in this study are not legalized coal mines. The coal mines of Meghalaya are mostly privately owned, where the owner is more concerned with profit and less concerned about the wellbeing of the workers. A lot of studies have been done on the health issue of coal mine workers but very few studies relating to rat-hole coal mine workers have been carried out so far. Although rat-hole coal mining has been banned in 2014 due to environmental damage, later in the year 2019 the Supreme Court of India passed an order to reopen mining in the state, with some changes in its operation rules (Sithou 2019). Now it is indeed a matter of concern to observe and bring real changes in the working of rat-hole mines with the adoption of the more environmentally friendly method of mining and better condition of working for the good health of the workers.

**Objective and Methodology.** This study intended to bring out a picture of the private coal mines in the South Garo Hills and to highlight the socio-economic profile of the workers and the various health problems faced by the coal mine workers. The study has been carried out in the South Garo Hills District, Meghalaya. All the Primary Data has been collected through personal interviews with a structured questionnaire from the sample size of 110 coal mine workers who are selected purposively. The questionnaire mostly consists of questions relating to the socio-economic profile of the workers, working conditions of the worksite, and the health problems faced by the workers of the coal mine in the area. A logit regression model is used to analyze the significant impact of the factors like age, gender, working hours, leisure time, the smoking habit of the workers, alcoholic habit, and the dependent dummy variables are respiratory diseases, back pain, hearing problems, indigestion problems, and skin problems. As there are five dummy independent variables, five logit regression models have been formulated to analyze the data, and in each model, the independent variables (age, gender, working hours, leisure hours, etc.) are the same, only the dependent dummy variables differ from one regression model to the other. The dependent variables are further categorized as individual habits (like smoking, alcohol), demographic (gender, age), working environment (working hour, leisure time, years of involvement in coal mining), and household factor (type of fuel used).

## **Findings and Discussion**

**Socio- Demographic Information.** This study reveals that out of the total sample around 58 % of respondents belong to the age group of 20 to 35 years. A gender-wise analysis reveals that 78 percent of

respondents were male and 12 percent were female. The males are engaged in digging and mining and the women are mainly engaged in carrying the coal from the mining site to the roadside. The education level of the worker reveals that 30 percent of them are illiterate, 52 percent are illiterate but most of them are up to the primary level of education and only 8 percent are class X passes. The category-wise distribution shows that 67 percent of respondents belong to Schedule Tribe (Garo, Bodo, Rabha, Kachari, Hajong, etc) and 33 percent of respondents belong to General Category. Most of the workers of coal mines in the South Garo hill district are migrated from different places. Among the 110 respondents, 52 percent of the respondents were from different places of Assam, like Goalpara and Dhubri. 15 percent of the respondents are from Nepal and 25 percent from different places of Meghalaya such as North Garo Hills, West Garo Hills, and West Khasi Hills, and only 8 percent of respondents are local. The wage rate of the coal mines is not regulated, there is a wide variation in wage rate paid to the workers, it ranges from Rs 300 to Rs 1200 per day. The wage rate varies on basis of the type of works and the working hours in the coal mine and also based on tonnes of coal extracted. The wage rates of women are less than the male as they are not involved in digging but only in carrying the extracted coal from the worksite to the roadside for loading them in the vehicle.

**The Health problem of Coal mine workers.** This study found that the common health problem suffered the coal mine of the area are back pain, respiratory diseases, indigestion, hearing loss, and skin problem, the following table holds descriptive statistics of the samples with regards to the various health problems.

Table 1: Descriptive Statistics of the data relating to various health problems suffered by the respondents					
Health issues	N	Sum	Mean	Std deviation	Variance
Respiratory	110	70	.64	.483	.234
Back pain	110	78	.71	.456	.208
Hearing problem	110	48	.44	.498	.248
Indigestion	110	44	.40	.492	.242
Skin problem	110	63	.57	.497	.247
Source: Field survey					

The descriptive statistics reveal that on average around 71 percent of the respondents suffer from back pain, followed by 64 percent suffering from respiratory problems and 57 percentages of the respondents suffer from skin problems. The value of standard deviation and variance is lower than 50, which indicates that the samples are closed to the mean value.

**Logit regression model.** The logit model of regression is given below, as there are five dependent dummy variables we have five different equations, but the independent variables are the same in all these five equations

$$Y_1 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \quad (1)$$

$$Y_2 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \quad (2)$$

$$Y_3 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \quad (3)$$

$$Y_4 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \quad (4)$$

$$Y_5 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \quad (5)$$

The model is presented in five equations (1) to (5) where the dependent variables stand for

$Y_1$ = Respiratory disease

$Y_2$ = Back pain

$Y_3$ =Hearing problem

$Y_4$ = Indigestion

$Y_5$ = Skin disease

In all the equations the independent variables are same,

$D_1$ = Smoking habit

$D_2$  = Alcoholic

$D_3$  = Gender

$X_1$ = Age

$X_2$ = working hours

$X_3$ = leisure time

$X_4$ = years of involvement in coal mine

$X_5$  = Type of fuel used for cooking

And  $\alpha$  =constant,  $\beta$  = coefficient

**Respiratory disease**

$$Y_1 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \quad (1)$$

Table 2:Logit analysis result of Respiratory disease					
Variables	B	S.E	Wald	Sig	Exp(B)
Smoking	-1.236	.631	3.834	.050	.290
Alcoholic	-.817	.556	2.157	.142	.442
Gender	-1.685	.960	3.078	.079	.182
Age	-.045	.039	1.340	.247	.956
Working hours	.418	.141	8.820	.003	1.519
Leisure	.432	.186	5.419	.20	1.540
Years of Involvement	-.056	.072	.609	.435	.945
Type of fuel used	.094	.530	.031	.860	1.098
Constant	-.653	2.427	.072	.788	.520

The logit regression for respiratory problems among the workers shows that factors like smoking habit (individual habit) gender of the workers (demographic factor), working hours, and leisure time (working environment) have a significant impact on this health problem. The Exp (B) values for working hours and leisure time are (1.5) and (1.5) respectively which indicate that workers working for long working hours and fewer leisure hours have 2 times more possibility of having respiratory problems For the other variables smoking habit and gender the exp (B) value is .29 and .44 respectively. It can be stated that individual habits and working environment have a more significant impact than the demographic factor.

**Back pain**

$$Y_2 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \quad (2)$$

Variables	B	S.E	Wald	Sig	Exp(B)
Smoking	-.999	-.562	3.154	.076	.368
Alcoholic	-.390	.567	.473	.492	.672
Gender	-.877	1.171	.555	.456	.418
Age	-.114	.041	7.722	.005	.892
Working hour	-.086	.119	.526	.468	.917
Leisure	.057	.057	.171	.740	1.058
Years of Involvement	.175	.079	4.945	.026	1.192
Type of fuel used	1.413	.548	6.638	.010	4.108
Constant	-.130	2.419	.003	.957	.878

Regarding the back pain problem, the analysis shows that smoking habits, age of the workers, numbers of years engaged in the coal mine, and the type of fuel they used have a significant impact on back pain. The rat-hole coal mine has narrow holes through which the workers enter and have to remain in a bending posture for a long period this leads to back pain for most of the workers. so as the number of years involved in coal mine increases the possibility of suffering from back pain is about 1 time more than the other workers as denoted by exp (b) 1.1. A study by the National Institute of Neurological Disorders and Stroke (NINDS) in the year 2020 found that Smoking reduces calcium absorption and prevents new bone growth, leaving smokers with an increased risk for osteoporosis (brittle, fragile bones) and slower healing after bone fractures, which can cause back pain. Another study by B.N Green and et al (2016) reveals that there is a significant association between back pain and smoking, it has been observed that the back pain increases with an increase in smoking. In this study also the logit analysis shows that smoking is a significant factor that leads to back pain. Fuel used in their residents for cooking is also a significant factor, majority of the workers use firewood as the cooking fuel, which releases some harmful gases and cause indoor air pollution, chronic exposure to those gases might lead to various health problems including back pain, chest pain, and other breathing problems. The exp (b) indicates that there is 4 times more possibility of suffering from back pain if they used firewood as fuel. , Age is also a general factor that leads to back pain, so also here age is a significant factor but here most of the workers are at the age of 25 to 40 years, so it seems that they get the problem of back pain at a quite early age due to their working environment where they spend of their time. The result shows that demographic factors (age) and working environment (Years of involvement in the coal mine) have a more significant impact compared to individual habits (smoking)

**Hearing problem**

$$Y_3 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \quad (3)$$

Variables	B	S.E	Wald	Sig	Exp(B)
Smoking	-.999	-.562	3.154	.076	.368
Alcoholic	-.390	.567	.473	.492	.672
Gender	1.527	1.195	1.631	.202	4.602
Age	-.114	.041	7.722	.005	.892
Working hours	-.086	.119	.526	.468	.917
Leisure	.057	.057	.171	.740	1.058
Years of Involvement	.175	.079	4.945	.026	1.192
Type of fuel used	1.413	.548	6.638	.010	4.108
Constant	-.130	2.419	.003	.957	.878

Another health problem associated with coal mines is hearing loss as pointed by McBride, (2004) that which has been a common issue among coal mine workers. The present study also that a sizable number of sample complain of hearing loss and the regression analysis reveals that the factors smoking habit, age of the workers, years of involvement in a coal mine, and the type of fuel used for cooking have some impact on the hearing loss of the workers. Age is a generally accepted factor for loss of hearing, but here the age of sample respondents are not more than 45, so it indicates that the coal mine workers face the problem of loss of hearing power at an early age, this type of hearing loss is called noise-induced hearing loss (NIHL), it can be temporary or permanent depending on the degree of noise a worker is an exposure to. The number of years involved in the coal mine is also one of the factors that have a significant impact on hearing loss, it is obvious that as the number of years in coal mine increases the duration of exposure to harmful noise levels increases and therefore more probability of suffering from hearing loss is one time more than the others, as indicated by the Exp (B) value 1.2. Smoking habits and the type of fuel used for cooking also seem to be significant factors. Smoking habit is also associated with loss of hearing as found by some studies Y B Duthey(2013) and Sun & Azman(2018) have found that the harmful gases emitted by burning firewood are also a cause of hearing loss. The present study also found that smoking and firewood fuel is a significant factor with Exp (B) value for fuel used is 4.1, which implies that the possibility of hearing loss is four times more for those who use firewood as cooking fuel than the others who do not use firewood as fuel. Relating to the hearing problem the result reveals that demographic factors (age) have a more significant impact than other factors like individual habits, working environment.

**Indigestion problem**

$$Y_4 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \tag{4}$$

Variables	B	S.E	Wald	Sig	Exp(B)
Smoking	-.513	.695	.543	.461	.599
Alcoholic	3.344	.739	20.488	.000	28.238
Gender	-.877	1.171	.555	.456	.418
Age	-.135	.047	8.298	.004	.874
Working hour	.240	.134	3.203	.073	1.272
Leisure	.255	.196	1.655	.193	1.287
Years of Involvement	.141	.079	3.230	.072	1.152
Type of fuel used	-.092	.651	.020	.888	.912
Constant	-.142	2.642	.024	.876	.662

The coal mine working also suffers from frequent indigestion problems, the gas mainly the carbon monoxide in coal mine cause breathing problems along with vomiting tendency among several coal miners. Here the analysis reveals that alcoholic habits, age of the workers, working hours, and years of involvement in the coal mine are significant factors. Alcoholic workers have 28 times more possibility of having Indigestion problem than nonalcoholics. Age is also a significant factor, but the relation between coefficient (B) and exp (B) reveals a negative relation between vomiting tendency and age, it implies that the younger workers have nearly one time more probability of suffering from indigestion problem compared to the aged workers. The exp (B) for the working hours and years of involvement indicated that as this value increases the possibility of suffering from vomiting tendency is one time more than those who have short working hours. The result reveals that among the factors the individual habit (consumption of Alcohol) is significantly associated with the indigestion problem among the coal mine workers.

## Skin problem

$$Y_5 = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 X_1 + \beta_5 X_2 + \beta_6 X_3 + \beta_7 X_4 + \beta_8 X_5 \quad (5)$$

Variables	B	S.E	Wald	Sig	Exp(B)
Smoking	1.036	.511	4.101	.043	-2.817
Alcoholic	-.973	.552	3.112	.078	.378
Gender	-.028	.029	.923	.337	.973
Age	-.904	.886	1.042	.307	2.471
Working hour	.252	.115	4.798	.028	1.287
Leisure	.323	.163	3.908	.048	1.381
Years of Involvement	.171	.063	7.232	.007	1.186
Type of fuel used	.078	.516	.023	.880	1.081
Constant	-6.653	2.368	6.533	.011	.002

The logit regression for skin problems shows that smoking habits, working hours, leisure time, and years of involvement in the coal mine are significant factors. The exp (B) for smoking indicated that a worker who smokes has almost three times more possibility of having skin problems than non-smokers. For the other significant factors namely working hours, leisure time, and years of involvement in the coal mine, the exp(B) value is 1, which implies that workers with long working hours, less leisure time, and many years of involvement in coal mines are likely to have one time more probability to suffer from skin diseases. Among all the factors it shows that the years of involvement in the coal mine (working environment) have a significant impact on the skin of the workers.

**Conclusion.** Meghalaya coal mining is not under any regulations, the mining policy drafted in 2012 is not yet implemented. It is only when the All Dimasa Students Union and the DimaHzaao District Committee highlighted the unscientific and unregulated rat-hole coal mining operations in the Jaintia Hills, the National Green Tribunal on 2014 banned rat-hole coal mining, but unfortunately, it is still running due to the influence of some powerful owners and politicians. The occurrence of the tragic accident in an illegal rat-hole coal mine in East Jaintia hill of Meghalaya gives evidence that despite the ban on rat-hole mining it is continuing in the area (Singh, 2018). The mining activity in Meghalaya is an important economic activity generating a good amount of revenue for the government that cannot afford to be suspended for a longer period, the state has to formulate a proper scientific mining process, to revive the economic activity of the state. The new policy for mining has to focus on being environmentally friendly and ensuring safe working conditions for the workers (Sitlhou 2019). This study is expected to highlight some important areas to be a focus in the formulation of mining policy especially the health status of the workers along with environmental protection measures. The working hours, safety measures, insurance of workers, first aid facility, etc. need to be the impetus in the mining policy. All the workers in illegal mining risk their lives as they have no other option of livelihood, and the mine owner takes full advantage of their situation by exploiting them to the possible extend. The recent incident of December 2018 in Jaintia Hills is evidence of this exploitation where the owners do not even maintain a proper record of the number of workers going to dig the coal through that rat hole and are not in a position to give an accurate number of workers who are trapped in the coal mine on the particular tragic incident of December 2018. Apart from this incident that has been reported but there might be several such incidences where the workers never return from the mine but unfortunately those cases were never reported over the years (Bose 2018). The present analysis also reveals that apart from workplace conditions some individual habits like smoking and alcohol habit of the workers and the household type of fuel used for cooking also have a significant impact on some of the health problems like hearing loss, indigestion, and back pain. The policymakers should also focus on the other



facilities like proper quarter facilities, drinking water supply, and fuel for cooking purposes, etc. along with the implementation of regulated and scientific mining techniques.

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