HEALTH AND ENVIRONMENTAL IMPACTS OF COAL MINING

A study
of the health of people
living close to mines
in Ramgarh district

Jharkhand

February 2021

Authors

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Acknowledgements

We are pleased to present this significant study of the human and environmental consequences of extensive and poorly monitored coal mining operations in Ramgarh district of Jharkhand, India. Our findings throw light on potentially lethal and unsustainable mining practices that are fast destroying our health, environment, and land and forest resources farmed by local tribal people for generations.

Health and Environmental Impact of Coal Mining; a study of the health of people living close to mines in Ramgarh district, Jharkhand draws upon the outstanding collective skills of local, Indian and international professionals, researchers, environmentalists, technical experts and residents of Charhi, Durukasmar, Parej, Tapin, Dudhmatia who not only participated in the study, but, alongside local institutions and organisations, helped make it happen. All are owed a debt of gratitude. We look forward to continuing our meaningful collaboration for further studies.

Our study would be incomplete without the contributions of Shweta Narayan of Healthy Energy Initiative & Community Environmental Monitoring's July 2019 environmental study, 'Biting the Dust'. A team of doctors from Kolkata, Dr V Indrani, Dr Protim Roy and Dr Smarajit Jana, conducted medical examinations for this study in temporary clinical facilities.

We would like to extend our gratitude to the team from BIRSA (Ranchi) for facilitating the local meetings. We would also like to thank the team from State Health Resource Centre, Chhattisgarh, and their field team members Punita Kumar and Nutan Prabha Dungdung in training the community members in conducting the survey. We would like to thank Dr Vishvaja Sambath of Healthy Energy Initiative in assisting us with data analysis for the report.

Finally, we are grateful to the team in Charhi, Deoghar and West Singhbhum for assisting in data collection in a timely manner, making this study possible.

Authors
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A Note from the Authors

The unprecedented Covid-19 pandemic and subsequent lockdown measures have affected people across the world. Routine activities are yet to return to normal. This study too has been affected for the same reason. The majority of the study, at the affected site and one of the comparison sites, was conducted before the lockdown was imposed. While we complete the unfinished tasks, namely conducting environmental assessments at the second comparison site and preparing the final report, we present the findings of the study in its current form as an interim report.

The main objective of the study is to understand the health status of people living near mines and associated industries in Charhi, near the town of Hazaribagh, Jharkhand, and to draw a profile of toxic pollutants in air, soil and water in the area so that the impact of coal is better understood.

The study comprises the documenting of health problems of residents (self-reporting as well as clinical examinations) in villages near Charhi and in two comparison sites, namely the district of Deoghar with no mines within 40 kilometres, and in West Singbhum where the selected villages are about 20 kilometres from iron ore mines. We are yet to study the toxic pollutants at the comparison site villages in West Singbhum but the preliminary findings from the household survey indicate that the residents at that site are not any different with respect to health complaints than those in Charhi who live close to coal mines.

The study team therefore felt that it would be prudent to present the findings of the study site i.e., people living in close proximity to coal mines, comparing with that of communities living with no mines nearby as a separate report while we further explored the pollutants and their impacts at the site in West Singbhum. This interim report therefore presents the toxic profile and its impact on residents in the Charhi area in Ramgarh district, and also comparing it with that of Deoghar district which has no mines nearby. Although described as an interim report, the report itself is a complete study in its own right.

We will however present another report, the final report, after looking into the pollutants and health impacts closely at the site in West Singbhum which is not too far from iron ore mines.

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Executive Summary

Jharkhand is one of the key coal producing states in India, producing 126.4 million tonnes (Mt) in 2016-17 i.e., which is over 19% of the total production in the country for the period. Of this, 13% of coal was extracted in Ramgarh itself. With huge reserves of coal spread across the country, Jharkhand remains at the top of the list of coal producing states in India – the largest concentration being in Ramgarh and adjacent two districts, Hazaribagh and Bokaro.

This health and environment study has been conducted in remote rural areas of the Mandu block of Ramgarh district, about 45 kilometres from Ranchi, the capital of Jharkhand. Ramgarh and adjacent districts like Hazaribagh and Bokaro, stretching up to Dhanbad, and the districts of Purulia to Birbhum in West Bengal, are traditionally known for their coal reserves or 'coalfields' and have been mined for decades. The expansion of mining in many of these areas is planned. Two companies – Central Coalfields Limited (CCL) and Tata Steel Limited (TSL) – are engaged in extraction activities at various coal 'blocks' in the district of Ramgarh, with CCL being the largest operator with an area of 260,000 ha (2,600 sq. km).

Charhi, Durukasmar, Parej, Tapin, Dudhmatia in the block are particularly affected –coal mines and coal washeries are close to these villages, some being as close as 50 meters from the mining operations. Residents of these villages complain of a range of health problems that they attribute to the pollutants from the nearby mines and washeries.

Adverse impacts of pollutants from coal mines on human health, particularly on respiratory and cardiovascular systems, are well documented, though less so on other systems or organs of human body. An earlier study of communities living next to coal mines in Chhattisgarh confirms specific health problems affecting a range of organs namely skin, joints, hair, eyes and abdomen, and that chronic debilitating diseases like tuberculosis are significantly higher than the national averages. The current study sets out to explore impacts of coal mining on the health of the populations living near mines, irrespective of their occupation.

This study was conducted predominantly among populations living within 5 kilometres of coal mines in Mandu block of Ramgarh district. It comprised three components:

1. Collecting of samples in the air, land and water that the residents of the villages are exposed to, and testing these samples with standard laboratory procedure to assess the levels of toxic contaminants.
2. Documenting of health complaints of residents of these villages using a set of pre-tested questionnaires and maintaining standard techniques.
3. Validating of these health complaints by a team of experienced health professionals through clinical examination, and where applicable, supported by laboratory investigations.

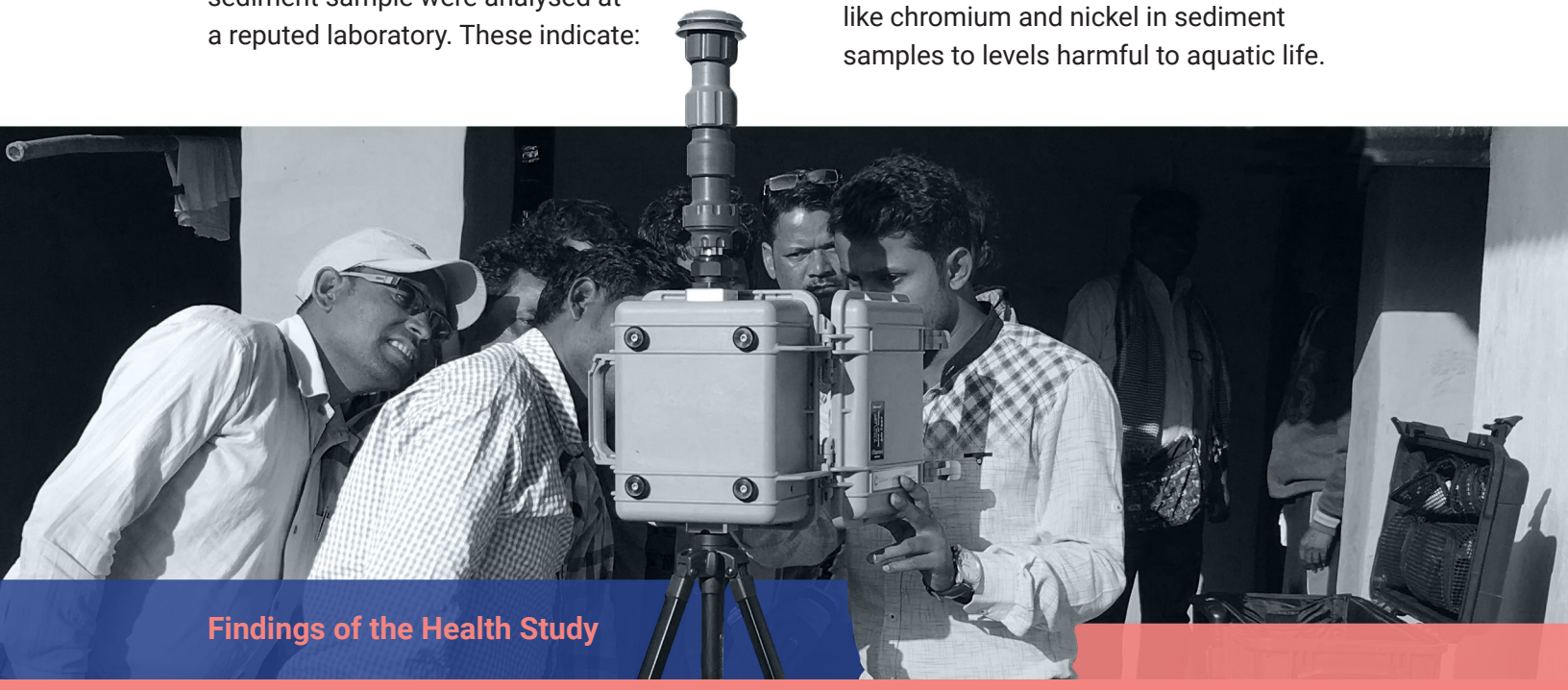
In addition to collecting information on the health complaints of the residents – symptoms related to respiratory, cardiovascular, musculoskeletal, gastrointestinal systems, and symptoms of eyes, skin and hair problems – the survey has documented the demographic and socio-economic status of the population, their water usage, smoking habits, and exposure to coal smoke/dust through cooking or other means.

The findings from the study site were compared with findings at a comparison site (Deoghar district) where the population belonged to similar ethnic, social and economic backgrounds but with minimum exposure to coal-related pollutants (as the nearest coal mines are at a distance of about 40 kms).

Results of Environmental Sampling at the Study Site

The analyses of air, water, soil and sediment samples in and around Durukasmar, Tapin, Dudhmatia, and Charhi villages *at the study site show severe contamination with various toxic heavy metals*. A total of 5 air samples, 8 water samples, 5 soil samples, and 1 sediment sample were analysed at a reputed laboratory. These indicate:

- the presence of PM 2.5 in air samples at levels above the Indian, World Health Organization and US EPA regulatory guidelines. Toxic heavy metals like manganese, nickel and silicon are also found in the air at levels above the health-based guideline limits.
- toxic metals like chromium, vanadium, nickel, arsenic and cadmium, in soil samples above the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health standards.
- toxic heavy metals such as aluminium, iron, manganese, total dissolved solids and total hardness in water above the Indian drinking water standards or the Canadian Council of the Ministers for the Environment guidelines; the presence of toxic chemicals like chromium and nickel in sediment samples to levels harmful to aquatic life.



Findings of the Health Study

The health problems reported by the respondents– respiratory (bronchitis, asthma and chronic obstructive lung or cardiovascular), of skin (dark patch), eye (watering and/or redness), hair (hair fall/loss), foot/sole (crack sole), or musculoskeletal (body/back ache and large joint pain) and abdominal – are in higher proportion at the study site than at the comparison site where there is no mining activity within 40 kilometres.

Overall, the study reveals:

- A variety of health complaints – respiratory and musculoskeletal issues, skin problems, hair fall, and cracked soles are in higher proportion at the study site than at the comparison site.
- The health complaints are mostly chronic in nature, and inflammatory rather than infectious. In other words, the causal agents are possibly environmental rather than microbial.
- Respiratory complaints like cough – with or without shortness of breath – and heaviness in the chest indicate the possibility of repeated exposure to pollutants from the surrounding mining operations at the study site nearby.
- The occurrences of skin-eye-hair-sole group of complaints at the study site are significantly high, possibly due to contact exposures to hazardous pollutants.
- Musculoskeletal complaints, like arthritis, among the younger age groups at the study site, are of serious concern and warrant further investigations.

Recommendations

The findings of the environmental and health assessment in the study site indicate that toxic chemicals and heavy metals are present in higher proportions in residential areas near coal mines; that communities living in the area are exposed to such toxic materials; that communities at the study site suffer from health problems in significantly higher proportions than those living further away from coal mines or coal-associated activities; and finally, the health problems suffered by the communities are predominantly due to exposure to toxic material from coal mines. Based on our findings we recommend the following:

A. Health

1. State agencies should initiate a thorough study and regular monitoring of health of residents of Charhi affected due to coal mines.
2. The state government should look into the coal and associated industries in Charhi, and introduce a necessary health mitigation plan for the region.
3. The state health department should set up specialised health care facilities to cater to the health issues of residents in the Charhi area, with costs borne by the polluters.

B. Environment

1. Complete moratorium on further expansion of industries or setting up of new polluting industries in the region till an acceptable standard of environment and health is restored.
2. Scientific remediation and restoration of the environment in the region (including water and soil clean ups) at the cost of the polluting facilities, under polluter pay principle.
3. Mandatory Health Impact Assessments as part of the commissioning of any new industries along with EIAs, both at baseline and interim time-points.
4. Continuous monitoring of PM2.5 and heavy metals in dust from the mines by the state and central Pollution Control Boards, and their results published periodically, along with regular engagement with reputable health agencies for issuing health advice.
5. Use of pollution data by appropriate agencies to apprehend polluters and take corrective action to bring levels of dust and heavy metals in dust to below detection limits in residential areas.

Introduction

1.0

Despite the fact that coal is a hazardous fossil fuel – from mining, washing, and transportation to its end-use like electricity generation or for blasting furnaces – and the fact that the whole operation is immensely damaging (both to the environment and to the people engaged in mining or those who live close to mines), the extraction of coal continues in countries like India. A recent study in Chhattisgarh, conducted by a team of environmentalists and health professionals, has looked into the extent of pollutants in air, soil and water (both surface and underground) as well as their impacts on communities living near coal mines and thermal power plants. The findings were alarming and led the government to set up a commission that acknowledged the damaging health impacts revealed in the study. Yet the excavation of coal continues.

With this study in mind, a similar study was conducted in 2019-20 in the state of Jharkhand, whose findings this document elaborates. Jharkhand, which shares more than just a border with Chhattisgarh, is known for its abundant reserves of coal and other minerals. Like Chhattisgarh, Jharkhand too is home to indigenous populations living in hamlets among the forests and hills where such mineral reserves exist.

1.1 Jharkhand and Coal Reserve

Jharkhand is one of the key coal producing states in India, producing 126.4 million tonnes (Mt) in 2016-17 i.e., over 19% of the total production in the country in that year, of which 13% of coal was excavated in Ramgarh itself. Despite huge reserves of coal spread across the country, Jharkhand remains at the top of the list of coal producing states in India – the largest concentration being in Ramgarh and adjacent two districts – Hazaribagh and Bokaro. According to the Geological Survey of India, of the total 'proved' reserve of 148,787 million tonnes of coal in India, Jharkhand itself has 45,563 million tonnes, i.e., over 30% of the reserve (according to a survey carried out in 2018).

In order to reduce the import of large quantities of coal, India is opting for commercial mining by opening auctions to private companies. Of the 41 coal blocks identified in Jharkhand, Chhattisgarh, Odisha, Madhya Pradesh and Maharashtra for this

purpose, Jharkhand itself has 9 blocks to be mined by the private sector. It is estimated that these coal blocks in Jharkhand will contribute 37 million tonnes per annum. Environmentalists have raised concerns over such an 'aggressive' mining policy on India's part, at a time when many countries are phasing out coal mining in order to reduce carbon pollution.

1.2 Ramgarh District, Coal Mines and the Study Site

This study has been conducted in remote rural areas of the Mandu block of Ramgarh district, about 45 kilometres from Ranchi, the capital of Jharkhand. Ramgarh and adjacent districts like Hazaribagh and Bokaro, stretching up to Dhanbad, and the districts from Purulia to Birbhum in West Bengal, are traditionally known for their coal reserves or 'coalfields' and have been mined for decades. The expansion of mining in many of these areas is planned.

Two companies, Central Coalfields Limited (CCL) and Tata Steel Limited (TSL) are engaged in excavation activities at various 'coal blocks' in the district of Ramgarh, the former being the largest operator spreading its operation over an area of 260,000 ha (2,600 sq. km). Of the six administrative blocks of the district, Mandu, Patratu, Chitarpur and Ramgarh are majorly mined, and Mandu tops the list with its huge coal reserves. CCL is in action in 14 mines, opencast and underground inclusive, in Patratu, Chitarpur, Mandu and Ramgarh blocks. During 2016-2017, CCL's coal production in India was 67 Mt, of which about 17% came from Ramgarh district alone. TSL's coal mine in Ghatotand (West Bokaro coalfields), the only one in the district, is situated in the Mandu block.

Villages affected by coal mines are much higher in number in Mandu than other blocks of the district. Charhi, Durukasmar, Parej, Tapin, Dudhmatia in the block are particularly affected as coal mines and coal washeries are close to these villages, with some at a distance of just 50 meters from mining operations. During a research visit prior to the study, residents complained of a range of health problems that they attribute to the pollutants from the nearby mines and washeries. Readers may refer to Map 1 showing the aerial view of mines near these villages, and Tables 1 and 2 below.

Table 1: Annual coal production in Ramgarh district (2016-2017)

Mining Companies	Production of Coal (Mt)
Central Coalfields Limited	11.57
Tata Steel Limited	4.98
Total	16.55

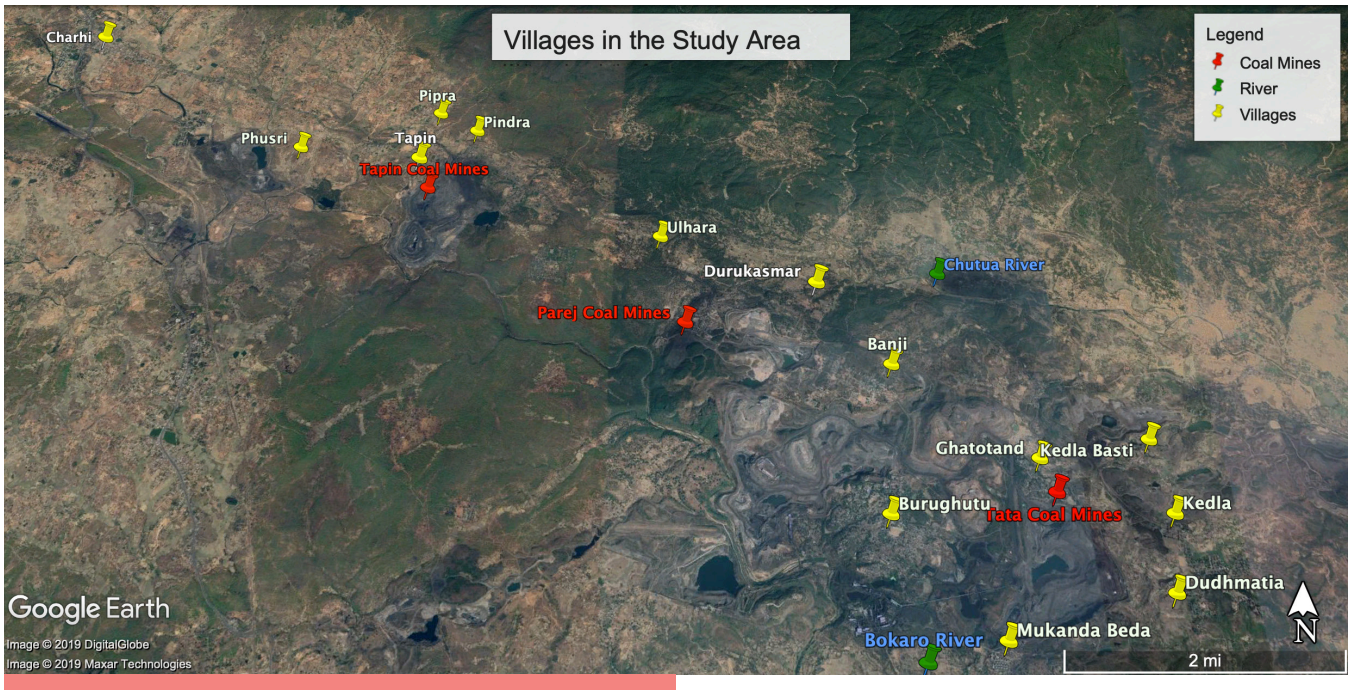
Source: Center for Science and Environment, 2017

Table 2: Coalmines in Ramgarh district

Mining Company	Block	Projects
Central Coalfields Limited (CCL)	Patratu	Sounda D; Bhurkunda
	Mandu	Pindra; Topa; Hesagada; Pundi; Karma; Tapin North; Tapin South; Parej; Kedla
	Chitarpur	Rajrappa
	Ramgarh	Sirka; Argadda
Tata Steel Limited (TSL)	Mandu	West Bokaro coalfields, Ghatotand

Source: Center for Science and Environment, 2017

Map 1: Villages in the Study Area



Purpose of the Study

2.0

The mining of coal is a dangerous and hazardous operation, particularly in the popular 'opencast' form. It is an established fact. Activities associated with extracted coal – from washing to transportation and industrial usage, i.e., the combustion of coal, produce solid wastes in the form of dust and coal ash – emit highly toxic gaseous by products into the atmosphere. Various studies in coal producing countries across the world, including India, have shown that the toxic pollutants released from coal comprise heavy metals like arsenic, chromium, lead, mercury in bulky solid wastes, dusts and in atmospheric particulate matters (PM2.5[1]), and sulphur dioxide (SO_2), nitrogen oxides (NO_x) and ozone in gaseous emissions.

Adverse impacts of the above pollutants on human health, particularly on respiratory and cardiovascular systems[2], are well documented, less so though on other systems or organs of the human body[3]. In India, the study conducted recently on populations living near coal mines (The Health and Environment Impact of Coal Mining in Chhattisgarh[4]) has revealed specific health problems affecting a range of organs namely skin, joints, hair, eyes and abdominal organs, and that chronic debilitating diseases like tuberculosis are significantly higher than the national averages. The study mentioned raises the question of whether the suppression of immunity induced by coal-associated pollutants is linked to multi-organ impact that is observed in that population, and indicates the need for further exploring this new area of toxicology and occupational health. The proposed study, on the other hand, is not designed to explore this further. While mining related studies often focus on the adverse impacts of mining (vis-à-vis pollutants) on the health of miners, the proposed study focuses, instead, on populations living near mines irrespective of their occupation, making for a more significant study.

1 Particulate Matter of diameter 2.5 micron or less.
2 https://www.sciencedirect.com/science/article/pii/S2300396017300551
3 https://noharm-uscanada.org/sites/default/files/documents-files/828/Health_Effects_Coal_Use_Energy_Generation.pdf
4 The Health and Environment Impact of Coal Mining in Chhattisgarh; November 2017; https://pfcollectiveindia.files.wordpress.com/2017/11/raigarh_report_final-2.pdf

The study is designed to investigate toxic heavy metals in air, soil and water in residential areas near coal mines in Mandu block; whether communities living close to the mines are exposed to such toxic materials; and whether residents show adverse health effects that they would not have experienced had they lived far from mines and associated activities.

In summary, the study is to explore reasonable answers to the following questions:

1. Does the study area present toxic chemicals and heavy metals in higher-than-normal proportions?
2. How do we know that the communities living in the area are exposed to such toxic materials?
3. Do communities at the study site suffer from health problems in significantly higher proportions than those living further away from coal mines or coal-associated activities?
4. Finally, are the health problems due to the exposure to toxic materials from coal mines, and not other causes?

2.1 Methodology

With the above questions in mind, the research study has been conducted among populations living close to coal mines (within 5 kilometres) in the Mandu block of Ramgarh district, and comprised three components:

1. Collection of samples in air, land and water that the residents of the villages are exposed to, and testing of the samples with standard laboratory procedures
2. Documentation of health complaints of residents of the said villages using a set of pre-tested questionnaires and maintaining standard techniques
3. Validation of the health complaints by a team of experienced health professionals through clinical examination, and where applicable, supported by laboratory investigations.

A set of structured questionnaires was prepared and a house-to-house survey was conducted among residents in villages of Durukasmar, Tapin, Dudhmatia, Charhi at the study site; a similar survey was conducted in selected villages at the comparison site. The survey has documented the demographics and socio-economic status of the population, their water usage, exposure to coal smoke/dust through cooking or other means, and personal habits in order to explore if they might have any bearing on the respondents' health complaints. The questionnaire about health complaints gathered data that included symptoms of respiratory, cardiovascular, musculoskeletal, gastrointestinal systems, and symptoms of eyes, skin and hair.

Variables and Comparisons

In order to investigate if the health complaints were connected to the residents' regular exposure to coal-related pollutants and not due to other factors, the selection of respondents and questions was set accordingly: e.g., permanent residents living for a period of minimum 6 months prior to the study; questions related to occupational exposure if any; also, potentially impacting factors like water usage, cooking fuel exposure, smoking habits. The efficacy of the questionnaire was assured as the questions were applied in a similar previous study that was successful and acknowledged by

the courts and the government[5]. Finally, the study findings were compared with findings at a comparison site where the population belonged to similar ethnic, social and economic backgrounds but with minimum exposure to coal-related pollutants.

In addition, another study was conducted at a third site with a population of similar ethnic, social and economic backgrounds but with possibilities of exposure to non-coal pollutants.

In summary, the study was planned at three sites: a) a coal mine exposure site or the 'study site'; b) a no-mine exposure site or the 'comparison site'; c) a non-coal but mine exposure site, or an 'additional site':

- Villages in the Mandu block of Ramgarh with coal mines within 5 kilometres. – *the study site*;
- Villages in the district of Deoghar with no mining activities within 40 kilometres as *the comparison site*; and
- Willages in the district of West Singhbhum with iron mines about 20 kilometres away - the additional site'.

This report does not include the findings from the 'additional site (please refer to the 'note from authors page iv.).

Sample Size, Sampling Method and Data Collection

In order to calculate the sample size with statistical significance, the study refers to a similar recent study conducted in Chhattisgarh with similar variables – both demographic and environmental. The adverse health impacts of interest to the study, namely in the respiratory, musculoskeletal, dermatological, ophthalmological and abdominal regions, were prevalent in between 10% and 60% of the total population of the mentioned study. Thus, taking the lowest prevalence (i.e., 10%) of the estimated total population (4500) in the villages of the study, and taking into consideration the confidence level at 95%, and adjusting 10% possibilities of non-participation and no responses, the sample size was calculated (using Epi-info package) to be 542.

The data has been collected on Android mobile phones using the Kobo Collect application, transferred to MS Excel format, and analysed with IBM SPSS v19. The categorical variables are expressed in proportions and continuous variables are expressed in mean (SD) or median (IQR).

Finally, the study has been conducted after securing the approval of an ethics committee designated for the purpose, and the procedures were in accordance with necessary norms and requirements.

5 A copy of the questionnaire is available on request.

Findings

3.0

In the following sections, we present the demographics of the population under the study, and the self-reported health complaints of the respondents. Before we compare specific health issues between sites – in the 'Discussion', we first look into a range of associated information such as, socioeconomic, environmental, toxic pollutant levels in air, soil and water, followed by the health complaints of the respondents both at the 'study' and 'comparison' sites. The medical examination findings of respondents (examined by a competent medical team), both at the study and the comparison sites, validate the self-reported health complaints, and are presented in a separate section. The complaints are, in general, of a chronic nature. Therefore, the medical findings, though acquired 3 months or so after the dates of household surveys, are considered valid.

The participants at the study and the comparison sites are traditionally agriculture-dependent, and are mostly low-income vulnerable groups – the paddy yields have decreased over the years, and job opportunities have become scarce. The residents at the study site, particularly those living near coal mines, have been particularly affected either because they have lost their lands or productivity has reduced drastically. Very few have jobs in coal mines.

Of the 661 respondents at the Charhi site, only 59 households (less than 10%) work in coal mines or are engaged in related activities to earn a living (excluding those daily wage labourers who collect coal from 'illegal' sources and transport heavy loads by pushing along the roads on specially constructed bicycles to depots that are 30-40 kilometres away). Of the 59 respondents, the majority (46) work as loaders or in hazardous coal-washing plants. We will look at whether coal-related activities have aggravated the health problems of those specific individuals who participated in the study.

Similarly, the study has explored the sources of water that the respondents use for drinking and other household purposes, as also the types of fuel, coal-based or non-coal, that they burn for cooking purposes. We have looked at whether fuel usage bears additional impacts on health complaints, and if so, the extent to which it does.

3.1.1 Ethnicity, Occupation, Average Monthly Income

The total number of respondents at the study site in Ramgarh district was 661, the gender distribution (male/female) being 45% and 55% respectively. At the comparison site (Deoghar district), the number of respondents was 325 with almost equal gender ratio (the male/female distribution being 49% and 51% respectively).

Ethnicity

The majority of the population at the study site belongs to adivasi or indigenous communities – 62% of respondents; the rest 38% are dalits (the lowest caste) or belong to other backward classes (OBC). At the comparison site (Deoghar district) all but one of the 325 respondents are from adivasi communities. In summary, the respondents, both at the study and comparison sites, are similar to their ethnic origins, the majority being adivasi or from other marginalised communities.

The findings are presented below.

Occupation, average monthly income and household assets

As mentioned earlier, the inhabitants at the study and comparison sites are traditionally agriculture- and forest-dependent, but mines and associated industries have impacted their living and traditional practices in recent decades. Although the purpose of the study is to investigate the environmental and health impacts, rather than social impacts, we have looked into the economic status of the households in question, both at the study and comparison sites, to check if the reciprocity between the economy and health is equally valid in coal mine areas. For this purpose, we have made a basic investigation into the economic status of the households by using a simple questionnaire rather than opting for a detailed socio-economic survey.

For the population in question, the monthly earning itself is not a reasonable marker to determine the economic status of a family; also, it is not easy to establish their economic profiles by documenting monthly earnings because those earning are not '9 to 5' permanent employees, but daily wage labourers. The 'cash' earnings of such workers is dependent on the availability of 'work', the food reserve from previous harvests. One must also take into account the festive seasons when the communities in question do not look for jobs on roads or warehouses or building sites as they would do in other months of the year. Even so, the fact that 71% of the respondents at the study site earn less than Rs. 5,000 a month, and slightly higher at the comparison site (85%) (see the Chart 1 below) does reflect the poor economic status of the respondents. In addition to documenting monthly earnings, we have profiled households' assets in the form of bicycles, motorbikes or similar higher value essential items. Such profiling gives an indication of the economic levels, bicycles being the minimum asset followed by motorbike, or both, or in addition a tractor, an auto-rickshaw or a pump-set. The associated charts (Chart 2 and 3) indicate that the respondents at the study site are only marginally better off in terms of cash and such specific assets.

In a later section, we will analyse households' assets and relate them to their health complaints.

Chart 1: Monthly income/cash comparison – Study and Comparison sites

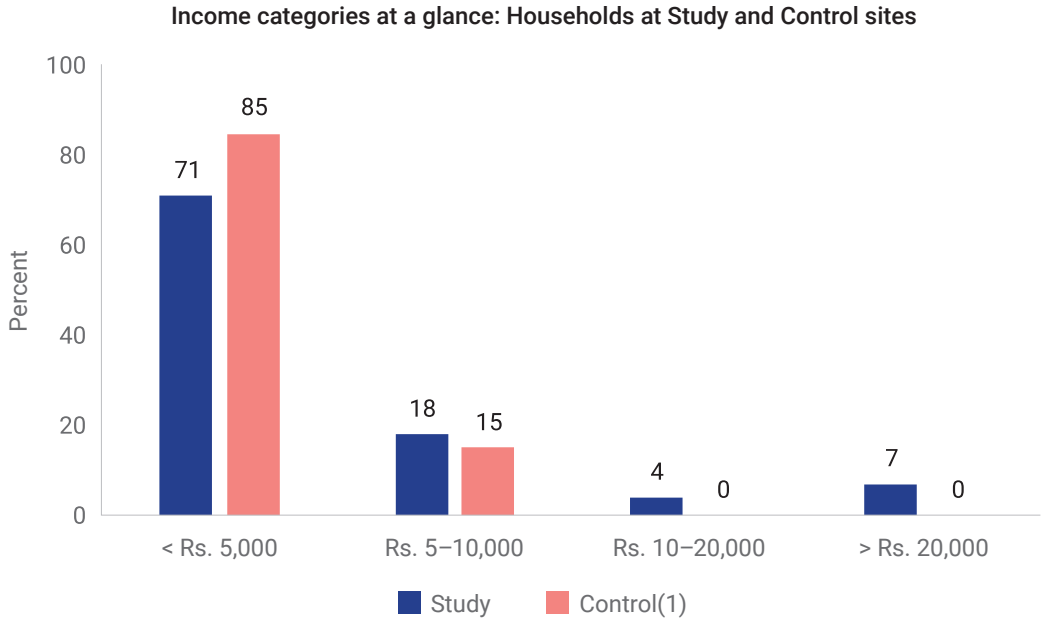
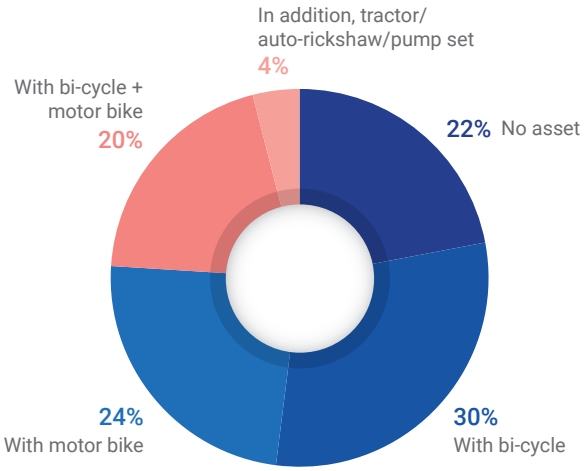
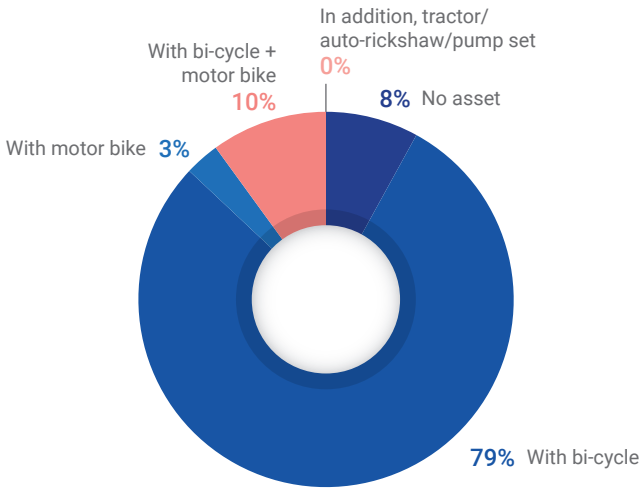


Chart 2: Asset overview (Study site)



Asset overview: Study site n = 573 (total respondents 661)

Chart 3: Asset overview (Comparison site)



Asset overview: Control site (1) n = 325 (total respondents 325)

3.1.2 Water Usage

While the study investigated the health status of populations living near coal mines, from the public health point of view it was imperative to look into the sources and quality of water, both for drinking and household purposes.

For the analysis, we have classified the water usages into the following combinations:

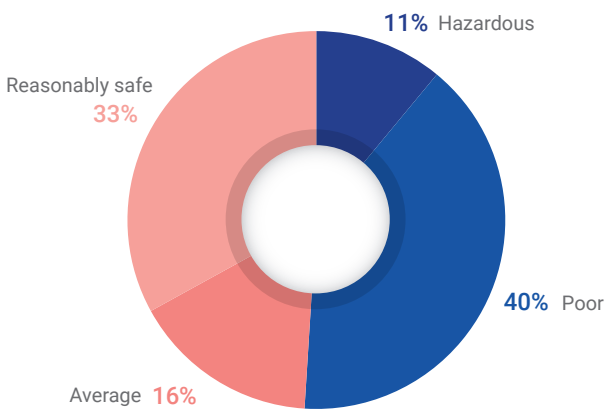
- *potentially hazardous* (pond or stream water for both drinking and bathing)
- *poor* (open well for drinking but pond or stream or well for bathing)

- *average* (underground water such as shallow tube well, deep bore well or tap water for drinking but open well for bathing)
- *reasonably safe* (underground water for both drinking and bathing)

Please note that water in rural India, particularly in remote places such as the study and comparison sites, is not treated for biological and chemical impurities or supplied to households through pipes. Charts 4 and 5 below present the usage of water and their quality at the study and the comparison sites respectively.

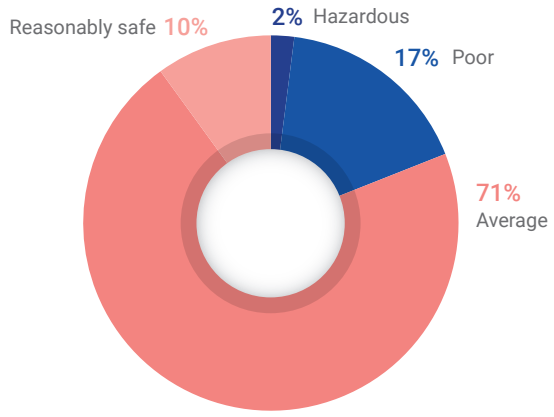
The quality of water, surface as well as underground, at the study site, if additionally contaminated with pollutants from mines and associated industries is likely to reflect in health complaints in stomach, skin and hair due to ingestion and/or contact. We will look at this closely at a later stage.

Chart 4: Water usage – Study site



Water usage (drinking + bathing):
Study site n = 651

Chart 5: Water usage – Comparison site 1 (Deoghar)



Water usage (drinking + bathing):
Comparison site-1 n = 322

These charts above indicate that only a third of the respondents at the study site use reasonably safe water, and half of the respondents opt for streams or ponds or open wells, classified as 'hazardous' or 'poor'. The pattern of water usage at the comparison site is different from that of the study site. With the social, economic and educational levels of the population at the study and the comparison sites being similar, the choice of using a pond or stream is more due to the convenience (in terms of ease of access) and abundance of water rather than households' awareness or hygiene practices – so is our understanding.

A number of respondents at the study site, particularly those who live close to coal mines, have reported that shallow tube wells often remained dry – due to the drawing of underground water table from wells towards the crater of the nearby opencast mines.

Health complaints of the households at the study site and the comparison site, when analysed and compared, will give a better clue about whether the waterborne health problems are due to general microbial contamination or toxic pollutants from nearby mines.

3.1.3 Fuel Usage

In order to understand if the fuel usage has an additional burden on the health complaints, we have grouped the fuel used by households into three categories: i) coal as cooking fuel, ii) coal and biofuel such as wood, cow dung or similar, and iii) biofuel only. Very few families (7 out of 661 at the study site; none at the comparison site) use liquid petroleum gas (LPG) as cooking fuel even though such fuel is made available to the communities in question at subsidised prices. Because of its statistical insignificance, we have ignored LPG in the analysis (Table 3 below).

3.1.4 Proximity to Coal Mines

At the study site, the majority of the respondents reside within a distance of 3 kilometres from coal mines or coal-associated activities; almost two-thirds live within a kilometre.

At the comparison site in the district of Deoghar, the nearest coal mine is more than 40 kilometres away.

Table 4 below gives an idea of the locations of households at the study site and their proximity to coal mines

3.2 Health Complaints

This section presents health problems commonly experienced by the households (respondents and family members). The health complaints have been recorded during the household surveys both at the study and comparison sites; that is to say, the complaints are self-reported, not clinically diagnosed. However, we have recorded only those for which the individuals had sought medical treatment – at a government health centre or a private clinic. In other words, the

Table 3: Fuel usage by households

Site		Fuel			Response/ non-response	Total
		Coal	Coal + Biofuel	Biofuel		
Study	N	407	234	20	661/0	661
	%	62%	35%	3%		
Comparison	No	0	0	303	303/22*	325
	%	1%	0%	99%		

* For simplicity purposes, non-response includes sole LPG and/or 'other' fuel usages.

Table 4: Households and proximity to coal mines at the Study site

Households	Distance				Total
	<500 M	500 M – <1 KM	1-3 KM	>3 KM (3-5 KM)	
N	224*	192	162	83	661
%	34%	29%	24%	13%	100

* 75 households reside within 500 miters from a coalmine.

health problems documented for analysis purposes must not be dismissed as 'trivial' simply because they are self-reported. We have compared the health complaints of respondents who live near mining operations with those who live away from mining activities. Only those complaints were recorded, which were no earlier than a year before the time of the interview.

In the 'Discussion' section, we will further scrutinize these complaints to find out the extent of the problems, their correlation with pollutants, occupation and economic status; and finally, will look at the validity of the self-reported complaints by correlating them with the professional medical assessment.

Frequency of Occurrence of a Range of Health Complaints

We have looked at the extent of occurrences of major health problems[6] of the residents living close to coal mines, grouping the complaints as follows: Bronchitis (includes asthma); COPD/Cardiovascular (includes respiratory complaints with shortness of breath); Tuberculosis; Skin (includes dark/white patch, itch, ulcer); Eye (watering and/or redness); Hair (hair fall/loss, discolouration); Foot/Sole (cracked sole, ulcer); Body/Back ache; Arthritis (large joint or small joints); and, Abdominal (discomfort, dull pain, belching or uneasiness after meals). The occurrences of these ten health complaints recorded during the survey, and their prevalence at the comparison site are presented in Table 5 and Chart 6 below (total health complaints documented at the study and comparison sites are 2353 and 479 respectively).

Chart 6 presents the proportions of each of the ten health complaints out of the total complaints reported, i.e., the rate of occurrence of the complaints. The chart indicates that the health complaints related to eye, hair, foot/sole and arthritis are in higher proportions at the study site. These do not point to disease prevalence in the truest sense but are an indication of the extent and frequency of illness and ill-health occurring at the sites, as reported at the time of the survey.

Comparison of Specific Health Complaints Between the Study and the Comparison Sites

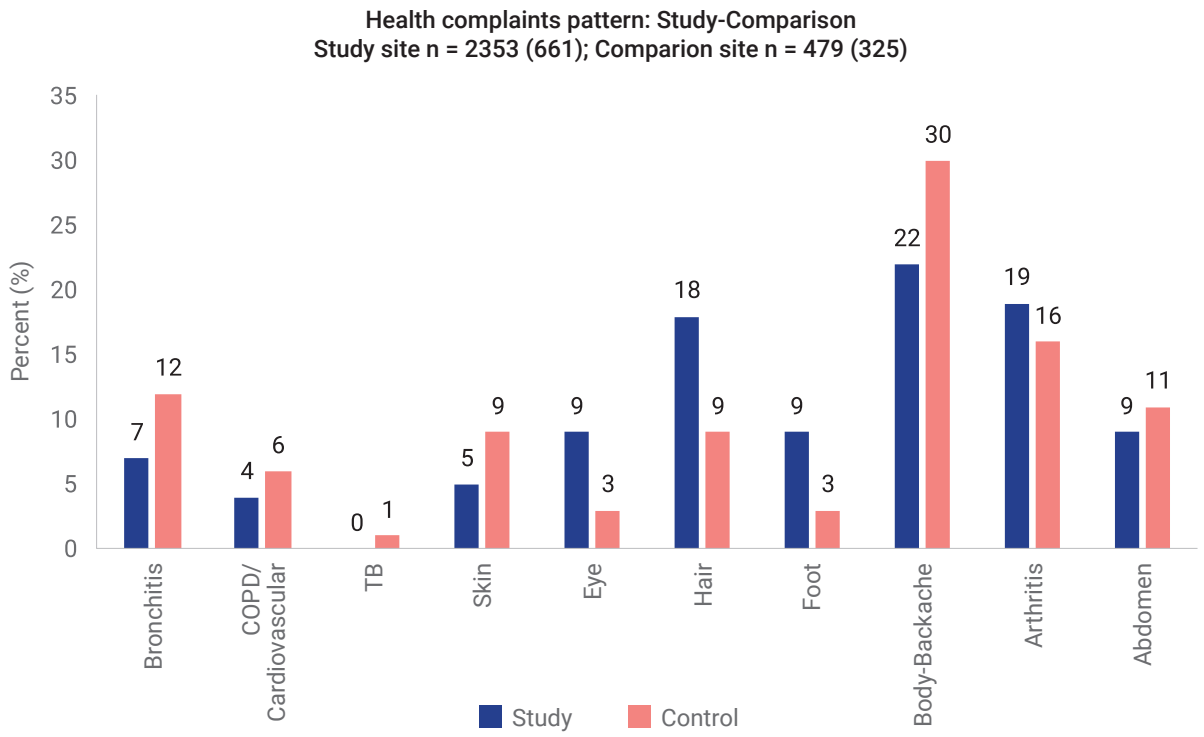
The occurrences of each of the ten health problems and their comparative prevalence at the study and the comparison sites are

Table 5: Health complaints – occurrence and comparison

Site	Bron chitis	COPD CVS	TB	Skin	Eye	Hair	Foot/ Sole	Body/ Back	Arthritis	Abdomen
Study n = 661	160	94	6	98	214	414	202	512	452	201
Comparison n = 325	57	28	4	44	16	44	15	141	77	53
Relative Risk	1.380	1.651	0.738	1.095	6.576	4.626	6.621	1.785	2.886	1.865

6 Not the prevalence of a disease or diseases in the truest sense but the proportions of a specific health problem out of the total complaints reported by the respondents.

Chart 6: Pattern of health complaints: 'Study' and 'Comparison'



presented in the following tables and charts. For each complaint, the "relative risk" between the two groups of respondents has been calculated using MedCalc statistical software (https://www.medcalc.org/calc /relative_risk.php) and is presented in Appendix 2 Table 18.

Respiratory complaints

Bronchitis', 'Asthma' and 'Chronic obstructive lung or Cardiovascular system

Our findings pertaining to respiratory complaints such as repeated cough, wheezing, chest tightness and/or shortness of breath on exertion, indicative of what we have categorised as 'Bronchitis', 'Asthma' and 'Chronic obstructive lung or Cardiovascular condition' respectively, have been analysed and presented together (Table 6) as non-infective respiratory conditions, following which 'Tuberculosis' is presented separately.

Of the total 661 respondents at the study site (Ramgarh district), 149 complained of persistent cough, suggesting bronchitis of one form or other. However, 52 of them, i.e., 35% also had a similar respiratory condition during the past one year, suggesting that the individuals were possibly suffering from chronic bronchitis (Table 6). The findings are significant even though they are self-reported and there was little opportunity to verify against medical records or prescriptions. Similarly, a sizeable proportion, 94 respondents, complained of chest tightness or shortness of breath, but a relatively smaller number – 11 respondents – complained of wheezing/ Asthma. The fact that 63 out of 94, i.e., 67% had chest tightness or shortness of breath both at the time of the survey as well as during the past one year suggests that their condition was possibly due to repeated exposure to a causal agent of non-infective in nature.

Table 6: Complaints of Bronchitis, Asthma, Chronic obstructive lung or Cardiovascular system at a glance

	Respiratory Complaints					
	Bronchitis		Asthma		Respiratory complaints with chest tightness/shortness of breath	
	No of complaints	Repeat complaints within 1 yr.	No of complaints	Repeat complaints within 1 yr.	No of complaints	Repeat complaints within 1 yr.
Study (total 661)	149	52	11	5	94	63
	23% of total	35% of bronchitis	2% of total	45% of asthma	14% of total	67% of short of breath
Comparison (total 325)	50	7	8	2	28	17
	15% of total	14% of bronchitis	2% of total	25% of asthma	9% of total	61% of short of breath

The respiratory complaints – chronic bronchitis – and chronic obstructive respiratory/ cardiovascular conditions are lower at the comparison site, where there are no mines within 40 km.

Skin, Eye, Hair, Foot/Sole complaints

We present the findings concerning skin, eye, hair, and foot/sole together as a group keeping in mind that the manifestations at the study site could be due to contact with of irritants/pollutants.

At the study site, 16%, 54%, 63% and 62% of the respondents complained of problems concerning skin, eye, hair, and foot/sole respectively. This prevalence is distinctly higher than that at the comparison site (refer to Table 7). We have further observed that at the study site 54% of the foot problems were related to cracked sole whereas the problem of cracked sole at the comparison site was significantly smaller (13%). Similarly, skin complaints with dark patch are significantly higher (55%) as opposed to 27% at the comparison site. For more details of the skin-eye-hair-foot findings, please refer to Appendix 3 Table 19.

Musculoskeletal

We have looked at the musculoskeletal complaints in two groups – 'joint pain' and 'body pain/backaches'. For the former, we have analysed the complaints related to large joints, small joints, large & small joints combined, and also multi-large joint problems. The prevalence of these complaints is higher at the study site for both joint pain and body pain/back aches (refer to Table 8). A large proportion of respondents at the study site (69%) complained of joint pain, mainly of large joints like knee, ankle, elbow and wrist, of which 42% had symptoms with more than one large joint. The complaints at the comparison site are at much lower rates, 24% and 22% respectively.

It appears that a large proportion of respondents (78%) at the study site complained of body and/or back pain, of which 82% had both. Similar complaints were much lower at the comparison site (refer to Table 9).

Table 7: Skin-Eye-Hair-Foot/Sole complaints

Site	Skin		Eye		Hair		Foot/Sole	
	All % of total	Dark patch % of complaints	All % of total	Watering/Redness % of complaints	All % of total	Hair fall % of complaints	All % of total	Cracked Sole % of complaints
Study	16%	55%	54%	61%	63%	86%	62%	54%
Comparison	13%	27%	19%	27%	13%	48%	39%	13%

Table 8: Musculoskeletal (large and small joint pain)

Musculoskeletal: Joint Pain								
Site	Large joint	Small joint exclusive	Large & Small joint	No complaint	Non-response	Multi-large joint	% of all respondents	% Multi-large joint
Study	448	4	52	200	9	187	69%	42%
Comparison	77	0	1	241	7	17	24%	22%

Table 9: Musculoskeletal (Body pain and backaches)

Musculoskeletal: Body/Back Aches or Pain						
Site	Body or Back ache	Body & Back ache	No complaint	Non-response	% of all respondents	Body & Back of all complaints
Study	90	422	144	5	78%	82%
Comparison	115	28	182	0	44%	20%

Abdominal Region

Abdominal complaints in the form of bloating, belching, uneasiness and/or pain after food intake, suggesting upper digestive tract problems, are in higher proportion at the study site (refer to Table 10). 30% of all respondents complained of abdominal problems, of which 20% had family members with similar problems as well. At the comparison site the findings were 16% and 21% respectively.

In summary, health problems reported by respondents – Respiratory (bronchitis, asthma and chronic obstructive lung or cardiovascular), Skin (dark patch), Eye (watering and/or redness), Hair (hair fall/loss), Foot/Sole (crack sole), Musculoskeletal (body/back ache and large joint pain) and Abdominal complaints, are in higher proportion at the study site than at the comparison site with no mining activities within 40 kilometres.

The household usage of water by the residents at the study site seems to be of poorer quality than those at comparison site. By living close to mining operations, populations at the study site are exposed to pollutants both in water and air. As for their economic status (based on monthly cash earnings and specific assets investigated)

Table 10: Abdominal complaints

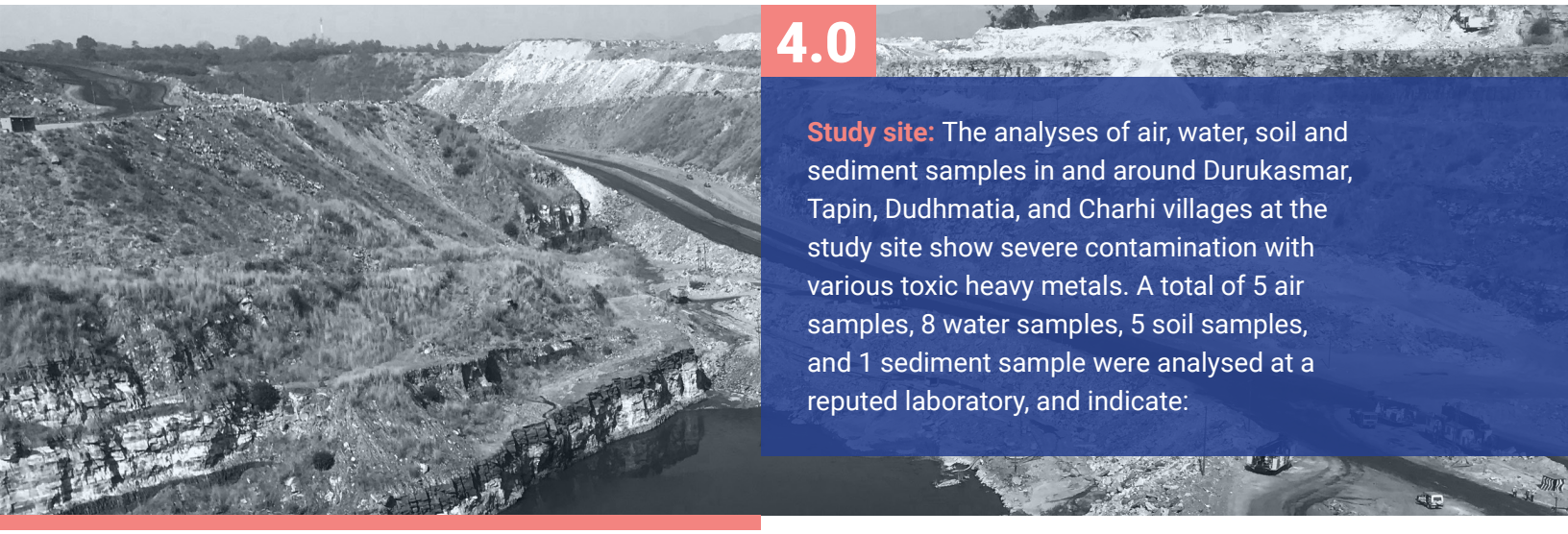
Abdominal							
Site	Respondent	Family member	Family	No complaint	Non-response	% of all respondents	% Family of respondents with complaint
Study	201	36	40	423	1	30%	20%
Comparison	53	3	11	269	0	16%	21%

there seems to be little difference between the residents at the study site and those in the comparison site. In other words, mining operations have not necessarily improved the local economy.

The above findings clearly indicate that there is a problem in the area, both at the study and the comparison sites, and that people living closer to mining activities are worse off in terms of their health. In other words, the findings show that the further the mines are, the lesser the impact on the population's health. The findings answer the third question of the purpose of the study – "do communities at the study site suffer from health problems in significantly higher proportions than those living further away from coal mines or coal-associated activities?" In the 'Discussion' we will elaborate on the impacts of mines on people's health. people's health.

In the next section we explore the first question, i.e., "does the study area present toxic chemicals and heavy metals in higher proportions?"

Air, Water, Soil and Sediment at the Study and the Comparison Site



4.0

Study site: The analyses of air, water, soil and sediment samples in and around Durukasmar, Tapin, Dudhmatia, and Charhi villages at the study site show severe contamination with various toxic heavy metals. A total of 5 air samples, 8 water samples, 5 soil samples, and 1 sediment sample were analysed at a reputed laboratory, and indicate:

- PM2.5 in air samples at levels above the Indian, World Health Organization and US EPA regulatory guidelines. Toxic heavy metals like manganese, nickel and silicon are also found in the air at levels above the health-based guidelines
- toxic metals like chromium, vanadium, nickel, arsenic, and cadmium are present in soil samples above the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health standards
- toxic heavy metals such as aluminium, iron, manganese, total dissolved solids and total hardness in water above the Indian drinking water standards per the Bureau of Indian Standards or the Canadian Council of the Ministers for the Environment guidelines
- toxic chemicals like chromium and nickel in sediment samples at levels harmful to aquatic life.

Please refer Table 11 below

Table 11: Chemicals in air, water, soil and sediment at a glance: Study site

Sample	Chemicals/Contaminants Found
Air	PM2.5, Manganese, Nickel, Silicon
Water	Aluminium, Iron, Manganese
Soil	Chromium, Vanadium, Nickel, Arsenic, Cadmium
Sediment of River	Chromium, Nickel

Comparison site: Total of 1 air sample, 3 drinking water samples and 2 soil samples were collected from various locations in the region.

Air samples in the village of Fatepur of the comparison site indicate the presence of PM2.5 at levels above the Indian, World Health Organization and US EPA regulatory guidelines; also, the levels of silicon (8.04 µg/m3) and aluminium (3.63 µg/m3) are significantly higher than typical background levels. Air quality in the area is considered to be clean because there are no major industries in the vicinity except a handful of stone crushers; also, traffic movement nearby is not heavy. It is likely that the higher levels in air samples were from pre-monsoon dust storms around the time of sampling (there was a sandstorm at the time of air sampling).

The quality of water (samples from tube well, open well and streams) is per the standards, except for the heavy metal manganese. The level of manganese in the water was above the Indian drinking water standards or the Canadian Council of the Ministers for the Environment guidelines.

The fact that toxic metals like chromium, nickel and arsenic in soil are in levels above the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health standards needs further looking into. Similarly, the levels of arsenic and nickel were above the standards in one of the samples. Please refer to Table 12 below.

Table 12: Chemicals in air, water, soil and sediment at a glance: Study site

Sample	Chemicals/Contaminants Found
Air	PM2.5, Silicon, Aluminum
Water	Manganese
Soil	Chromium, Nickel, Arsenic

Discussion

5.0

The farther the area is from mines, industries and heavy traffic, the cleaner the environment is. This is common sense. Also, it follows that residents who are exposed to dust and fumes are more likely to show health problems, especially respiratory complaints. This study has established precisely this, but in great detail and with statistical backing. The presence of toxic chemicals and heavy metals at high levels and the higher prevalence of health complaints at the study site indicate that the health problems faced by the residents of the villages are likely due to their exposure to toxic materials from coal mines, and not due to other miscellaneous causes. In this discussion we will further explore the nature and extent of the health problems and their association with the toxic pollutants as causal agents.

Range of Complaints and Spread

In order to explore the spread of health impact, we have analysed 10 health complaints (respiratory[7]-3; musculoskeletal[8] -2; skin, hair, eye, foot/sole, and abdomen), categorising them as: with one complaint (I); with two or three complaints (II); with four or five complaints (III); and, with six or more complaints (IV). The comparisons (see Table 13 and Charts 7-9) indicate that there are significant differences of the extent of health complaints between the two sites, with the study site showing higher proportions of categories III and IV (41% and 15% respectively), whereas the comparison site shows a higher proportion (37%) of category I. Also, the fact that a sizeable section of respondents (129 out of 325) at the comparison site fell under the 'no complaint' and 'no response' categories signifies that the impact on health in areas without mines in close proximity is much less than that near coal mines.

Health Impact and Proximity to Coal Mines

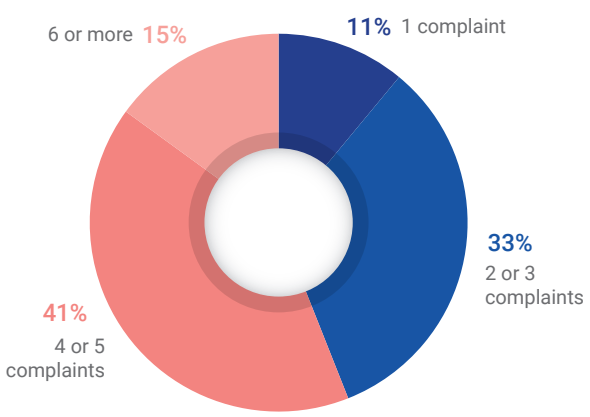
The impact on health of toxic pollutants from coal mines can be further explained by examining the number and range of health complaints, and by relating it to the

7 bronchitis-asthma; chronic obstructive lung conditions or cardiovascular; tuberculosis.
8 arthritis (small and large joint pains); body and/or back pain (headache excluded)

Table 13: Range of complaints and their spread

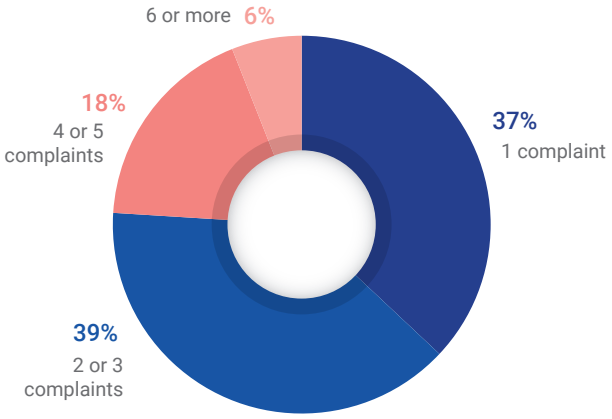
	Number of Complaints				Response	
	1 Compl. (I)	2 or 3 Compl. (II)	4 or 5 Compl. (III)	6 or more (IV)	Number of response	No complaint or no-response
Data	**Study Site**					
N	68	207	259	93	627	34
%	11%	33%	41%	15%		
Data	**Comparison Site**					
N	73	77	34	12	196	129
%	37%	39%	18%	6%		

Chart 7: Spread of health complaints – Study site



Spread of health complaints during 1 year
Study site: n = 627; total = 661

Chart 8: Spread of health complaints – Comparison site



Spread of health complaints during 1 year
Comparison site: n = 196; total = 325

respondents' proximity to mines. Table 4 (page 11) shows that a third of the respondents (34%) reside within a distance of 500 km from coal mines (opencast). Chart 10 below shows that residents living within 500 km of mines at the study site have higher proportion of health complaints than those who live 3 to 5 km away. It further shows that residents living closer to mines have a higher spread of health complaints – six or more complaints as opposed to one to three complaints. The findings answer the fourth question of the 'purpose of the study': "are the health problems due to exposure to toxic materials from coal mines, and not due to other causes?"

The fact that the majority of respondents (97%) use coal or coal and wood for cooking purposes (refer to Table 3, page 11) and the above findings establish that *the causal agents of health complaints are the pollutants from mines (and trucks plying with coal to and from the mines) than by burning coal as cooking fuel.*

Chart 9: Spread of health complaints: Study and Comparison sites

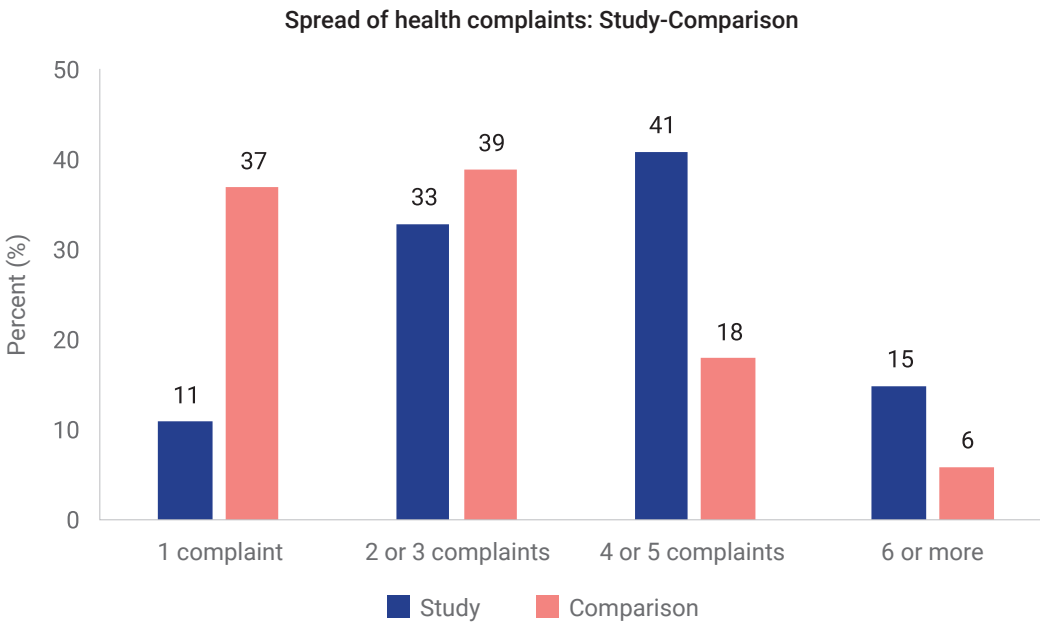
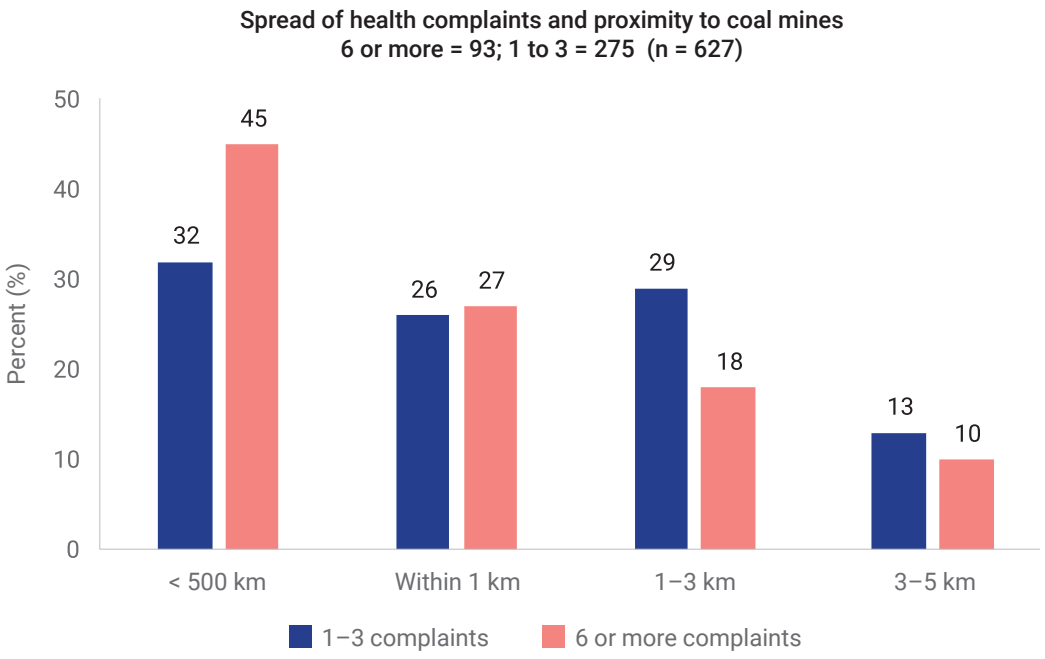


Chart 10: Health impact and proximity to coal mines



A thorough study of the levels of specific heavy metals in the human body and bio-chemical assays e.g., C-Reactive Protein assay, and their correlation with specific health complaints will reveal the true nature of the impact of coal mines on the population.

Infective or Inflammatory

The nature of health complaints reported suggests that the illnesses are chronic in nature and possibly, in most cases, caused by non-infective agents. The fact that a sizeable

section of the respondents experienced respiratory complaints (cough with or without shortness of breath) more than once in a year suggests chronic bronchitis or chronic obstructive lung conditions rather than acute respiratory infections. Similarly, for the 'skin-eye-hair-foot' group, the manifestations such as dark patch skin, watering/redness of eyes, hair fall or deep cracked sole make us believe that the conditions are caused by irritants or allergens rather than microbial infections. Please refer to Tables 6 and 7 (page 14 and 15 respectively).

A similar study in the district of Raigarh, Chhattisgarh[9] has documented complaints of dark patches on skin, watering and redness of eye, hair fall, and deep cracked sole among the population living close to coal mines. Also, the non-specific abdominal complaints in the form of belching, bloating or uneasiness after food intake, as opposed to acute pain or diarrhoea, among residents (Table 10) are similar to the findings of the study in Chhattisgarh.

Musculoskeletal Complaints Among Young Adults

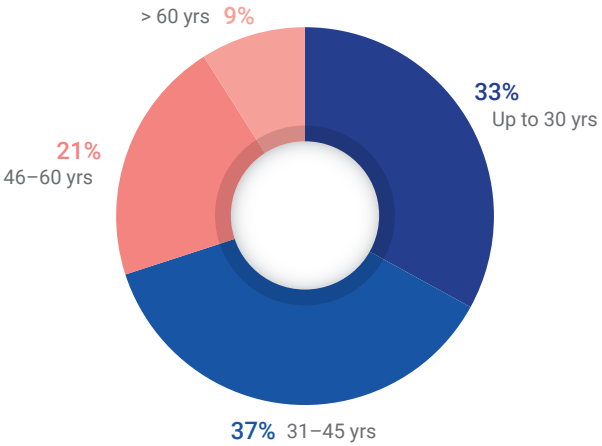
We have looked at musculoskeletal complaints among different age groups – young adults (upto 30 years), adults (31-45 years), middle-aged adults, and older people (above 60 years). Table 14 and Charts 11 and 12 below indicate that the complaints of joints, body and back pain among younger age groups at the study site are higher than older age groups - the occurrence of joint complaints (arthritis) and body/back pain is as high as 70% and 73% respectively. This is at odds with the normal occurrences of such complaints –arthritis is more common among older people. The comparison of musculoskeletal complaints between the study and the comparison sites (Table 15; Charts 13 & 14) further establishes the fact that younger people at the study site are with musculoskeletal illnesses in higher proportions than at the comparison site. Please also refer to Tables 8 & 9 (page 15).

Table 14: Musculoskeletal complaints and age distribution – Study site

	Number of Complaints: Study Site				Respondents
	Young adults (Up to 30 yrs)	Adults (31-45 yrs)	Middle age (46-60 yrs)	Older people (> 60 yrs)	Number of response
Data	Joint Pain (Arthritis)				
N	149	166	95	39	449
%	33%	37%	21%	9%	
Data	Body-back Pain				
N	199	175	90	47	511
%	39%	34%	18%	9%	

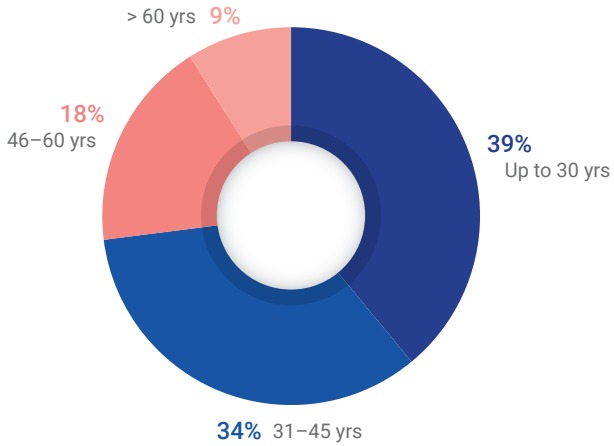
9 For the findings of that study, ...

Chart 11: Arthritis and Age – Study site



Arthritis & Age: Study site
n = 449

Chart 12: Body/Back ache and Age – Study site



Body/Back ache & Age: Study site
n = 511

Table 15: Musculoskeletal complaints and age distribution – Comparison site

	Number of Complaints: Comparison Site				Respondents
	Young adults (Up to 30 yrs)	Adults (31-45 yrs)	Middle age (46-60 yrs)	Older people (> 60 yrs)	Number of response
Data	**Joint Pain (Arthritis)**				
N	11	32	27	7	77
%	14%	42%	35%	9%	
Data	**Body-back Pain**				
N	31	61	37	12	141
%	22%	43%	26%	9%	

Abdominal Complaints

Residents at the study site complained of abdominal problems that could not be easily associated with a specific stomach or abdominal condition. While it is not unusual to experience the occasional stomach upset or uneasiness or belching after a meal but the fact that a sizeable section of residents in a community complain of such abdominal complaints is not usual. It raises the question of whether the households in the community are exposed to some common causal agent through ingestion of contaminated water, possibly toxic pollutants from the nearby coal mines. It must also be noted that similar vague abdominal complaints were registered during the study among people living close to coal mines in Chhattisgarh.

Chart 13: Arthritis and Age – Study and Comparison sites

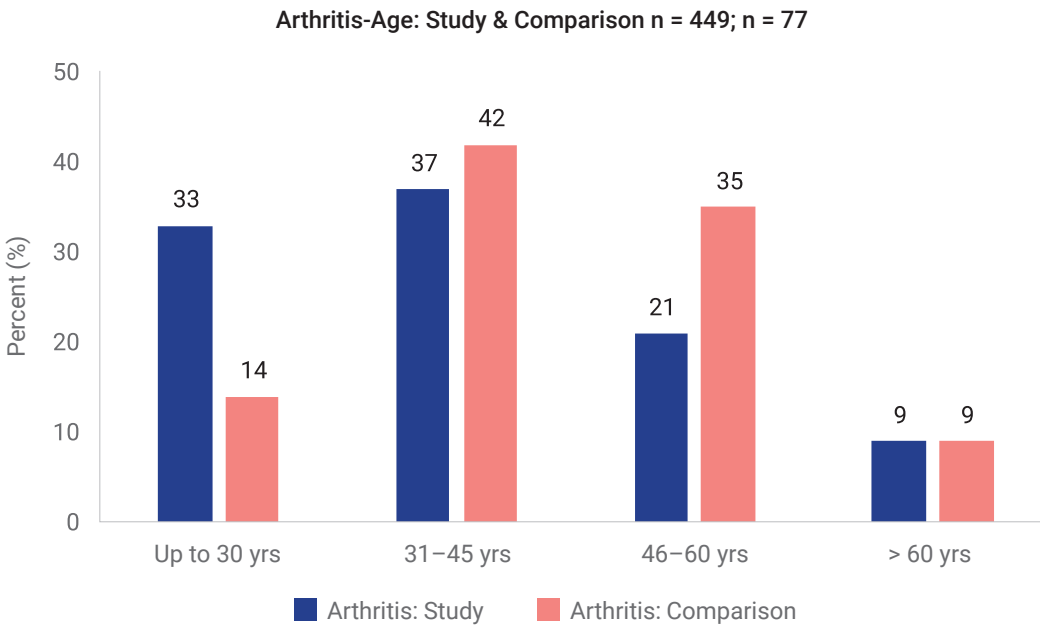
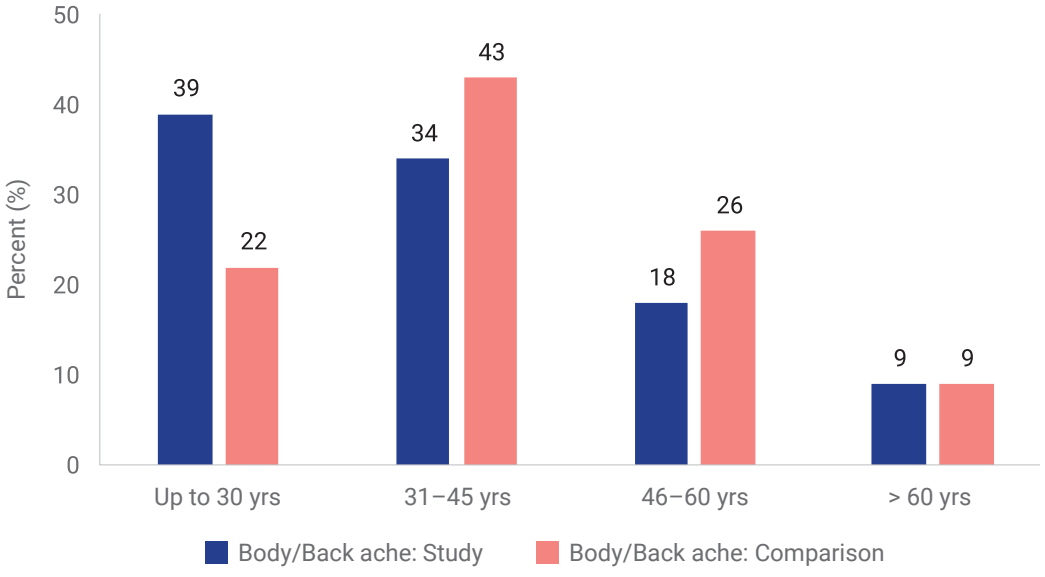


Chart 14: Body/back ache and Age – Study and Comparison sites



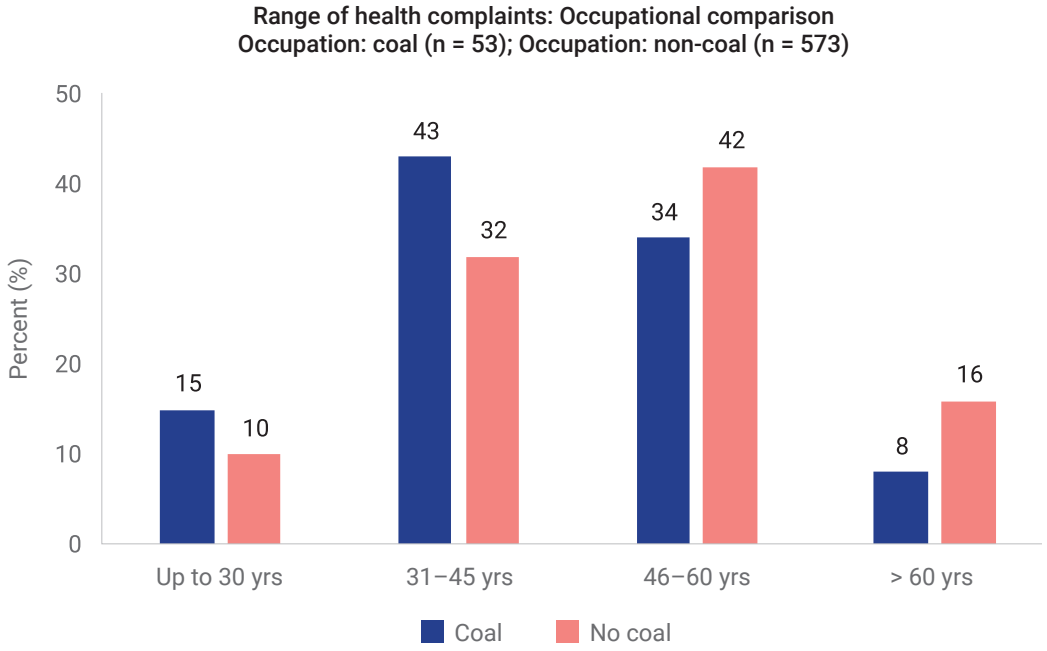
Occupational-environmental Exposure and Health Complaints

Unless the strictest protective measures are in place, people engaged in coal-associated activities are likely to present with health complaints particularly because of exposure to coal dusts. The study has investigated whether such workers presented health problems in significantly higher proportions in comparison to the rest of the population living in the same area but not engaged in coal-associated occupations. In other words,

Table 16: Occupation and the spread of health complaints comparison

	Number of Complaints				Response	
	1 Complaint	2 or 3 Complaints	4 or 5 Complaints	6 or more Complaints	Number of responses	No complaint or no-response
Data	**Non-coal Occupation**					
N	60	183	241	89	573	30
%	10%	32%	42%	16%		
Data	**Coal-associated Occupation**					
N	8	23	18	4	53	5
%	15%	43%	34%	8%		

Chart 15: Spread of health complaints and Occupation



the absence of such a pattern would indicate that the residents in the area were exposed to pollutants in the environment irrespective of their occupation.

Table 16 and Chart 15 below indicate that such an expected pattern does not exist at the study site; rather, they indicate that residents, whether engaged in coal-associated activities or not, are equally affected, presenting a similar range and spread of health problems. The findings indicate that the population is possibly exposed to a causal factor, or factors, in the environment they inhabit. This is however not a definitive conclusion but indicative, because the number of individuals in coal-associated occupation is far too low to compare with those in non-coal occupations.

However, the *findings raise serious questions about the possibility of residents being exposed to pollutants in the environment* and point towards the second question of the 'purpose of the study': "how do we know that the communities living in the area are exposed to such toxic materials?"

Socio-economy and Health

The majority of households at the study site as well as at the comparison site earn a maximum of Rs 5000 a month, which is barely enough to maintain a family even in rural India (Chart 1). Wages for unskilled labourers – whether working on lands, roads or warehouses in nearby towns, or working as migrant labourers in mines, factories or in 'mega-city' projects in distant cities, are low – just enough to survive. This is reflected in the monthly earnings of the households in the study. In order to better reflect the economic status of the population, we have looked into the basic but essential 'assets' of the families (see page 9 and Charts 2 & 3). It appears that households at the study site are marginally better off in comparison to those at the comparison site – 18% as opposed to 15% for the 'Rs 5-10,000' earning group, or 4-7% as opposed to 0% for households in the 'Rs10-20000 and more' group.

The increase in monthly earnings at the study site is possibly due to increased 'cash' flows in coal mine areas – for example, the selling of coal (from 'illegal' sources) or opportunities such as setting up a shop or a tea stall or a roadside automobile repair garage. Households that received cash as compensation in return their lands for mining were able to invest the money in such 'cash' opportunities or in buying motorbikes. But the overall economic status at the study site is not significantly better than at the comparison site. The loss of forests and lands due to mining operations, decreasing productivity of agricultural lands, and the 'cash' opportunities mentioned above have destroyed the traditional socio-economic fabric of the communities at the study site and have contributed to their decreasing dependence on agriculture, all possibly contributing to economic insecurity and the poor health status revealed in the study.

Do families with 'good' monthly earning (the. 'Rs 20,000 and more' group) present better health (understood as fewer health

Table 17: Socio-economic status and the spread of health complaints

	Number of Complaints				Response	
	1 Complaint	2 or 3 Complaints	4 or 5 Complaints	6 or more Complaints	Number of responses	No complaint or no-response
Data	**< Rs. 5,000**					
N	42	141	176	80	439	24
%	10%	32%	40%	18%		
Data	**> Rs. 20,000**					
N	6	21	12	3	42	5
%	14%	50%	29%	7%		

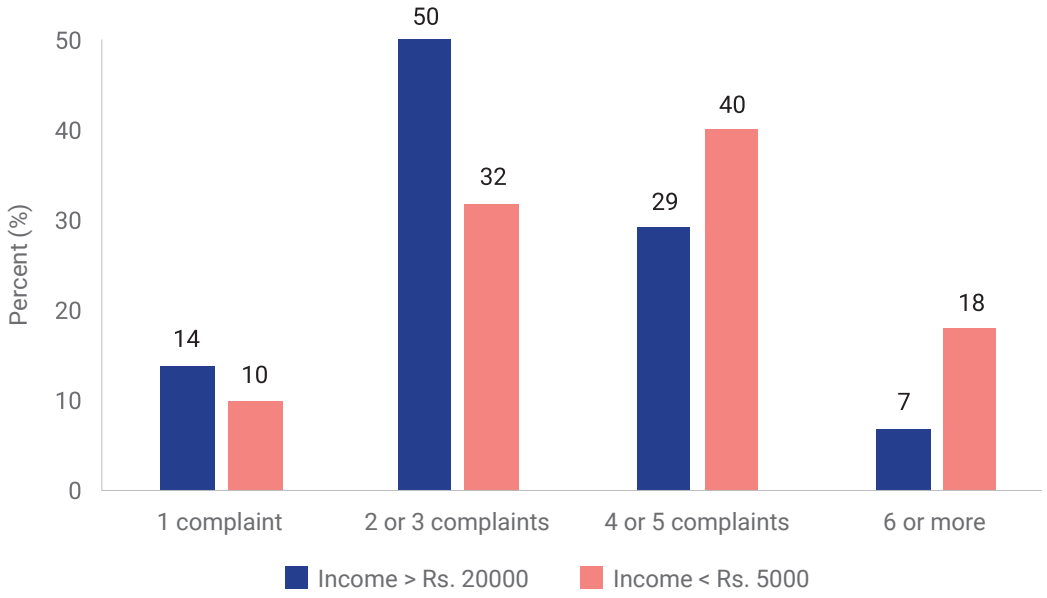
complaints) in comparison to those in the low earning band (the. 'Rs 5000 or less' group)? Similar to the difficulties in drawing a definitive conclusion in the case of coal- and non-coal occupational exposures groups, the response sizes between the two earning groups in question are significantly different – 439 households with 'less than Rs 5000 monthly' earners group as opposed to only 42 households that belonged to the 'over Rs 20,000' group (please refer to Table 17). However, the Table and the associated Chart 16 indicate that at the study site, households with higher income are no better than the poorer socioeconomic group in terms of their health statuses. In other words, the public notion of 'the better the economy, the lower the health problems', does not apply to the population at the study site. A number of factors other than the economic status contribute to ill health though. For the population at the study site where residents are likely to get exposed to a range of toxic pollutants from coal operations – through breathing or ingesting contaminated water or through the food chain – the exposure to chemicals and heavy metals is a significant consideration in the ill health of the population. Refer to 1.

For a significantly large number of cases, the illnesses are inflammatory or allergic in nature, validated by a clinical examination of the patients by a professional medical team. The nature of health conditions not only substantiates the possibility of exposure to toxic pollutants but also raises serious public health concerns.

Medical Findings

The study included the examining of the medical conditions reported by the residents during the survey. At the study site, a team of health professionals conducted a 2-day medical camp and examined residents who attended the clinic. The team

Chart 16: Comparison of monthly income and the spread of health complaints



included experienced medical doctors with the following specialties – toxicology & occupational health, general medicine with experience in lung diseases, obstetrics & gynaecology, and psychiatry. A similar medical camp was organised at the comparison site where respondents with health complaints attended the clinic at a community-based health centre.

The clinical findings were obtained from a make-shift medical clinic (without laboratory facilities) to further investigate the complaints and the diagnosis results are similar to self-reported health complaints obtained during the survey. In other words, the findings and analysis in earlier sections are substantiated by clinical examinations of the residents with health problems. For a summary of the findings obtained from the case notes and prescriptions please refer to Appendix 4 Table 20.

Significance of the Findings and Limitations

The study establishes that residents near coal mines have health complaints in a much higher proportion than those living in villages far from mining activities (40 KM or more) but with similar geographical, cultural and socioeconomic backgrounds. It has also established that a total of 12 toxic metals including aluminium, arsenic, cadmium, chromium, manganese, nickel, iron, silicon, zinc, lead, selenium and vanadium are in the air, water, soil and/or sediment samples obtained in villages near coal mines.

In summary the study reveals,

- residents at the study site are exposed to a range of toxic heavy metals, 12 in number, some of which are carcinogenic, present in air, soil and water at the study site, and are above acceptable standards.
- a variety of health complaints, namely respiratory, musculoskeletal, and relating to skin, hair fall, and cracked sole are in higher proportion at the study site in comparison to the comparison site.
- the health complaints are mostly chronic in nature, and inflammatory rather than infective. In other words, the causal agents are possibly environmental rather than microbial.
- Respiratory complaints like cough with or without shortness of breath, and chest tightness are chronic in nature and, indicate the possibility of repeated exposure to pollutants from the surrounding mining operations at the study site nearby.
- The occurrence of skin-eye-hair-sole group of complaints at the study site is significantly high, possibly due to contact exposure to hazardous pollutants.
- Musculoskeletal complaints like arthritis among the young age group at the study site, are of serious concern and warrant further investigation.

The findings have reasonably answered the questions that the study raised – that toxic chemicals and heavy metals are present in higher proportions in residential areas near coal mines; that communities living in the area are exposed to such toxic materials; that communities at the study site suffer from health problems in significantly higher proportions than those living further away from coal mines or coal-associated activities; and finally, the health problems suffered by the communities are predominantly due to exposure to toxic materials from coal mines.

The study findings echo the findings of a similar study with similar settings, and the relevant ministries have acknowledged the issues prevalent near and around coal mines and coal-associated activities. The significance of the study is in highlighting the impacts of the hazardous route the government has opted for, to address energy issues. The impacts highlighted in the study are manifold – concerning the habitat, social and cultural fabric and traditional practices of communities, agriculture, and, above all causing lasting damage to health and wellbeing.

It goes without saying that a study of this nature will have its limitations. A major limitation was to do with managing such an extensive research project with little resources, particularly the medical camps that followed the surveys conducted at three sites geographically wide apart. The medical examination of patients in makeshift clinics was not ideal as they lacked adequate facilities and equipment, and more importantly not all patients turned up for the examination, for a variety of reasons. But the fact that a section of the respondents was clinically examined and that the medical findings validated their health complaints recorded during the survey is significant and outweighs the limitations. We consider the study unique because contrary to many other research studies, the findings are not just self-reported, the validation of the respondents' health complaints is based on the physical examining of respondents by a team of competent clinicians, rather than extrapolating medical records of health facilities in the area.

Finally, the study recommends a thorough investigation of the levels of specific heavy metals in the human body, i.e., bio-chemical assays and their correlation with specific health complaints, that will help understand the true nature of the impact of coal mines on nearby populations. But the findings, even in their current form, draw attention to the serious concerns of people's health and wellbeing, and recommend stopping further mining of coal and looking for safer energy options.

Recommendations

The findings of the environmental and health assessment in the study site indicate that toxic chemicals and heavy metals are present in higher proportions in residential areas near coal mines; that communities living in the area are exposed to such toxic materials; that communities at the study site suffer from health problems in significantly higher proportions than those living further away from coal mines or coal-associated activities; and finally, the health problems suffered by the communities are predominantly due to exposures to toxic materials from coal mines. Based on our findings we recommend the following:

A. Health

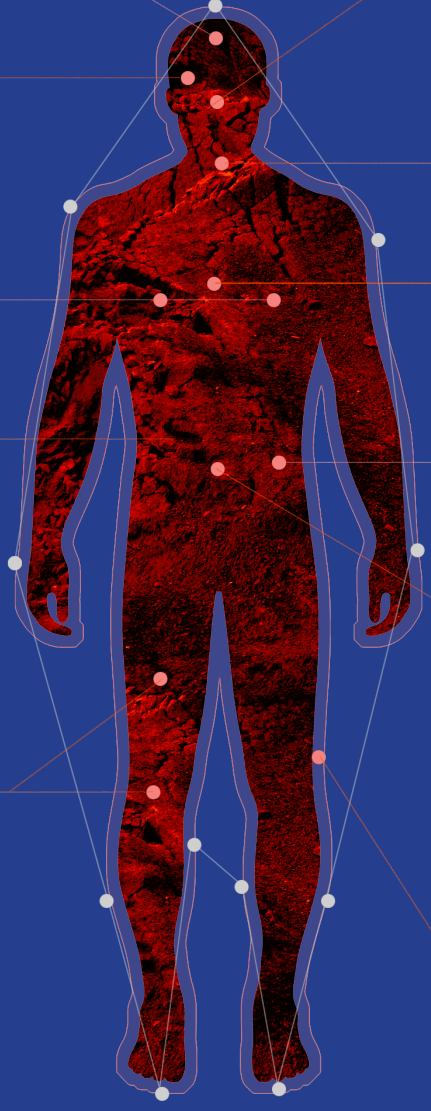
1. State agencies initiate a thorough study and regular monitoring of health of residents of Charhi affected due to coal mines.
2. The state government should look into the coal and associated industries in Charhi and introduce a necessary health mitigation plan for the region.
3. The state health department should set up specialised health care facilities to cater to the health issues of residents in the Charhi area, with costs borne by the polluters.

B. Environment

1. Complete moratorium on further expansion of industries or setting up of new polluting industries in the region till an acceptable standard of environment and health is restored.
2. Scientific remediation and restoration of the environment in the region (including water and soil clean ups) at the cost of the polluting facilities, under polluter pay principle.
3. Mandatory Health Impact Assessments as part of the commissioning of any new industries along with EIAs, both at baseline and interim time-points.
4. Continuous monitoring of PM2.5 and heavy metals in dust from the mines by the state and central Pollution Control Boards, and their results published periodically, along with regular engagement with reputable health agencies for issuing health advice.
5. Use of pollution data by appropriate agencies to apprehend polluters and take corrective action to bring levels of dust and heavy metals in dust to below detection limits in residential areas.

Appendix 1

Figure 1: Health impacts of toxic contaminants found in the environment



Nervous System
Arsenic, Lead, Manganese, Mercury, Selenium, Thallium, Vanadium

Brain
Aluminum, Boron, Lead, Manganese, Mercury, PM2.5

Eyes
Antimony, Arsenic, Boron, Cadmium, Chromium

Lungs and Respiratory System
Aluminum, Boron, Lead, Manganese, Mercury, PM2.5

Liver
Antimony, Arsenic, Boron, Cadmium, Chromium, Manganese, Thallium

Muscle and Joints
Lead, Manganese, Molybdenum

Cancer
Arsenic, Cadmium, Silica, Radium

Probable Cancer
Radium, PM2.5

Nose
Antimony, Arsenic, Boron, Cadmium, Manganese

Throat
Antimony, PM2.5, Thallium

Heart
Antimony, PM2.5, Thallium

Kidney
Antimony, Boron, Cadmium, Chromium, Lead, Mercury, Silica

Intestine
Boron, Lead, Mercury

Skin
Antimony, Arsenic, Cadmium, Chromium, Selenium, Zinc

Effects in all parts of the body
Radium, PM 2.5

Appendix 2

Table 18: Health complaints comparison between the Study and Comparison sites: statistical significance

Bronchitis		Positive	Negative	n	
Bronchitis					
	Study	160	501	661	
	Comparison	57	268	325	95% CI 1.0519 to 1.8109
	Relative Risk	1.380152348			
COPD/ CVS					
	Study	94	567	661	
	Comparison	28	297	325	
	Relative Risk	1.650637562			95% CI 1.1059 to 2.4638
TB					
	Study	6	655	661	**Not significant;** tendency towards less TB - large sample size required.
	Comparison	4	321	325	
	Relative Risk	0.737518911			95% CI 0.2096 to 2.5954
Skin					
	Study	98	563	661	**Not significant;** tendency towards more skin diseases - large sample size required.
	Comparison	44	281	325	
	Relative Risk	1.095103837			95% CI 0.6904 to 1.3385
Eye					
	Study	214	447	661	
	Comparison	16	309	325	
	Relative Risk	6.576210287			95% CI 4.0274 to 10.7380
Hair					
	Study	414	281	661	
	Comparison	44	281	325	
	Relative Risk	4.626254986			95% CI 3.4930 to 6.1272
Foot/Sole					
	Study	202	459	661	
	Comparison	15	310	325	
	Relative Risk	6.621280888			95% CI 3.9863 to 10.9981
Arthritis					
	Study	452	209	661	
	Comparison	77	248	325	
	Relative Risk	2.886221192			95% CI 2.3586 to 3.5319
Body/Back					
	Study	512	149	661	
	Comparison	141	184	325	
	Relative Risk	1.785388569			95% CI 1.5664 to 2.0349
Abdomen					
	Study	201	460	661	
	Comparison	53	272	325	
	Relative Risk	1.864670454			95% CI 1.4207 to 2.4474

Appendix 3

Table 19: Skin-Eye-Hair-Foot/Sole complaints

Skin	Dark patch*	Itch/Ulcer/ Discolouration	No complaint	Non-respondents	% Skin complaints % Skin dark patch of total complaints
Study site	59	49	548	5	16% skin problems of which 55% dark spot
Comparison site	12	32	281	0	13% skin problems of which 27% dark spot
Eye	**Watering/ Redness****	**Low vision**	**No complaint**	**Non-respondents**	**% Eye complaints % Eye watering of total complaints**
Study site	220	138	300	3	54% eye problems of which 61% watering or redness
Comparison site	17	46	261	1	19% eye problems of which 27% watering or redness
Hair	**Hair fall/ Hair loss*****	**Discolouration/ Brittle**	**No complaint**	**Non-respondents**	**% Hair complaints % Hair fall of total complaints**
Study site	357	58	242	4	63% hair problems of which 86% hair fall
Comparison site	21	23	281	0	13% hair problems of which 48%% hair fall
Foot	**Deep crack sole******	**Mild crack sole/Itch**	**No complaint**	**Non-respondents**	**% Foot complaints % Deep crack sole of total complaints**
Study site	218	187	252	4	62% foot/sole problems of which 54% with deep cracks
Comparison site	16	110	199	0	39% foot/sole problems of which 13% with deep cracks

* With or without itch or ulcer
** With or without itch
*** With or without brittle hair or colour change
**** Significant cracking of sole; with or without itch

Appendix 4

Table 20: Clinical findings from case notes and prescriptions – Study and Comparison sites

Total patients examined	Ten health problems (exclude Asthma) of high occurrence reported during the survey											Additional conditions diagnosed			
	1		2	3	4	5	6	7	8	9	10				
	Bronchitis	Asthma	COPD/CVS	TB	Dermatitis	Eye-red/ Watering	Hair	Foot/ Sole	Arthritis	Musculo-skeletal pain	Abdominal discomfort	Fatigue/Anaemia	Vertigo	Menstrual Irregularities	More than 2 health conditions
Study Site															
146	7	0	10	3	16	6	0	0	43	51	15	36	3	4	10
Comparison Site															
55	6	0	2	2	6	0	0	1	7	11	2	11	0	1	1

Comments:

1. Ten health complaints documented during the survey and illnesses clinically diagnosed – both mostly follow a similar pattern in regard to their occurrences. Despite the fact that the medical examinations were conducted 2-3 months after conducting the survey indicates that the health *problems are possibly chronic in nature*.
2. Residents with conditions of skin, arthritis, musculoskeletal (body/back pain) and non-specific abdominal discomfort possibly attended the clinic in high proportions, particularly at the study site, possibly signifying the *severity and rates of occurrences of these health conditions*.
3. The absence of hair and foot/sole conditions is possibly due to the fact that the residents in question i.e., *disadvantaged rural population of low economic status, do not give as much attention to such health conditions* as people of higher economic status in cities do. Also, it is likely that for one reason or other a section of residents will miss out clinics of this nature i.e., makeshift, short notice, one or two-day clinics.
4. The complaint "fatigue/weaknesses' may appear like a vague or trivial condition, but the high occurrence of such a non-specific complaint at the study site may be due to *some serious underlying conditions triggered by toxic pollutants*, and therefore demands further investigations.
5. Similarly, the *non-specific abdominal complaint might be due to ingestion of toxic pollutants in drinking water*.

People First Collective, India (PFCI) brings together professionals, environmentalists and social activists deeply concerned at evidence of complete disregarding for human rights and the destruction of our natural environment in the wake of India's economic 'miracle'. For as long as current indiscriminate mining and industrial practices inflict irreparable damage to the land and natural resources on which Dalit and Adivasi people have dwelt for generations, PFCI will continue to undertake social research, investigate and highlight violations of environmental norms, environmental health and the basic human and land rights of India's most disenfranchised people.