

**STUDY OF PREVALENCE OF DIABETES MELLITUS,
HYPERTENSION AND CHRONIC LUNG DISEASE AMONG
EX-MINERS OF KOLAR GOLD FIELDS**

By

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**Sri Devaraj Urs Academy of Higher Education and Research,
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In partial fulfilment of the requirement for the degree of

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In

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Under the guidance of

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LIST OF ABBREVIATIONS

BGML	– Bharath Gold Mines Limited
KGF	– Kolar Gold Fields
IBM	– Indian Bureau of Mines
GSI	– Geological Survey of India
ILO	– International Labour Organization
NIMH	– National Institute of Miners' Health
WHO	– World Health Organization
DM	–Diabetes Mellitus
IFG	–Impaired Fasting Glucose
JNC	– Joint National Committee
WC	– Waist Circumference
HC	– Hip circumference
WHR	– Waist-hip ratio
BMI	– Body Mass Index
GOLD	– Global initiative for chronic Obstructive Lung Disease
PFT	– Pulmonary Function Tests
NIHL	– Noise Induced Hearing Loss
FVC	– Forced Vital Capacity
FEV1	– Forced Expiratory Volume in one second
PEFR	– Peak Expiratory Flow Rate
SPSS	– Statistical Package for the Social Sciences
CI	– Confidence Interval
OR	– Odds Ratio

ABSTRACT

BACKGROUND AND OBJECTIVES:

Employment or work is the important social determinant of health. Health of the worker is influenced by the conditions prevailing in their workplace. Besides the occupational diseases, workers are also susceptible to the lifestyle related chronic non-communicable diseases. Mining is a temporary activity which can last from few years to decades depending on the availability of resources and the relative costs of operating the mines. After the mine is closed, it has impacts on the environment where mining was carried out and also on the mental and social health of the people and communities who were dependent on the mining activity for their livelihood. Apart from the traumatic injuries, miners are also prone to chronic illnesses which may be recognized late in their life. The process of contracting such diseases is usually slow and takes months to years.

The gold mines of KGF were closed down in 2001 due to reducing deposits and increasing mining costs. Since then a legal struggle is being waged by the ex-employees of BGML against the Ministry of Mines. Most of the miners were migrants who were dependent on the mining activity and they continue to live near the areas where mining was carried out. The mental stress caused by job loss, unemployment, job insecurity and change of jobs could have adversely affected the health of these ex-miner population at KGF.

Systematic studies of the health of the ex-miners have not been undertaken. Anecdotal reports show that the residents of the mining colony have poor health status and live in poor socio-economic conditions. Hence, this study was undertaken with the following objectives:

- i) To study the prevalence of diabetes mellitus and hypertension among the ex-miners of Kolar Gold Fields.
- ii) To study the prevalence of chronic lung disease among the ex-miners of Kolar Gold Fields.

METHODS:

This study was undertaken in Kolar Gold Fields taluk of Kolar district. Out of 35 municipal wards, 16 were mining wards, under the Bharath Gold Mines Limited (BGML) when it was functional. Out of the 16 mining wards, 8 of them were randomly selected. In the second stage, first, the list of all the ex-miners in the selected 8 wards was obtained from the previous survey data. The required number of eligible participants from each of these 8 clusters were sampled by simple random sampling.

All the consenting individuals who were employed in BGML and currently residing in any of the selected mining wards were included for the study. This descriptive cross-sectional survey was carried out during the period of July 2016 to February 2017. A structured interview questionnaire was used to collect the information. Clinical examination, anthropometric measurements, blood sugar testing and pulmonary function testing were done on study participants.

RESULTS:

The study found that majority of the ex-miners studied were married men aged between 50 to 69 years belonging mostly to a nuclear family. 72.1% of them were unemployed and belonged to lower socioeconomic class. Tobacco and alcohol consumption was reported by one fourth of study participants. 66.7% of those studied were either overweight or pre-obese and had higher waist circumference and waist-hip ratio.

Around 13% are known diabetics and 4% of them were identified newly with high blood sugar levels on examination. 21% are known hypertensives and about 6% of them were identified newly with high blood pressure on examination. Around 10% of them have cough of more than or equal to 8 weeks and one fourth of them have features of chronic lung disease on pulmonary function test.

Age more than or equal to 60 years, middle socioeconomic status, higher body mass index, higher waist hip ratio, tobacco smoking and living in a joint or three generation family were the factors associated with diabetes mellitus and hypertension in the ex-miners. Tobacco smoking and higher number of years of work in mining were the factors which were found to be significantly associated with chronic lung disease in the ex-miners studied.

CONCLUSION:

The past occupational exposure, stress of job loss, poor socio-economic conditions, lack of family support (as evident by higher number of nuclear families with ex-miners living alone or with their dependent partner), raising overall burden of non-communicable diseases along with the environmental risk of dust from mill tailings in KGF put these ex-miners at higher risk of chronic debilitating mental and physical illnesses,

The study reports a high prevalence of non-communicable disease risk factors among ex-miners of KGF and emphasises on the need for regular screening for non-communicable diseases like diabetes mellitus and hypertension in this risk group. Every mining company should have a clearly defined mine closure plan at the start of mining activity to which they should be legally adhering. These mine closure plans should not only address the environmental impacts but also the health and social status of the employees following mine closure. Since the development and manifestation of occupational illnesses among miners takes several years and often go unrecognized, a well defined rehabilitation scheme by the government for regular periodic screening, counselling and health education related to such diseases should be implemented.

KEY WORDS: Ex-miners, Kolar Gold Fields, Diabetes mellitus, Hypertension, Chronic lung disease, Barath Gold Mines Limited.

TABLE OF CONTENTS

SL NO.	CONTENTS	PAGE NO.
1	INTRODUCTION	1-4
2	OBJECTIVES	5
3	REVIEW OF LITERATURE	6-42
4	MATERIALS AND METHODS	43-58
5	RESULTS	59-78
6	DISCUSSION	79-90
7	SUMMARY AND CONCLUSION	91-92
8	BIBLIOGRAPHY	93-103
9	ANNEXURE	104-115

LIST OF TABLES

TABLE NO.	TITLE OF THE TABLE	PAGE NO.
1	Epidemiological studies on prevalence of diabetes in India.	27
2	Epidemiological studies on prevalence of hypertension in India	31
3	List of mining wards and ex-miner population in each municipal ward in KGF	46
4	Joint National Committee 8 classification of hypertension	48
5	WHO classification of waist circumference for South Asians	49
6	WHO Body Mass Index classification for Asians	50
7	WHO classification of waist-hip ratio	50
8	Classification of fasting blood sugar levels	51
9	Classification of ventilatory abnormality in spirometry	52
10	Classification of individuals according to their occupation	54

LIST OF TABLES

TABLE NO.	TITLE OF THE TABLE	PAGE NO.
11	Kuppuswamy socioeconomic status classification, 2017	55
12	Distribution of sociodemographic profile of ex-miners residing at Kolar Gold Fields	59
13	Distribution of socioeconomic status of ex-miners residing at Kolar Gold Fields	60
14	Distribution of ex-miners studied according to the characteristics of their mining occupation	62
15	Distribution of current alcohol and tobacco consumption among ex-miners at KGF	63
16	Nutritional status of the studied ex-miners at KGF	64
17	Anthropometric characteristics of the studied ex-miners at KGF	65
18	Distribution of mean measurements of anthropometry, blood pressure and fasting blood sugar among ex-miners at KGF	66

LIST OF TABLES

TABLE NO.	TITLE OF THE TABLE	PAGE NO.
19	Distribution of ex-miners according to fasting capillary blood sugar levels	67
20	Distribution of ex-miners according to blood pressure reading	68
21	Distribution of ex-miners according to their pulmonary function	70
22	Distribution of mean pulmonary function of study participants	71
23	Distribution of Lung function among the ex-miners by number of years of work in mining	72
24	Factors associated with Diabetes mellitus in ex-miners residing at KGF	73
25	Factors associated with Hypertension in ex-miners residing at KGF	75
26	Factors associated with Chronic cough in ex-miners residing at KGF.	77

LIST OF FIGURES

FIGURE NO.	TITLE OF THE FIGURE	PAGE NO.
1	Types of mining operations	7
2	Types of mining: an example of coal mining	8
3	Mining shaft at Champion reef, KGF	12
4	Mill tailings in Kolar Gold Fields	16
5	Map of Karnataka showing Kolar district	43
6	Sampling procedure for inclusion of study subjects	47
7	Types of tobacco products currently used by ex-miners studied	63
8	Distribution of ex-miners based on history of cough	69

LIST OF ANNEXURE

ANNEXURE NO.	TITLE OF THE ANNEXURE	PAGE NO.
1	Proforma for data acquisition	104-106
2	Information sheet	107-108
3	Information sheet - Kannada	109
4	Informed consent form	110
5	Informed consent form - Kannada	111
6	Map of KGF	112
7	Map of mining wards of KGF	113
8	Data acquisition images	114
9	Gantt chart	115

INTRODUCTION



INTRODUCTION:

The economically active population of the world spend at least one third of their time at the workplace. Employment or work is the important social determinant of health and is essential for the economic development.¹ Workers are exposed to various physical, chemical and biological environment at work. Health of the worker is influenced by the conditions prevailing in their workplace. Occupational diseases and injuries pose a significant burden even in the advanced industrialized countries, despite legislative and technological changes.² Besides the occupational diseases, workers are also susceptible to the lifestyle related chronic non-communicable diseases. The mining industry is one of the major activity contributing to the economy and it contributes to around 2.5% of India's gross domestic product (GDP).³ During 2015-16, there were 668 reporting metallic mineral mines in India.⁴

Mining is among the most hazardous occupations and it not only has an impact on the health of the miners but also has various environmental and social impacts.⁵ The earth is mined for various metals, gems, minerals and salts. The mined ore contains principle mineral plus trace amounts of other potentially toxic material. Thus during the processing of the ore, miners can be exposed to dust of various potentially toxic substances for decades and not exhibit any effects of exposure.⁶

Irreversible damage to lungs following variable period of exposure to dust of size 0.5 to 3 micron, which may progress once developed, even without further exposure and the superimposition of infections like Tuberculosis makes pneumoconiosis a serious preventable disease among miners. In addition, the toxic substances such as Mercury, Cyanide, and Arsenic can have an impact on the health status of people residing in and around the mining area by direct inhalation or by contamination of water resources.^{7,8}

Mining is a temporary activity which can last from few years to decades depending on the availability of resources and the relative costs of operating the mines. In general, the resources are depleting fast and some landfills now contain a higher concentrations of the ore than mines themselves. Mines without a proper mine closure plan can have adverse impacts on the mine employees and on the environment. After the mine is closed, it has impacts on the environment where mining was carried out and also on the mental and social health of the people and communities who were dependent on the mining activity for their livelihood.⁹ Apart from the traumatic injuries, miners are also prone to chronic illnesses which may be recognized late in their life. Cancer of the lung, stomach and liver, pneumoconiosis, pleural diseases, pulmonary tuberculosis; chronic lung diseases; noise induced hearing loss, diminished vision, diabetes mellitus, hypertension, and heart diseases are found to be more frequent in the mining population.¹⁰⁻¹⁴ The process of contracting such diseases is usually slow and takes months to years.

India is rich in mineral resources which are spread over diverse geographic locations. In India, the mining sector employs nearly 1.5 million people directly or indirectly.¹⁵ Karnataka has the distinction of being the principal gold producing state in the country.¹⁶ Kolar Gold Fields (KGF) also known as 'little England' is a town in the Kolar District of Karnataka state, India. Once a self-sustaining city, now comes under the local municipality, where reside mainly the families of the employees of the erstwhile Bharat Gold Mines Limited (BGML) and the Bharat Earth Movers Limited (BEML). Mining gold at Kolar is believed to have been carried out as early as the first millennium BC with linkages to the Indus Valley civilization.¹⁷ The Champion Reefs mine at KGF was the second deepest underground mine in the world when it was operational.¹⁸

The gold mines of KGF were closed down in 2001 due to reducing deposits and increasing mining costs. Since then a legal struggle is being waged by the ex-employees of BGML against the Ministry of Mines.^{19,20} Most of the miners were migrants from neighbouring states of Tamilnadu and Andhra Pradesh and were dependent on the mining activity. Job loss is known to have adverse impact on physical and mental health. It has been linked with increased mortality²¹, poor mental health status²², poverty, higher morbidity and long term illness, increased exposure to lifestyle related risk factors, impact on utilization of health services, negative effects on the family and the wider community.²³

Most of the ex-miners of KGF now continue to live near the areas where mining was carried out and they commute in large numbers daily to nearby cities for work. The mental stress caused by job loss, unemployment, job insecurity and change of jobs could have adversely affected the health of these ex-miner population at KGF.

Systematic studies of the health of the ex-miners have not been undertaken. Anecdotal reports show that the residents of the mining colony have poor health status and live in poor socio-economic conditions.¹³ Hence, this study aims to find the prevalence of certain chronic non-communicable diseases and of chronic lung disease among the former miners residing at Kolar Gold Fields.

OBJECTIVES

A decorative graphic consisting of a horizontal line and a vertical line intersecting at the right end of the horizontal line. Both lines have a thin grey shadow offset to the right and bottom, creating a 3D effect.

OBJECTIVES:

1. To study the prevalence of diabetes mellitus and hypertension among the ex-miners of Kolar Gold Fields.
2. To study the prevalence of chronic lung disease among the ex-miners of Kolar Gold Fields.

REVIEW OF LITERATURE

A decorative graphic consisting of a thick horizontal line and a thick vertical line intersecting at the right end of the horizontal line, positioned below the title.

REVIEW OF LITERATURE:

MINING SECTOR:

Overview:

Mining industry constitutes the back-bone of economic growth in any country. During 2016-17, the mining sector has contributed 309 billion (2.25% of country's gross domestic product) to India's gross value added (GVA) in Indian rupees.²⁴ It also contributes to the industrial development as it provides the basic raw materials for most of the industries. Indian mining industry employs more than one million workers which is around 4% of the country's workforce. There are evidences that exploitation of minerals has been going on in the country from time immemorial. However, in India, the first recorded history of mining dates back to 1774 when an English Company was granted permission by the East India Company for mining coal in Raniganj.²⁵

India has vast reserves of metallic, non-metallic, atomic, fuel, and minor minerals. The country is endowed with vast reserves of iron ore, bauxite, coal, limestone and manganese, and is among the top 10 countries globally for these ores.²⁶ Since independence, there has been a pronounced growth in the mineral production both in terms of quantity and value. India produces as many as 95 minerals, which includes 4 fuel, 10 metallic, 23 non-metallic, 3 atomic and 55 minor minerals. There were a total of 1899 reporting mines in the country in 2016-17. Among them, 558 mines belonged to fuel minerals, 590 mines to metallic minerals and 751 mines to non-metallic minerals. Karnataka has a total of 147 reporting mines.²⁷

Types of mining:

Mining is the process of exploiting substances such as metallic and non-metallic minerals from the earth's crust. There are broadly two types of mining.

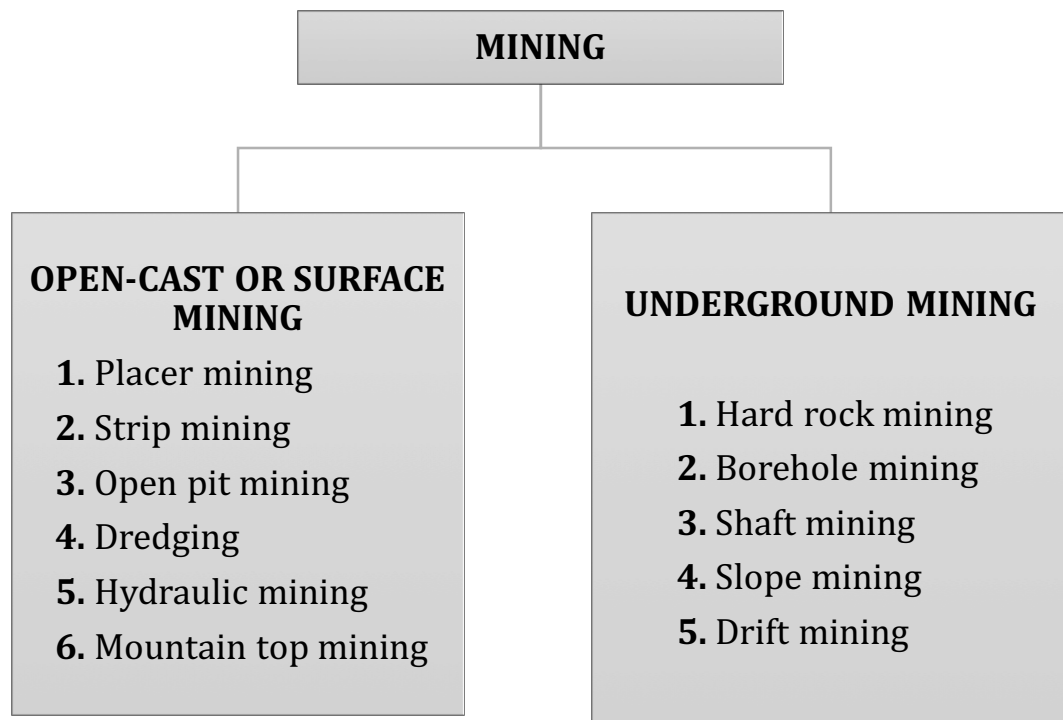


Figure 1: Types of mining

Surface mining or open-cast mining is the process of extracting minerals and ores located in close proximity to the surface of the earth. A layer of soil, subsoil, and strata are removed to gain access to the minerals and ore.

i) Placer mining: It is the process of mining alluvial deposits in sand or gravel for minerals. It is frequently used for precious metal deposits like gold and gemstones.

ii) Strip mining: In this technique, the soil and rocks that lie above is removed generally by heavy machinery and then the material is extracted. The mineral generally extracted by this method is coal or some kinds of sedimentary rocks.

iii) Open pit mining or open cut mining: It is the easiest and cheapest way to mine minerals that are close to the surface by digging downward in benches or steps which slope in towards the centre of the pit. Gold, nickel, copper and few other minerals are extracted by this method.

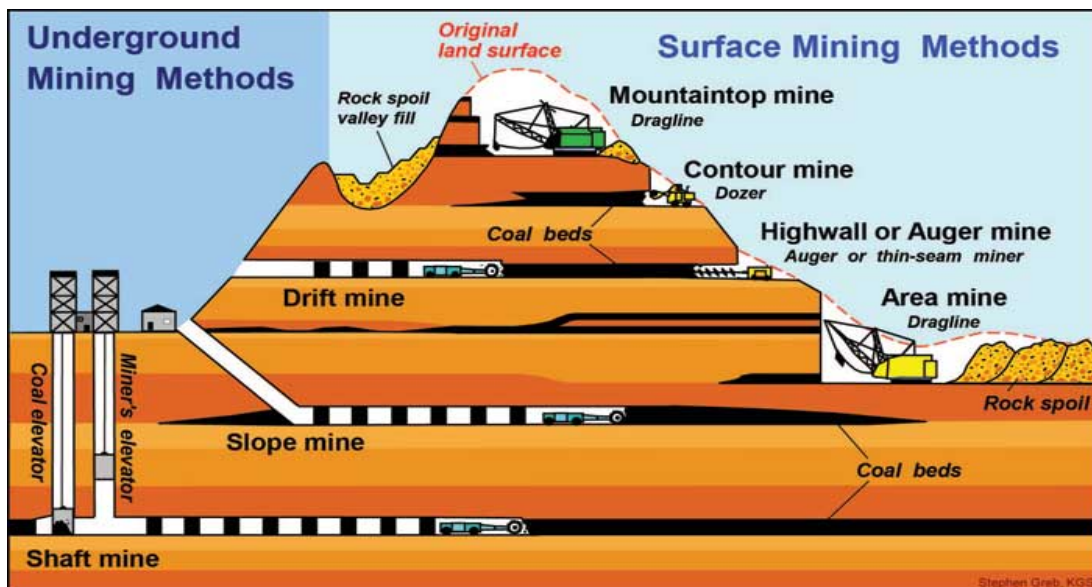


Figure 2: Types of mining: an example of coal mining

iv) Dredging: It is the process of using chain bucks and draglines to scrape up the sand, gravel and other material from harbours, rivers and other water bodies to extract the minerals.

v) Hydraulic mining: In this process high pressure water jets are used to dislodge rocks and minerals. Gold was extracted in an easier way by this method. However, this process has been discontinued due to environmental concerns.

vi) Mountain top mining: A relatively new process which involves blasting of the top of mountains to expose the ore below it. Coal is extracted by this method.

Underground or sub-surface mining consists of digging tunnels or shafts deep into the earth to reach buried ore deposits. Access to these underground deposits is by vertical shafts or by a sloping tunnel called a 'decline'. All underground mines have ventilation systems which continually circulate fresh air for the people working there.

i) Hard rock mining: In this method, tunnels deep in the ground are dug sometimes with dynamite or large drills. The tunnels are supported by pillars through which miners can move about. Tin, lead, copper, silver, gold etc. are mined with this process.

ii) Borehole mining: Using a drill a deep hole is dug and a high pressure water-jet is used to force the materials up the hole. Sand, galena, gold etc. are mined by this process.

iii) Shaft mining: It is the deepest form of underground mining done by excavating a vertical passageway deep down. Elevators are used to take the miners and excavated ore up and down the shaft. Generally, coal is mined in this process.

iv) Slope mining: In this method, in contrast to shaft mining, a sloping access is made downwards towards desired material.

v) Drift mining: This process is carried out when the material is situated sideways of a mountain. A horizontal access is made slightly lower than the resource area so as to allow gravity to pull down the materials easily. Generally, coal or iron ore is mined through this process.²⁸

Gold mining - overview:

Gold which usually appears in very low concentrations in mineral deposits has been treasured for its natural beauty and radiance throughout the history. It is the oldest metal exploited by humans. The gold production in 2016 was about 3000 tonnes, with China, Australia and Russia being the leading producers with production amounts of 464, 287 and 274 tonnes, respectively.²⁹ It is said that 56,000 tonnes of gold reserves are present in the world, while other authors state that the amount of recoverable reserves is 135,000 tonnes.³⁰

In India, first ever exploration of gold started in Kolar Gold Fields prior to the 2nd and 3rd century AD. As of date, there are a total of 5 underground gold mines operational in the country. Karnataka has highest share in the country's gold production. In the year 1880, M/s John Taylor & Sons Ltd. started gold mining in KGF. Golden objects found in Harappa and Mohenjo-Daro have been traced to Kolar through the analysis of impurities.¹⁸

Gold can be exploited either by placer mining (surface) where the gold that has accumulated in a placer deposit is extracted or by hard rock mining (underground) where the gold encased in rock is extracted rather than fragments in loose sediment.

Gold mining - process:

The mining operation comprises the following phases:

1. Exploration
2. Development
3. Extraction and processing
4. Beneficiation or refining
5. Decommissioning.

Exploration is defining of the extent and value of the ore present in the nature. During the development stage, the mineral deposit is opened for exploitation, i.e. access is gained to the deposit. Extraction is the actual process of exploiting the ore. Beneficiation is the process of removing unwanted ore constituents in order to prepare it for subsequent processing stages. It is carried out in a mill, which is usually located near the mine site in order to reduce costs of transportation. The metallurgical process of smelting or refining usually takes place in areas away from mining sites in larger cities and towns. When active mining ceases, mine facilities and the site are reclaimed and closed. This is called decommissioning.³¹



Figure 3: Mining shaft at Champion reef, KGF

During the processing of the gold ore, mercury is used to extract gold from ore by forming “amalgam” – a mixture composed of approximately equal parts mercury and gold. The amalgam is heated, evaporating the mercury from the mixture, leaving the gold. Although currently there are several processes to extract gold such as gravity concentration, flotation, pyrometallurgy and hydrometallurgy, this method of gold extraction using mercury is used small scale gold mines in third world countries because it is cheaper, can be used by one person independently, and is quick and easy.³²

Gold mining at KGF:

The gold mines in KGF has an history of more than 130 years beginning in the year 1880, when John Taylor & Sons Ltd. company was granted licence to start gold mining in KGF. After independence, it was decided to nationalise the mines and in 1956 the mines were handed over by John Taylor & Co. to the government of Mysore to be run as a state enterprise. In 1960, with the Gold control act, the finance ministry of the central government took over the mines and in 1972, the Bharat Gold Mines Limited (BGML) was established by the Government of India under the Ministry of mines and the gold mines at KGF was handed over to the BGML to be run as a Public Sector Undertaking (PSU).³³

During the initial years of mining operation at KGF, the mines gained lot of name and fame with the word "Kolar" becoming a synonym for gold in India. KGF was the first in Asia to get hydro-generated electricity and the city has many such firsts to its credit because of the gold mines.³⁴

Mine closure and its impacts:

Gradually, over the years, the gold ore at Kolar gold mines started depleting and the miners had to go deeper and deeper to extract gold. The quality of gold ore also started steadily deteriorating. By 1998 the reserves came close to exhaustion and the cost of extracting gold exceeded the price of gold by more than ten times.

As a result, the formal decision to close down the mine was taken by the Government of India on the basis of the Chari Committee Report and the gold mine at KGF was closed in 2001. Since then, protests and legal struggles ensued between the ministry of mines and the ex-employees of BGML. There are many ex-employee unions in KGF who are still voicing for the rights of those miners who suddenly lost their jobs. Although the Supreme Court finally gave its nod to the Union government's plan to float a global tender to revive Bharat Gold Mines Ltd. on 9 July 2013, the gold mine remains closed as of date.³³

Mining operations are to be carried out as per the approved mining plan and after extraction of minerals, the mines are required to be reclaimed as per an approved Mine Closure plan. Mine closure operation is a continuous series of activities starting from day one of the initiation of mining project. Mines without a proper closure plan can have an immense impact on the environment. These impacts can persist for decades and even centuries. After the mine is closed, the site should be returned to a condition that most resembles the pre-mining condition. Mine reclamation and closure plans must describe in sufficient detail how the mining company will restore the site to a condition that most resembles pre-mining physical, chemical and biological quality; how it will prevent the release of toxic contaminants from various mine facilities; and how funds will be set aside to insure that the costs of reclamation and closure will be paid for. The mine closure plan must also aim to create a self-sustained ecosystem.⁵

During the beneficiation process, high-volume waste called 'tailings,' (the residue of an ore that remains after it is milled) will be generated. If a mining project involves the extraction of a few hundred million metric tons of mineral ore, then the mine project will generate a similar quantity of tailings. How a mining company disposes off this high-volume toxic waste material is one of the central questions that will determine whether a proposed mining project is environmentally acceptable. The key long-term goal of tailings disposal and management is to prevent the mobilization and release into the environment of toxic constituents of the tailings.

There are about 32 million tonnes of this tailings, which makes up the 15 dumps spread out along 8-km long distance in the mine area in KGF. Major constituents of these tailings in KGF are silica, aluminium oxide, ferrous oxide, magnesium oxide and calcium oxide which can be toxic to humans. When the weather is dry and windy, these sands are carried eastward to Robertsonpet and Andersonpet areas of KGF upto a distance of 3 km.³⁵ Some of the worst environmental consequences of mining have been associated with the open dumping of tailings which may contain hazardous chemicals.



Figure 4: Mill tailings in Kolar Gold Fields

The environmental impacts following a mine closure include disruption of the ecosystem, habitat loss and habitat fragmentation, contamination of surface and ground water sources with toxic substances and metals, damage to aquatic life, soil contamination, contamination of air with high concentrations of sulphur dioxide, particulate matter and heavy metals.⁵

Following mine closure, apart from the environmental impacts, sudden job loss and unemployment can have various social and health impacts on the miners who were dependent on the mining activity. The negative health effects of unemployment include increased mortality, worse mental health status, higher morbidity and chronic illnesses and increased exposure to lifestyle related risk factors. It also has been shown to affect the family and wider community.³⁶

A study on 'The impact of Unemployment on mental and physical health, access to health care and health risk behaviours' by Pharr JR and others in Las Vegas, USA in the year 2012 indicated that unemployed participants were at least 2.1 times more likely to delay health care due to cost as compared with employed participants and also they were more likely to smoke when compared to employed participants. Participants who were unemployed longer than one year had significantly lower (worse) mental health scores compared to the employed participants and reported more days of poor physical and mental health.³⁷

Mine closure laws:

In the federal structure of India, the State Governments are the owners of minerals located within their respective boundaries. The Central Government is the owner of the minerals underlying the ocean within the territorial waters or the Exclusive Economic Zone (EEZ) of India. The Indian Bureau of Mines (IBM) and Geological survey of India (GSI) lay down rules for the regulation of mines. While GSI maps the mineral resources of the country and intensifies the exploration of minerals, IBM is engaged in promotion of conservation, scientific development of mineral resources and protection of environment in mines other than coal, petroleum and natural gas, atomic minerals and minor minerals.

Later in 1972, Mineral Exploration Corporation Limited (MECL) was established as an autonomous Public Sector Company, under the administrative control of Ministry of Mines, Government of India for systematic exploration of minerals, to bridge the gap between the initial discovery of a prospect and its eventual exploitation.

While approving the mining plans, schemes of mining and mine closure plans, IBM ensures that environment impact assessment studies have been carried out and to that effect environmental management plan has been incorporated for its effective implementation, besides reclamation and rehabilitation of mined out areas. IBM also ensures that mining operations are carried out in accordance with the approved mining plan or scheme of mining. Simultaneous reclamation in working mines, and reclamation of abandoned mines are required to be carried out wherever it is feasible.

The Central Government, in the year 2003 amended the Mineral Concession Rules, 1960 and Mineral Conservation and Development Rules, 1988 respectively. As per these amendments all the existing mining lessees had to submit the "Progressive Mine Closure Plan" along with prescribed financial sureties within 180 days from date of notification. A "Final Mines Closure Plan" should be submitted one year prior to the proposed closure of the mine and should be approved at least nine months before the date of proposed closure of mine. The guidelines for preparation of progressive and final mine closure plans has been laid down by Indian Bureau of Mines (IBM).³⁸

IBM plays a key role in fostering awareness and inculcates competition amongst the mine owners by organising Mines Environment and Mineral Conservation (MEMC) Week in different mining areas in the country towards the protection and restoration of mine environment with sustainable development.³⁹ Additionally, a scheme of Star Rating of Mines or mining leases for implementation of Sustainable Development Framework (SDF) launched by the ministry of mines in the year 2016 is of importance. Star Ratings will be awarded based on evaluation of performance of mines on techno, socio-economic and environmental parameters and give objective reporting of their activities. The scheme aims to bring all mines to a minimum standard of star rating in the shortest possible timeframe to adopt sustainable practices. Star ratings will be based on:

- i) The management of impact by carrying out scientific and efficient mining.
- ii) Addressing social impacts of resettlement and rehabilitation requirements from mining activities.
- iii) Local community engagements and welfare programmes.
- iv) Steps taken for progressive and final mine closure.
- v) Adoption of international standards.²⁷

WHO has mandated by Article 2 of its constitution to promote the improvement of working conditions and other aspects of environmental hygiene. The 'Global Plan of Action for workers' health' given by the 60th world health assembly urges countries to strengthen governance by devising and implementing policy instruments to promote workers' health, to protect and promote health at the workplace, to improve performance of and access to occupational health services, to provide and communicate evidence for action and practice and to incorporate workers' health into other policies.⁴⁰

MINING AND HEALTH:

Occupational hazards of mining:

Mining is an ancient and one of the most hazardous industrial occupations. Diseases caused by exposure to mineral dust persists in both developed and developing countries despite a fair knowledge about the means of their prevention. Miners are exposed to various harmful or potentially toxic materials including fuels, reagents, solvents, detergents, chemicals, coal dust, silica dust, asbestos, noise, welding fumes, poisonous plants and metal dust. Health impacts from mining can be divided as:⁴¹

1. Physical hazards: Traumatic injuries, Noise induced hearing loss, Heat strokes, Health effects of exposure to vibration, Radiation and electromagnetic fields.

2. Chemical hazards: Pneumoconiosis, Exposure to toxic metals leading to diseases such as Lung cancer, nasal sinus cancer, bladder cancer, occupational asthma etc., Irritant dermal exposures and resulting skin lesions.
3. Biological hazards: Risk of tropical diseases such as malaria and dengue, leptospirosis, ankylostomiasis, legionella infection are common in mining sites.
4. Ergonomic hazards: Although mining has become increasingly mechanized, there is still a substantial amount of manual handling. Cumulative trauma disorders continue to constitute the largest category of occupational disease in mining and often result in prolonged disability. Musculoskeletal disorders, health effects of disturbed sleep and cognitive disorders.
5. Psychosocial hazards: Drugs and alcohol abuse, smoking, post-traumatic stress disorders in witnesses following a fatal and severe traumatic injuries.

Exposure to crystalline silica has long been a serious hazard in mining. Silicosis, a notifiable disease under the Factories act and the Mines act, is a well known pneumoconiosis commonly occurring in mine workers. The first case of silicosis in the country was reported from the gold mines at Kolar Gold Fields. Exposure to large amount of free silica can pass unnoticed because, silica is odorless, non-irritant and does not cause any immediate noticeable effect and hence is confused with ordinary dust.

Chronic exposure to silica predisposes to tuberculosis, which is still a major health problem in developing countries including India. Recently crystalline silica has been classified as a human carcinogen (Group I) by International Agency for Research on Cancer (IARC). Hence National Institute for Occupational Safety and Health (NIOSH) has said, "Silica is not just dust but it is dangerous dust". Silicosis also increases the risk of contracting Tuberculosis and possibility of developing lung cancer in the future. Silicosis is strongly associated with scleroderma, rheumatoid arthritis and renal disease.⁴²

Mercury, used in the processing of gold ore, and Arsenic, which is a constituent of some gold ores, are common occupational exposures that are hazardous not only to humans, but also to wildlife and domestic animals and may accumulate in the environment causing serious damage to ecosystems and human health. Mercury vapours in the air around amalgam burning sites can be alarmingly high and almost always exceed the WHO limit for public exposure of 1.0 µg/m. These exposures affect not only mine workers but also those in the communities surrounding the processing centers. The vaporized mercury eventually settles in soil and the sediment of lakes, rivers, bays, and oceans and is transformed by anaerobic organisms into methyl mercury. In water bodies, the methyl mercury is absorbed by phytoplankton, ingested by zooplankton and fish thereby contaminating the food chain. It especially accumulates in long-lived predatory species including shark and swordfish.³²

Studies conducted throughout the world have reported the presence of high Hg concentrations in human urine, breast milk, blood, hair, and nails, and in plant and fish samples. Prolonged exposure to mercury and arsenic have been linked to skin diseases, cancer (acute leukemias), high blood pressure, cardiovascular diseases, and neurological and reproductive disorders among others. Even a low level of mercury exposure in pregnant women have been linked to significant birth defects and in addition, mercury exposure due to transmission through breast milk could have an effect on the healthy development of infants.⁴³

The mining process involves multiple steps with the potential for elevated occupational and community noise levels. Noise exposure is associated with hearing impairment, hypertension, ischemic heart disease, annoyance and sleep disturbance. Noise is linked to both psychological and physiological stress, cortisol and heart rate variability.⁴⁴

Often the chronic diseases in miners go unreported. A miner maybe aware of the disease or illness, but may be afraid of reporting the disease because of fear of losing his or her job, health insurance, or other job-related benefits. Therefore, the disease or illness might not be reported. In the second case, medical attention might be received, but neither the attending physician nor the miner associates the disease with the work environment. Again, the disease or illness goes unreported.

In the third case, the miner might have symptoms of a disease, but no medical attention sought, and the disease or illness is not reported. This again could be because of fear of losing a job, health insurance, etc. Also, a miner could be affected with a disease, but might have no symptoms of the disease.⁴¹

Health status of miners:

Mine workers and people residing near the mining areas are exposed to dust of various toxic materials which can cause chronic lung diseases. The major toxicants in gold mining environment are lead, manganese, mercury, arsenic and cadmium. Not many studies are available from India to make accurate extrapolations regarding the number of Indian miners at risk of toxicity. However, some of the studies done indicate that there is high prevalence of chronic diseases among the mining population.

A study was carried out from November 2010 to April 2011 among mine workers from an open-cast iron ore mine in South Goa with an objective to assess morbidity among these workers. Out of 314 workers studied, majority i.e., 207 (65.9%) belonged to 18-35 years' age group. There were only five female mining workers, who worked as helpers. 116 (38.16%) of them had hearing loss (111 had slight impairment, four had moderate impairment and one severe impairment in hearing), 87 (27.7%) had defective vision, 8 (2.5%) had cardiovascular morbidity and 25 (8%) had anemia.⁴⁵

A cross-sectional study was conducted between January and June 2015 at gold mine supply sites at the border between French Guiana and Suriname in South America. The study included 421 persons working in 68 different gold mining sites in French Guiana and aged more than 18 years. Half of the gold miners (48%) never went to school or only had a primary school level. Only 13 workers (3.1%) had French social security. 357 persons reported of having malaria, 203 had leishmaniasis, 135 had dengue or chikungunya, 76 had digestive disorders, and 67 had musculoskeletal disorders. 7 (1.7%) persons declared having had a myocardial infarction, 14 (3.3%) suffering from cardiac rhythm disorder and 22% had anaemia. The study concluded that the hostile living conditions at mining sites erodes the miners' health and leads to a broad range of serious non-communicable and communicable diseases that may spread beyond mining sites and beyond borders.⁴⁶

A study was conducted among miners working in a small-scale gold mine in Sitio Dalisay, Philippines in the year 2016 to assess the environmental health and safety hazards of indigenous small-scale gold mining using cyanidation. The study revealed that 35% of the study subjects were injured during the mining activity, 21% suffered from blurring of vision, and 18% suffered from eye pain and eye redness. The respondents also reported morbidities like ear aches (12%), chest pains (23%), exertional dyspnea (23%), low back pain (23%), and bone joint pains and redness/ swelling of joint (32%).⁴⁷

A study done in Rajasthan which compared the health status of miners with the that of office staff found that 12 out of 150 miners surveyed had musculoskeletal morbidity like Joint pains (4.7%), backache (2.7%) and muscle cramps (1%) while none of the controls had any musculoskeletal morbidity.⁴⁸

Periodical medical examination of employees of Rajasthan State Mines and Minerals (RSMML) by National Institute of Miners' Health, in which 682 employees from seven different mines of Rajasthan were examined in 2010-11 found 24.8% workers having Noise Induced Hearing Loss, 3% employees had vision less than recommended standard.⁴⁹

Diabetes Mellitus:

Diabetes Mellitus has increased rapidly worldwide as a result of unfavorable modification of lifestyle and dietary habits and urbanization. Global diabetes prevalence was 422 million in 2014, and an estimated 1.5 million people died from the consequences of elevated blood sugar. Low and middle income countries account for more than 80% of diabetic deaths and the Indian population have an increased susceptibility for the disease. India has the second largest number of people with diabetes in the world next only to China.^{50,51} Diabetes prevalence studies prevalence studies have been carried out in different parts of the country and is described in Table 1. The disease shows a rising trend over the past two decades.

Table 1: Epidemiological studies on prevalence of diabetes in India.

First Author	Year	Study site	Sample size	Age	Rural/Urban	Prevalence (%)
Zargar AH [52]	2000	Srinagar	5083	40+	Rural	4.3
Prabhakaran D [53]	2005	Delhi	2122	20-59	Urban	15.0
Mohan V [54]	2006	Chennai	2350	20+	Urban	14.3
Ramachandran A [55]	2008	Chennai	2192	20+	Urban	18.6
Vijayakumar G [56]	2009	Kerala	1990	≥ 18	Rural	14.6
Rao CR [57]	2010	Karnataka	1239	≥ 30	Rural	16
Ravikumar P [58]	2011	Chandigarh	2227	≥ 20	Urban	11.1
Anjana RM [59]	2013	Tamilnadu	1029	≥ 20	Urban	13.7
			2480		Rural	7.8
		Maharashtra	1093		Urban	10.9
			2476		Rural	6.5
		Jharkand	840		Urban	13.5
			2051		Rural	3.0
		Chandigarh	839		Urban	14.2
			2247		Rural	8.3
Murthy PD [60]	2014	Tenali	534	≥ 20	Urban	18

The exact etiology of type 2 diabetes mellitus is unknown and various factors are known to play a role. Genetic factors contribute to 30% of the cause, environment 5%, social factors 15%, behavioural factors 40% and health care related factors 10%.⁶¹

The behavioural, social and environmental factors play a major role. Apart from chronic calorie excess and inadequate physical activity, mental stress and depression are the important risk factors. Social factors such as economic status and occupation also have a significant influence.

Hypertension:

Raised blood pressure or hypertension is one of the leading risk factors for global mortality. Hypertension account for 9.4 million deaths worldwide every year. Raised blood pressure is a major risk factor for coronary heart disease, ischemic stroke and haemorrhagic stroke. In some age groups, the risk of cardiovascular disease doubles for each increment of 20/10 mmHg of blood pressure, starting as low as 115/75 mmHg. In addition to coronary heart diseases and stroke, complications of raised blood pressure include heart failure, peripheral vascular disease, renal impairment, retinal haemorrhage and visual impairment.⁶²

Hypertension rarely causes symptoms in the early stages and many people go undiagnosed. Those who are diagnosed may not have access to treatment and may not be able to successfully control their illness over the long term. Not only is hypertension more prevalent in low and middle income countries, there are also more people affected because more people live in those countries than in high-income countries.

Further, because of weak health systems, the number of people with hypertension who are undiagnosed, untreated and uncontrolled are also higher in low and middle income countries compared to high-income countries. Social determinants of health have an adverse impact on behavioural risk factors and thus influence the development of hypertension. For example, unemployment or fear of unemployment may have an impact on stress levels that in turn influences high blood pressure. The risk of hypertension increases with age due to changes in the blood vessels.⁶³

The Indian Council of Medical Research India Diabetes study (ICMR-INDIAB) phase I (from November 2008 to April 2010) which included three states (Tamil Nadu, Maharashtra and Jharkhand) and one union territory (Chandigarh) of India. The results of the study were assessed to determine the prevalence of hypertension (HTN) and its risk factors in urban and rural India. Blood pressure was measured in all study subjects (n=14059). HTN was defined as systolic blood pressure ≥ 140 mm Hg, and/or DBP ≥ 90 mm Hg and/or use of antihypertensive drugs. Overall age-standardized prevalence of HTN was 26.3% (self-reported:5.5%; newly detected:20.8%). Multivariate regression analysis showed that age, male gender, urban residence, generalized obesity, diabetes, physical inactivity and alcohol consumption were significantly associated with HTN.⁶⁴

A systematic review and meta-analysis of prevalence, awareness, and control of hypertension in India by Anchala R and others between January 2013 and 30 May 2013, in which the studies were comprehensively searched in Medline, Embase, Scopus, and web of knowledge. After screening for eligible studies, 142 studies (cross-sectional – 97, cohort – 6, case-control – 12 and mixed methods – 27) were included in the review. Overall prevalence of HTN in India, after weighting the regional population size, was 29.8% (95% CI: 26.7–33.0, $P < 0.001$). Significant differences in HTN prevalence were noted between rural and urban parts of India [rural vs. urban: 27.6% (23.2–32.0, $P < 0.001$) and 33.8% (29.7–37.8, $P = 0.05$]. In south India, the pooled prevalence of HTN for the rural and urban population was 21.1% (20.1–22.0) and 31.8% (30.4–33.1), respectively.⁶⁵

Table 2: Epidemiological studies on prevalence of hypertension in India

First Author	Year	Study site	Sample size	Age	Rural/Urban	Prevalence (%)
Anand MP [66]	2000	Mumbai	1662	30-60	Urban	34.0
Gupta R [67]	2002	Jaipur	1123	20+	Urban	33.4
Shanthirani CS [68]	2003	Chennai	1262	20+	Urban	21.1
Gupta PC [69]	2004	Mumbai	88653	35+	Urban	47.9
Kusuma [70]	2004	Andhra	1316	20+	Rural	21.0
Prabhakaran D [53]	2005	Delhi	2935	20-59	Urban	30.0
Reddy KS [71]	2006	National	19973	20-69	Urban	27.2
Mohan V [72]	2007	Chennai	2350	20+	Urban	20.0
Krishnan [73]	2008	Haryana	2828	15-64	Rural	9.3
Todkar SS [74]	2009	Maharashtra	1297	20+	Rural	7.2
By Y [75]	2010	Karnataka	1900	18+	Rural	18.3
Kaur P [76]	2012	Tamilnadu	10463	25-64	Rural	21.4
Haddad S [77]	2012	Kerala	1660	18-96	Rural	23.5
Gupta R [78]	2013	National	6106	20+	Urban	31.5
Bhansali A [79]	2014	National	14059	20+	Urban	26.3

Diabetes and Hypertension in Miners:

People employed in mining occupation are constantly under stress and are at increased risk of developing diabetes and hypertension. Mahant SD and Kolay SK studied 179 employees of National Mineral Development Corporation (NMDC) at Bachel, Chattisgarh and reported that there can be undesirable consequences for those working in shifts outside standard daytime hours, particularly those covering the night or with early morning starts. Shift work may result in disruption of the internal body clock, fatigue, sleeping difficulties, disturbed appetite and digestion, reliance on sedatives and/or stimulants, social and domestic problems. These in turn can affect performance, increase the likelihood of errors and accidents at work and might have a negative effect on health which leads to metabolic disorders like diabetes. The study concludes that due to a range of existing risk factors, mining sector employees are at increased risk of developing type 2 diabetes. 150 out of 179 mine workers studied were diabetic and 2.79% of them were pre-diabetic.⁸⁰

A survey on health and social status of ex-miners of Kolar Gold Fields by Ranganath BG in the year 2013 showed that among 3347 ex-miners who were interviewed, 11% reported of having Diabetes Mellitus, 11.7% of Hypertension. Around 85% of them had retired from work or were unemployed and 10.8% of them were working as security personnel in various places of Kolar and Bangalore.¹³

Periodical medical examination of employees of Rajasthan State Mines and Minerals (RSMML) by National Institute of Miners' Health in the year 2010, in which 682 employees from seven different mines of Rajasthan were examined from September 2010 to February 2011 showed that 34 (4.9%) workers had raised blood sugar levels indicative of Diabetes and 39 (5.7%) employees had high blood pressure suggestive of hypertension.⁴⁹

A study done by Oliviera A and others included all 314 mining workers employed in an open-cast iron ore mine in a rural area of Quepem taluka in South Goa from November 2010 to April 2011. Data were collected by interviewing the workers at their workplace. The prevalence of diabetes and impaired glucose tolerance was 5.1% and 24.2% respectively. 1.9% of them had glycosuria. Hypertension was present in 8.3% and prehypertension in 11.8% of the study subjects.⁴⁵

A study was undertaken in 12 different Gypsum mines in Rajasthan (2009) to determine the health status of miners by Nandi SS and others. 150 workers engaged in mining activities were included in the study and their health status was compared with that of 83 office staff of the same mines. The study findings showed that the 12 out of 150 (8%) of miners had diabetes (random blood sugar >200 mg/dl) as compared to 2.4% in the control group. The prevalence of hypertension (systolic blood pressure > 140 and diastolic blood pressure > 90) in miners was 22.6% while it was 20.5% in the control group.⁴⁸

A study was conducted in nine organized mines located in the Kachchh, Surat, Bharuch, Vadodara and Bhavnagar districts of Gujarat state in 2015 which included 1690 mine employees of the age group of 18–60. Among 1690 mine employees studied, 653 (38.6%) had normal blood pressure, 773 (45.7%) had prehypertension, and 264 (15.6%) had hypertension. There was a significant positive correlation between age and hypertension in the employees, irrespective of their level of BMI.⁸²

It is known that mine workers are exposed to noise at work place. A study done by Green A and others to assess the association between noise, cortisol and heart rate in a small scale gold mining community in Kejetia, Ghana found that a 1 dBA (A weighted decibel) increase in noise variation over time was associated with a 0.5 BPM (beats per minute) increase in heart rate. The study reveals that occupational noise exposure increases the resting heart rate.⁴⁴

Another prospective study was conducted by Wang L and others in northern China, a 4 year follow-up study of 73357 participants, to study the resting heart rate and the risk of developing impaired fasting glucose (IFG) and diabetes found that faster resting heart rate is associated with higher risk of developing IFG and diabetes with the corresponding adjusted hazard ratios (HRs) for each 10 beats/min increase in heart rate were 1.23 [95% CI: 1.19, 1.27] for incident diabetes, 1.11 (95% CI: 1.09, 1.13) for incident IFG and 1.13 (95% CI: 1.08, 1.17) for IFG to diabetes conversion. The study concludes that faster resting heart rate is associated with higher risk of developing IFG and diabetes.⁸³

A study by Liu J and others in which 738 Chinese coal miners were studied to assess whether they were at risk of developing hypertension and noise induced hearing loss (NIHL), and whether occupational noise exposure was a risk factor of hypertension. The noise-exposed group composed of 360 volunteers who engaged in the noise-generating activities such as wood sawing, forging, and casting were compared with the control group composed of 378 volunteers including managers, transport drivers, and maintenance workers. The prevalence of hypertension in the noise exposed and control group was 29.2% and 21.1% respectively. Taking the control group as reference, it was found that the noise-exposed group had the increased risk of hypertension (age-adjusted OR =1.52, 95% CI =1.07–2.15) and systolic hypertension (age-adjusted OR =1.96, 95% CI =1.23–3.13).

The mean values of systolic blood pressure (SBP) and diastolic blood pressure (DBP) of the noise-exposed groups were significantly higher than the control group ($P=0.006$ and $P=0.002$ respectively). The study concluded that the occupational noise was an independent risk factor for hypertension and could increase the values of SBP and DBP.⁸⁴

A study was done among the small-scale gold miners in Sitio Dalisay located in Barangay Gumatdang in the province of Itogon, Philippines with the aim to study the environmental health hazards at work and cyanide exposure of small-scale gold miners engaged in gold extraction from ores. The study revealed that the miners had a mean age of 36 years and worked in mines for a mean duration of 10.3 years and all of them were male. A total of 41% of them were in prehypertension stage, whereas 29% were in stage 1 hypertension.⁴⁷

A study done by Rajae M and others in 2011 to assess the relationship between organic and inorganic mercury exposure and blood pressure in a small-scale gold mining community in Ghana included two groups – 70 active miners of a small-scale gold mining community and 101 non-miners from a subsistence farming community. 45.7% of the miners studied were in pre-hypertension stage (SBP 120-139 DBP 80-89) and 15.7% of them had hypertension (SBP ≥ 140 DBP ≥ 90). Total specific gravity-adjusted urinary and hair mercury was higher among the miners than non-miners (median urinary Hg: 5.17 and 1.18 $\mu\text{g/L}$, respectively; hair Hg: 0.945 and 0.181 $\mu\text{g/g}$, respectively). However Urinary and hair Hg were not significantly associated with systolic or diastolic BP.⁸⁵

A retrospective, descriptive one year hypertension prevalence study in Gauteng Harmony Mine Operations in South Africa which studied the patient profiles and blood pressure (BP) measurements retrieved from the company electronic data systems to establish the 12-month prevalence of hypertension (2010) in gold miners. Out of 4297 mine workers studied 69.8% were older than 40 years and 90% were male. The overall prevalence of hypertension was 39.5% (n=1696), with a higher prevalence among males (40.5%) compared with females (29.9%). The prevalence of hypertension increased with age, ranging from 15.97% in the 18-29 year old age group to 83.02% in the 60-69 year old age group.⁸⁶

A study was done among a population-based cohort of adults that contained underground miners of Kailuan, a district of Hebei in China (2012) to determine the link between vitamin D concentrations and incident hypertension. During a median follow-up of 2 years, 42.6% of the cohort (n=1047) developed hypertension. Compared with the 25-hydroxyvitamin D >30ng/ml, 25-hydroxyvitamin D <20 ng/ml was associated with a greater hypertension risk (OR: 1.225 [95% CI: 1.010 to 1.485] p=0.04), although the association was attenuated and not statistically significant after adjusting for potential confounders (OR: 1.092 [95% CI: 0.866 to 1.377] p=0.456). A meta-analysis and systematic review of seven available prospective studies for 53,375 participants was done. Using adjusted Hazard ratio, it found a significant association between vitamin D deficiencies and incident hypertension (HRs = 1.235 95% CI: 1.083 to 1.409, p = 0.002).⁸⁷

A study done by Douine M and others (2015) among 421 persons working in 68 different gold mining sites in French Guiana and aged more than 18 years. The blood pressure (BP) was measured twice with a wrist monitor after resting. It was classified according to European recommendations: normal (systolic BP (SBP) <140 mmHg, diastolic BP (DBP) < 90 mmHg), grade 1 (140<SBP<160, 90<DBP<100), grade2 (160<SBP<180, 100<DBP<110), and grade3 (180 < SBP, 110 < DBP). More than a third (37.1%, 95%CI:32.4–41.7) of gold miners suffered from high blood pressure, mainly men (42.1% versus 25%, $p = 0.001$). 93 (22.1%) at grade 1, 47 (11.2%) at grade 2, and 16 (3.8%) at grade 3. Among the ten persons reporting a past history of high blood pressure, two had a medical follow up at a health center and 2 had erratic treatment use.⁴⁶

Chronic lung disease:

Gold miners may also be exposed to respirable crystalline silica in ore, which may exceed 30% crystalline silica in some gold ore dust. Long-term exposure to crystalline silica can cause silicosis, an irreversible pulmonary fibrosis that can exhibit restrictive and obstructive lung disease patterns, which often develop 20 to 45 years after exposure to silica. Miners with silicosis also have accelerated pulmonary function loss.⁸⁸

A study was done among open-cast iron ore mine workers in Goa (2011), in which chest X-rays of all workers were evaluated for pneumoconiotic opacities in accordance with International Labour Organization (ILO) International Classification of Pneumoconiosis and spirometry was performed using a portable spirometer. Two workers (0.6%) suffering from pneumoconiosis were males; one 26 years old working as a plant operator and the other was 41 years old working as a supervisor. 102 (32.5%) workers had radiological abnormalities of perfusion grade 0/1. 9 (2.9%) and 1 (0.3%) of the mining workers had obstructive impairment and combined restrictive and obstructive impairment in spirometry respectively.⁴⁵

Periodical medical examination of employees of Rajasthan State Mines and Minerals (RSMML) by National Institute of Miners' Health, in which 682 employees from seven different mines of Rajasthan were examined in 2010-11 found 21 (3%) employees with suspected pneumoconiosis and 16 (2.3%) employees with pneumoconiosis. 15.6% employees had restrictive impairments in spirometry.⁴⁹

A survey on health and social status of ex-miners of Kolar Gold Fields by Ranganath BG in the year 2013 showed that among 3347 ex-miners who were interviewed, 8% had chronic cough of more than two years.¹³

In a study done to compare pulmonary function and respiratory health of rural farmers and artisanal and small scale gold miners in Ghana in 2011, out of 172 participants, spirometry was performed to 159 subjects. Percent predicted FEV1, FVC and FEV1/FVC, which were lower than predicted for a healthy population, were not significantly different between rural farmers and artisanal and small scale gold miners. Abnormal lung function was elevated for predicted FEV1 (15.0%) and FEV1/FVC (22.0%) beyond an expected five percent in healthy populations. This study did not show an obvious relationship between mining involvement and lung function abnormality, but did show associations between the use of biomass fuels, adverse respiratory symptoms, and reduced pulmonary function in both populations. The authors are of opinion that a number of factors including age differences between the populations and the required lag time after silica exposure for the onset of respiratory disease may have affected results.⁸⁵

A study was done by the National Institute for Occupational Safety and Health (NIOSH), United States to assess the current knowledge regarding US metal and nonmetal miner health in the year 2014. Recent national surveys were analyzed, and literature specific to metal and nonmetal miner health status was reviewed. Studies evaluating respiratory symptoms have demonstrated increased chronic cough, sputum production, wheezing, physician-diagnosed chronic bronchitis, and increased inflammatory cells in sputum among miners.

Miners exposed to dust have exhibited excess loss of lung capacity with a clear exposure-response relationship to respirable dust and respirable quartz. Prevalence of silicosis among persons exposed to dust increased with years of exposure, from 15.4% of miners with <20 years of dust exposure to 47.1% of miners with ≥ 30 years of exposure. This demonstrates the importance of assessing workers after they leave the mining workforce to determine the true burden of silicosis. Approximately 97% of study subjects were evaluated at least 20 years after first dust exposure, and approximately half of those with silicosis were unaware of the diagnosis.⁸⁹

A cross-sectional study on Lung function loss in relation to silica dust exposure among the South African gold miners by Ehrlich RI and others in 2010 showed that lung function loss was demonstrable whether due to silicosis, tuberculosis or an independent effect of dust. A miner working at a respirable dust intensity of 0.37 mg/m^3 for 30 years would lose on average an additional 208ml in FVC in the absence of other disease, an impact greater than that of silicosis and comparable to that of tuberculosis.⁹⁰

A study on the prevalence of Occupational lung disease among Botswana men formerly employed in South African mining industry by Steen TW and others in 1997 showed that out of 304 former miners examined, 26.6% had a history of Tuberculosis, 23.3% had experienced disabling occupational injury and 31% had pneumoconiosis.⁹¹

A cross sectional survey done in Philippines among the miners working in a small scale gold mine to study the environmental health hazards at work revealed that the miners had worked for a mean of 10.3 years, had a mean age of 36 years, with mean lifetime mining work hours of 18,564. The respondents reported of suffering from occasional cough (59%) or frequent cough (12%), dyspnoea (15%) and clear or purulent phlegm production (56%).⁴⁷

MATERIALS & METHODS

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MATERIALS AND METHODS:

STUDY SETTING:

This study was undertaken in Kolar Gold Fields (KGF), a newly created Taluk in Kolar district. Kolar district is situated in southern part of Karnataka state at a distance of about 70kms from Bengaluru. Once famous as one of the largest gold producers in Asia, Kolar is known for silk, milk and mangoes. It occupies an area of about 4012 sq. km. and comprises a population of 15,36,401.¹⁸ It consists of six taluks viz., Mulbagal, Kolar, Bangarpet, Malur, Srinivaspura and KGF.

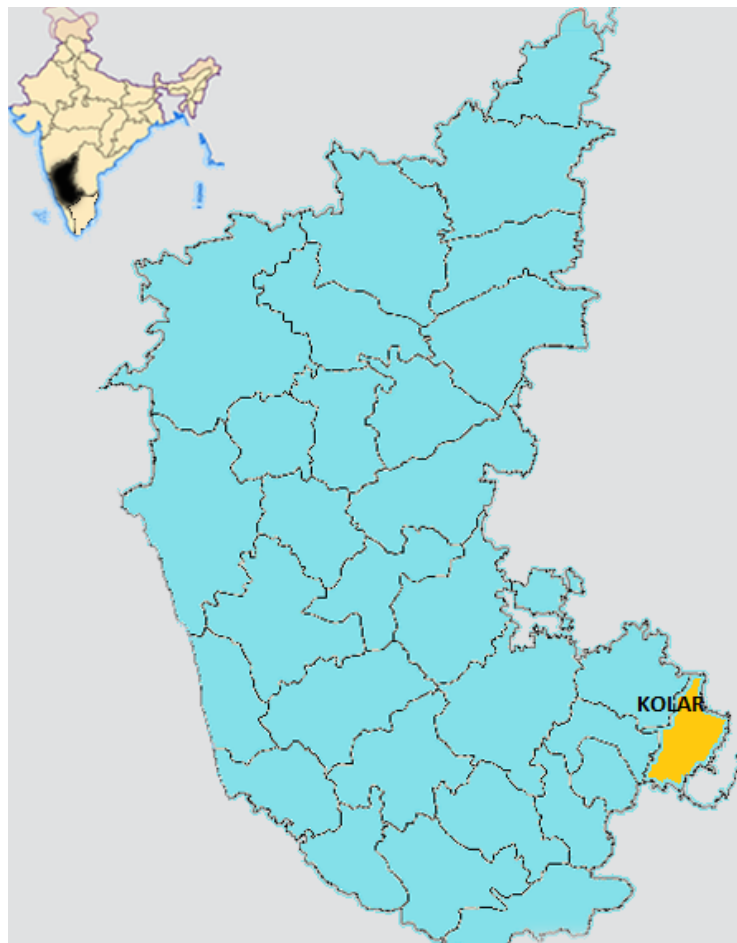


Figure 5 : Map of Karnataka showing Kolar district.

KGF is situated at a distance of about 30 kms from Kolar. It is spread over an area of 58.12 sq km. with a population of 1,63,643 and governed locally by Robertsonpet city municipal council, the biggest municipality in Kolar district. It has 35 municipal wards which includes both mining and non mining areas. The population in Kolar district are Kannada and Telugu speaking and in KGF majority are Tamil speaking. There is also a substantial population of Anglo-Indians at KGF.

STUDY POPULATION:

Individuals who were former employees of Bharat Gold Mines Limited (BGML) and are current residents of KGF are considered for the purpose of the study.

Criteria for inclusion: All those consenting individuals who were employed in BGML and currently residing in any of the selected mining wards were included for the study.

Criteria for exclusion: Ex-miners who were employed in BGML for a duration of less than 5 years¹¹².

SAMPLING:

Sample size: Sample size for the present study was estimated based on the outcome of a survey done on the Health and Social status of ex-miners of Kolar Gold Fields in the year 2013.¹³ It was derived based on the self-reported prevalence of hypertension among the ex-miners which was 11.7% (p). With 95% confidence level and with 4% absolute error (d) using the formula $N = (1.96)^2 p(1-p)/d^2$ with a design effect of 2 and an expected non response of 10% the calculated sample size was 550.

Sampling procedure: Out of 35 municipal wards, 16 were mining wards, under the Bharath Gold Mines Limited (BGML) when it was functional. The ex-miners who were employed in BGML continue to live in these mining wards which are now governed by Robertsonpet city municipal council.

Multi stage (2 stage) sampling was done in order to select the participants from these mining wards. In the first stage, out of the 16 mining wards where each ward is considered as a cluster, 8 of them were randomly selected (Table 3). In the second stage, first, the list of all the ex-miners in the selected 8 wards was obtained from the previous survey data.¹³ The required number of eligible participants from each of these 8 clusters were sampled by simple random sampling. The households of the sampled ex-miners were visited and the questionnaire was administered by the investigator. Next, the ex-miners were invited to come for health examination, blood sugar testing and pulmonary function testing on a fixed date at a specified place in the studied wards.

Table 3: List of mining wards and ex-miner population in each municipal ward in KGF.

Sl no	Ward no.	Ward name	Population of Ex-miners
1	3	Bhalgat ward	303
2	4	Tank ward	119
3	5	Oriental ward	176
4	6	Hendry's ward	159
5	7	Bullens ward	270
6	8	Edgar's ward	210
7	9	Chellappa ward	208
8	10	Chinnakannu ward	169
9	11	Revitter's ward	284
10	12	St. Mary's ward	209
11	13	BGML hospital ward	247
12	14	Albert ward	128
13	15	South town ward	223
14	16	East town ward	230
15	17	North town ward	229
16	18	Kennedy's ward	183
Total			3347

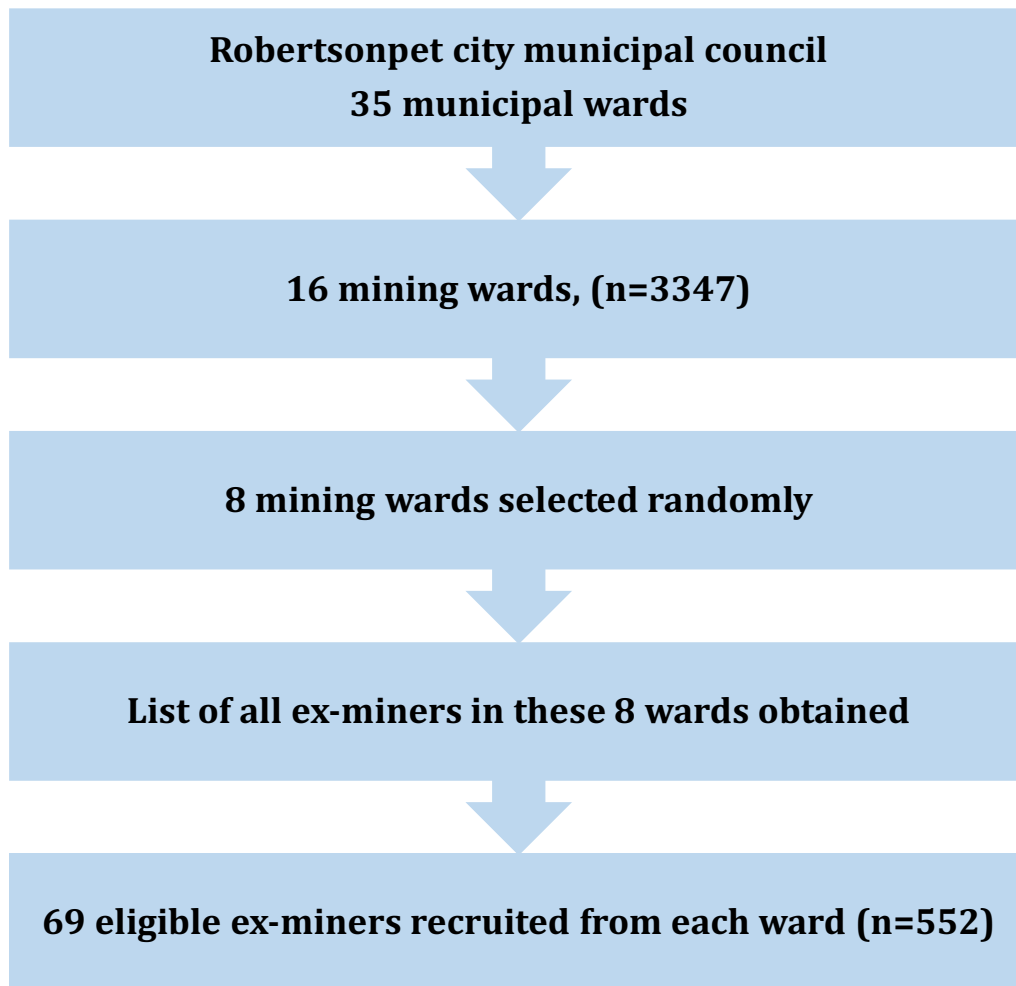


Figure 6: Sampling procedure for inclusion of study subjects

STUDY DESIGN AND STUDY PERIOD:

This descriptive cross-sectional survey was carried out during the period of July 2016 to February 2017.

STUDY TOOLS:

- 1. Structured questionnaire (Annexure I):** A close ended structured questionnaire was administered by interview method. The questionnaire was prepared in English, validated pilot tested and was later translated to Kannada language.

The variables collected by interview were basic demographic details namely age, sex, marital status, address, religion and type of family. The occupational history such as present occupation if employed, past occupation, number of years of work in mining, type of work and designation held was asked. The socio-economic status which included number of working members in family, number of dependents and the educational status was assessed; Smoking and alcohol consumption habits, history of chronic diseases namely diabetes mellitus and hypertension, history of cough more than or equal to 8 weeks¹¹¹ was assessed.

2. Physical examination and anthropometric measurements:

i) Blood pressure measurement: Measured using the OMRON HEM-7132, fully automatic blood pressure monitor which operates on the oscillometric principle.

Blood pressure reading was taken in the right upper arm with the examiner relaxed and comfortably seated on a chair with the arm cuff at the same level as the heart. Two such readings were taken 5 minutes apart and the average of these two readings was considered.^{92,93} Eighth Joint national committee (JNC 8) classification was used to classify hypertension in the study subjects.

Table 4: Joint National Committee 8 classification of hypertension⁹⁴

Classification	Systolic BP (mmHg)	Diastolic BP (mm Hg)
Normal	<120	<80
Pre Hypertension	120-139	80 - 89
Stage 1 Hypertension	140 - 159	90 - 99
Stage 2 Hypertension	≥ 160	≥ 100

iii) Height: Height was measured using a stadiometer fixed to the wall. The subject was made to stand straight on the flat floor, barefoot, with heels, buttocks, shoulders and back of the head touching the upright such that the lower border of the orbit was in the same horizontal plane as the external auditory meatus (Frankfurt plane). The headpiece of the stadiometer was gently lowered, crushing the hair, and making contact with the top of the head. The reading was recorded to the nearest 0.5 centimetre.⁹⁵

iv) Weight: Weight was measured using digital weighing scale. The subject was made to stand barefoot on the centre of the weighing scale, kept on the flat platform, with minimal clothing without touching anything else. The reading was noted and was recorded to the nearest kilogram. The instrument was calibrated daily with a known 5 kg weight before being used.⁹⁵

v) Waist circumference: It was measured with a non-stretchable measuring tape made of fibre at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest. It was recorded to the nearest centimetre.^{96,97}

Table 5: WHO classification of waist circumference for South Asians.⁹⁷

Sex	Waist Circumference	
	Normal	At risk
Male	<90 cms	>90 cms
Female	<80 cms	>80 cms

vi) Hip circumference: It was measured at the widest portion of the buttocks with the subject standing straight.^{96,97}

For the measurement of both waist and hip circumference, the subject was made to stand straight with the feet close together, arms by the side of body, weight evenly distributed across the feet and wearing minimum clothing. Measurements were taken with a non-stretchable tape snug around the body at a level parallel to the floor at the end of normal expiration.^{96,97}

vii) Body Mass Index (BMI): Calculated by dividing the weight of the subject in kilograms by the square of the subjects height in centimetre. The following BMI classification for Asians was used.⁹⁸

Table 6: WHO Body Mass Index classification for Asians⁹⁸

Classification	BMI For Asians
Underweight	<18.5
Normal Weight	18.5-22.9
Over Weight	23-24.9
Pre-obese	25-29.9
Obese	≥ 30

viii) Waist Hip Ratio (WHR): Computed by dividing waist circumference by hip circumference of individual. WHR of ≥ 0.90 for men and ≥ 0.85 for women indicates abdominal obesity and is considered as substantially increased risk of metabolic complications.

Table 7: WHO classification of waist-hip ratio⁹⁸

Sex	Waist-Hip ratio	
	Normal	At risk
Male	≤ 0.90 cm	> 0.90 cm
Female	≤ 0.85 cm	> 0.85 cm

3. Investigations: Blood sugar testing and pulmonary function test were done wardwise at a predefined place on a particular date after explaining the procedure in detail to the participants.

i) Fasting capillary blood sugar: It was done on all the study participants. The ex-miners were advised to remain fasting (no food of beverage except water) overnight for at least 8 hours. It was tested using Accucheck blood glucose meter which works on the principle of reflectance photometry. Fresh capillary blood under aseptic conditions was taken for the test. The following cut-offs were used to classify the participants.

Table 8: Classification of fasting blood sugar levels⁹⁹

Classification	Fasting glucose
Normal	<110 mg/dl
Impaired fasting glucose or Prediabetes	≥ 110 and <126 mg/dl
Diabetes Mellitus	≥ 126 mg/dl

ii) Pulmonary function test: Spirotech CMSP-01 handheld spirometer manufactured by Clarity medical pvt ltd. which uses infrared sensor technology was used to perform pulmonary function test on all the study participants who gave history of cough for more than or equal to 8 weeks. Participant's name, age, sex, height, weight and smoking status were entered into the software and the study participants were explained about the test procedure and its intended purpose. The procedure was first demonstrated by the investigator and then the subject was made to perform the test in a comfortably seated posture.

The standard operating procedure given by the manufacturer was followed to perform the tests. The instrument was calibrated periodically using a 3-liter syringe. The best of the three performed spirometry readings were taken and the following criteria were used to classify the study participants.

Table 9: Classification of ventilatory abnormality in spirometry
100,101

	Normal	Obstructive	Restrictive	Mixed
FEV₁	Above 80% predicted	Reduced	Normal or Mildly reduced	Reduced
FVC	Above 80% predicted	Reduced or Normal	Reduced	Reduced
FEV₁/FVC	Above 0.7	Reduced	Normal or increased	Reduced

TRAINING:

- The investigator underwent hands on training on spirometry at the Pulmonary Medicine department of Christian Medical College, Vellore under the aegis of Indian Chest Society.
- The investigator observed the pulmonary function testing procedure and performed the test under supervision at department of Physiology, Sri Devaraj Urs Medical College.
- Validation of the investigator's method and reading was done in comparison with one of the faculty of department of physiology who regularly perform the test on patients referred at the medical college hospital.

OPERATIONAL DEFINITIONS OF VARIABLES UNDER STUDY:

- 1. Age:** The completed age of ex-miner in years at the time of interview was considered.
- 2. Employment status:**
 - **Employed (workers)** - Persons who are engaged in any economic activity or who, despite their attachment to economic activity, have abstained from work for reasons of illness, injury or other physical disability, bad weather, festivals, social or religious functions or other contingencies necessitating temporary absence from work constitute workers. Unpaid helpers who assist in the operation of an economic activity in the household farm or non-farm activities are also considered as workers.
 - **Unemployed** - Persons, who owing to lack of work, had not worked but either sought work through employment exchanges, intermediaries, friends or relatives or by making applications to prospective employers or expressed their willingness or availability for work under the prevailing condition of work and remuneration are considered as those who are 'seeking or available for work' (or unemployed).
- 3. Education:** Highest completed formal education was considered.
- 4. Occupation:** Engagement in a particular income earning activity for the major part of the day was categorized as main occupation.

Table 10: Classification of individuals according to their occupation¹⁰².

Professional	Doctor, Engineer, Principal, Lawyer, Military officer, Senior executive, Business Proprietor, Writer, Scientist, Large employer, Director, University Professor, Police officer, Others (Horse rider)
Semi Professional	Teacher, Pharmacist, Social worker, Owner of small business and manager, Farmer, others (Computer programmer, constructor, Govt employee, Nurse)
Skilled worker	Artisans, clerk, Supervisor, Carpenter, Tailor, Mechanic, Electrician, Railway guard, Painter, Modelor, Smiths, Baker, Driver, Shop assistant, Petty trader, constable, soldier, potter, barber, linesman, others (tinkering, welder, gardner, cook, mason, postman, plumber)
Semi skilled	Factory operator, Agricultural labour, shoemaker, security guard, shop helper
Unskilled	Labourer, Domestic servants, peon, sweeper, washerman, others.

5. Socio-economic status: The modified Kuppuswamy socioeconomic scale was used to classify socioeconomic status of study participants.

Table 11: Kuppuswamy socioeconomic status classification, 2017.¹⁰³

Education of head of family		Score
Profession or honours		7
Graduate or postgraduate		6
Intermediate or post high school diploma		5
High school certificate		4
Middle school certificate		3
Primary school certificate		2
Literate		1
Occupation of head of family		
Profession		10
Semi-profession		6
Clerical, Shop-owner		5
Skilled worker		4
Semi-skilled worker		3
Unskilled worker		2
Unemployed		1
Monthly income of family (Jan 2017 CPI)		
>41430		12
20715-41429		10
15536-20714		6
10357-15535		4
6214-10356		3
2092-6213		2
<2091		1
Socioeconomic class		Total score
Class I	Upper	26-29
Class II	Upper middle	16-25
Class III	Lower middle	11-15
Class IV	Upper lower	5-10
Class V	Lower	<5

6. Ex-miner: (In the context of present study): Person who was formerly employed in mining sector (BGML, KGF) and currently residing at KGF.

7. Mining occupation:

i) Fitter: Routine repairs and maintenance of mining mechanisms and equipment, control of mine doors, hydraulic feeders, installation, assembly and disassembly, replacement and inspection of selected mechanisms and equipment.

ii) Foreman: Supervises a staff who prepares, inspects, and works in mining projects such as underground or surface mining. Ensures that project/departments milestones/goals are met and adhering to approved budgets.

iii) Timberman: Examines the roof and side walls of haulage ways, air passages, shafts, galleries etc. inside the mines and erects timber or steel props, frames etc. He also removes or repairs the defective props fixed earlier.

iv) Trammer: Loads the mineral ore onto shaker or belt conveyors, fill and haul the mine cars, bring in the mine timber and other materials to support and equip the mine workings, serve the mining and transport machines.

v) Driller: Operates drilling machines to bore blast holes in open-pit mines and to bore holes for blasting.

8. Chronic Lung disease: Chronic respiratory diseases or chronic Lung diseases are a group of chronic diseases affecting the airways and the other structures of the lungs.¹¹⁰ For the purpose of this study, chronic lung disease is defined as having chronic cough of ≥ 8 weeks and/or respiratory abnormality on pulmonary function testing.¹¹¹

9. Type of Family:

i) Nuclear family: Consists of married couple and their dependent children occupying the same dwelling place.

ii) Joint family: Consists of number of married couple and their children live together where all the men are related by blood and the property is held in common.

iii) Three generation family: Has representatives of three generations where couple and their dependent children live with their parents.

STATISTICAL ANALYSIS:

Data collected was coded and entered into Microsoft Excel. Analysis of data was done using SPSS version 20. The summarized data is presented as frequencies, proportions, mean and standard deviation. The association between the study outcomes and its risk factors is analyzed using Chi square test. The risk analysis for the study outcomes is done using logistic regression analysis and expressed as Odds Ratio with 95% confidence intervals. P value of ≤ 0.05 is considered as statistically significant.

ETHICAL CONSIDERATIONS:

The study is approved by the institutional ethical review committee of Sri Devaraj Urs Academy of Higher Education and Research, Kolar. Prior informed written consent was obtained from the participants of the study.

RESULTS

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RESULTS:

Table 12: Distribution of sociodemographic profile of ex-miners residing at Kolar Gold Fields (n=552).

	Characteristic	Frequency	Percentage
1. Age group (years)	<50	20	3.5
	50 to 59	199	36.1
	60 to 69	252	45.7
	≥70	81	14.7
2. Sex	Male	528	95.7
	Female	24	4.3
3. Marital status	Married	509	92.2
	Widower/widow	40	7.2
	Unmarried/Separated	03	0.6
4. Religion	Hindu	359	65.0
	Christian	191	34.6
	Muslim	02	0.4
5. Type of family	Nuclear	388	70.3
	Three generation	134	24.3
	Joint	30	5.4
6. Number of household members	<5	352	63.7
	5 to 10	196	35.5
	>10	04	0.8

The table shows that 45.7% of the study subjects were in the age group of 60 to 69. The mean age of study subjects in this study was 61.9 (SD 7.6 years). Majority of them (95.7%) were males and were married (92.2%). 65% of them belonged to Hindu religion, 70.3% of them belonged to nuclear family. 63.7% of the study subjects had less than 5 members in their household.

Table 13: Distribution of socioeconomic status of ex-miners residing at Kolar Gold Fields (n=552).

Characteristic		Freq	%
1. Education status*	Graduate/postgraduate	22	3.9
	Intermediate/diploma	78	14.1
	High school	285	51.6
	Middle school	66	12.0
	Primary school	39	7.1
	Illiterate	62	11.3
2. Occupation*	Professional	04	0.8
	Semi-professional	09	1.6
	Clerk, farmer, shopkeeper	17	3.1
	Skilled	19	3.4
	Semi-skilled	60	10.9
	Unskilled	45	8.1
	Unemployed	398	72.1
3. Monthly family income*	>=41430	02	0.4
	20715 - 41429	43	7.8
	15536 - 20714	58	10.5
	10357 - 15535	117	21.2
	6214 - 10356	175	31.7
	2092 - 6213	29	5.3
	<2091	128	23.1
4. Socioeconomic status*	Upper	01	0.2
	Upper middle	23	4.2
	Lower middle	110	19.9
	Upper lower	384	69.5
	Lower	34	6.2

* Classification according to modified Kuppuswamy socio-economic status scale 2017

Table 13 shows the socio-economic profile of study subjects. 51.6% of ex-miners studied had completed high school. Many of the study subjects (72.1%) were unemployed at the time of interview. Among those who were employed, 10.9% had a semi-skilled job. 31.7% of study subjects had monthly family income in the range of Rs.6214 to Rs.10356. Majority of them (69.5%) belonged to upper lower socio-economic class.

Table 14: Distribution of ex-miners studied according to the characteristics of their mining occupation (n=552).

Characteristic		Freq	%
1. Type of mining work	Surface mining	196	35.5
	Underground mining	295	53.4
	Both	61	11.1
2. Number of years of work in mining	≤15	25	4.5
	16 to 25	454	82.2
	>25	73	13.3
3. Designation held in BGML	General labourer	228	41.3
	Fitter	54	9.8
	Mechanic	31	5.6
	Machine operator	29	5.3
	Foreman	25	4.5
	Timberman	23	4.2
	Mill worker	22	4.0
	Trammer	20	3.6
	Driver	20	3.6
	Driller	18	3.3
	Others*	82	14.8

* Security ,electrician, welder, clerk, sanitary worker, payroll officer, engineer, stores supplier, nurse, lab technician.

The table shows the distribution of the sampled ex-miners according to the characteristics of work done in BGML. About half (53.4%) of the study subjects were employed in underground mining work, 35.5% in surface work and 11.1% in both underground and surface. Majority of study subjects (82.2%) had worked in the mining sector for a period of 16 to 25 years. The mean number of years of employment in mining sector among the study participants was 22.1 ± 4.5 years. 228 (41.3%) of them said that they had worked as general labourers.

Table 15: Distribution of current alcohol and tobacco consumption among ex-miners at KGF (n=552).

Current users	Frequency	Percentage
1. Tobacco use	126	22.8
2. Alcohol use	86	15.6

Figure 7: Types of tobacco products currently used by ex-miners studied (n=126).

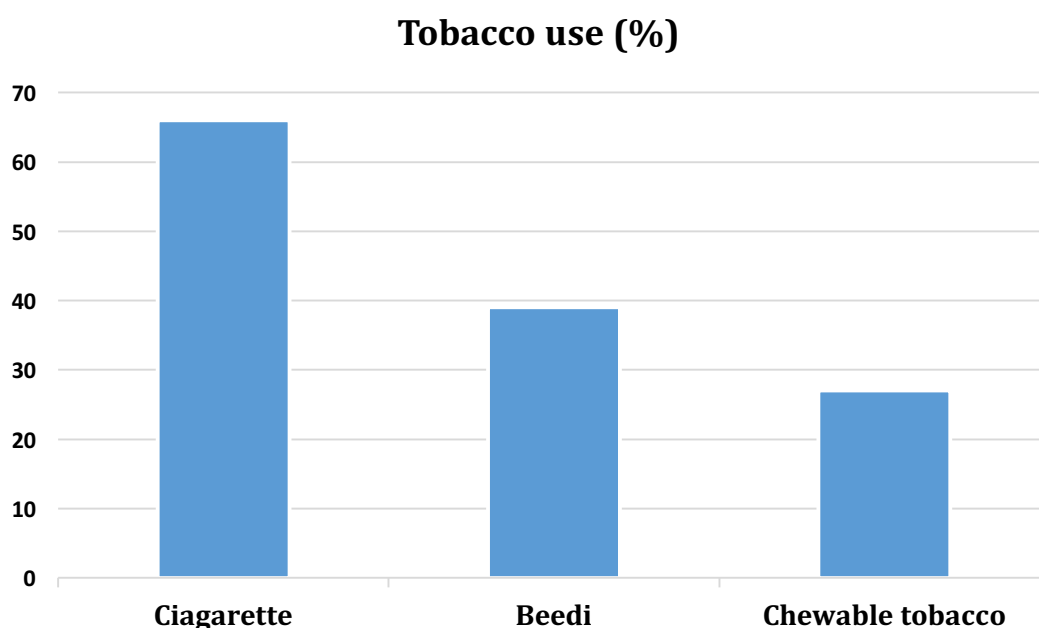


Table 15 depicts the percentage of the study subjects who were consuming tobacco and alcohol at the time of interview. 22.8% and 15.6% of the ex-miners studied gave history of tobacco and alcohol consumption respectively. Out of the 126 who were tobacco users, 83 (65.8%) were cigarette smokers, 49 (38.8%) were beedi smokers and 34 (26.9%) consumed chewable tobacco (Figure 7) (The total percentage is more than 100% as few individuals gave history of consuming more than one form of tobacco). 12 (2.2%) of the study subjects gave history of betel consumption.

Table 16: Nutritional status of the studied ex-miners at KGF (n=532).

Body Mass Index (BMI)		Frequency	Percentage
Underweight	<18.5	13	2.4
Normal	18.5 to 22.9	162	30.5
Overweight	23.0 to 24.9	178	33.5
Pre-obese	25.0 to 29.9	173	32.5
Obese	≥ 30	6	1.1

WHO BMI classification for Asians⁹⁸

Table 16 shows the nutritional status of the study subjects. Body Mass Index classification for Asians was used as it is well known that Asian Indians are at higher health risk at comparatively lower BMI. Accordingly, 33.5% of the ex-miners studied were overweight, 32.5% were pre-obese while 30.5% had body mass index within the normal range.

Table 17: Anthropometric characteristics of the studied examiners at KGF (n=532).

Characteristic		Frequency	Percentage
Waist circumference	Normal	195	36.7
	At risk	337	63.3
Waist-Hip ratio	Normal	177	33.3
	At risk	355	66.7

WHO waist circumference and WHR classification for South Asians⁹⁷

Table 17 shows the distribution of the study participants by their anthropometric characteristics. Out of 515 men who were examined, 37.9% and 34.4% had normal waist circumference and WHR respectively while 62.1% and 65.6% had high waist circumference and WHR respectively. All the 17 women examined had high waist circumference and WHR. Overall, 63.3% had high waist circumference and 66.7% had high waist-hip ratio.

Table 18: Distribution of mean measurements of anthropometry, blood pressure and fasting blood sugar among ex-miners at KGF.

Variable	Mean(SD)	Minimum	Maximum
1. Fasting blood sugar	92.8 (5.6)	71	147
2. Systolic blood pressure	128.4 (12.1)	108	168
3. Diastolic blood pressure	82.8 (7.1)	77	112
4. Weight (kgs)	69.3 (9.6)	45	94.5
5. Height (cms)	169.6 (6.6)	156.5	182
6. BMI	24.0 (2.5)	17.9	32.9
7. WC (cms)	92.2 (6.5)	64.5	110
8. HC (cms)	97.2 (9.1)	60.5	113.5
9. Waist Hip ratio	0.95(0.08)	0.81	1.52

SD - Standard deviation, BMI - Body mass index, WC - Waist circumference, HC - Hip circumference.

Table 18 describes the distribution of mean measurements of anthropometry, blood pressure and fasting blood sugar among ex-miners at KGF. The mean fasting blood sugar of the ex-miners studied was 92.8 ± 5.6 mg/dl. Mean systolic and diastolic blood pressure was 128.4 ± 12.1 and 82.8 ± 7.1 mm Hg respectively. The mean weight in Kgs was 69.3 ± 9.6 , mean height in centimeters 169.6 ± 6.6 , mean body mass index 24 ± 2.5 , mean waist circumference in centimeters 92.2 ± 6.5 , mean hip circumference in centimeters 97.2 ± 9.1 and the mean waist hip ratio 0.95 ± 0.08 among the study participants.

Table 19: Distribution of ex-miners according to fasting capillary blood sugar levels, known diabetics excluded (n=464).

Fasting Blood Sugar (FBS)	Frequency	Percentage
Normal FBS	423	91.2
Elevated FBS	21	4.5
Impaired fasting glucose	20	4.3

FBS-Fasting blood sugar

Table 19 depicts the distribution of ex-miners studied according to their fasting capillary blood sugar levels. Among the ex-miners without a known history of diabetes, 91.2% had normal, 4.5% had elevated and 4.3% had impaired fasting blood sugar levels. A total of 89 (16.7%) study participants had either a known history of Diabetes mellitus or had an elevated fasting blood sugar on examination (95% CI 13.7 to 20.1).

Table 20: Distribution of ex-miners according to blood pressure reading, known hypertensives excluded (n=418).

	Frequency	Percentage
Normal Blood Pressure	388	92.8
High Blood Pressure	30	7.2

BP-Blood pressure

Table 20 shows the distribution of ex-miners according to their blood pressure readings. Systolic blood pressure of ≥ 140 and diastolic blood pressure of ≥ 90 is considered as high blood pressure. Among the ex-miners without a known history of hypertension, 92.8% had normal blood pressure and 7.2% had elevated blood pressure on examination. A total of 144 (27.1%) ex-miners studied had either high blood pressure on examination or a known history of hypertension (95% CI 23.4 to 31.0).

Figure 8: Distribution of ex-miners based on history of cough (n=552).

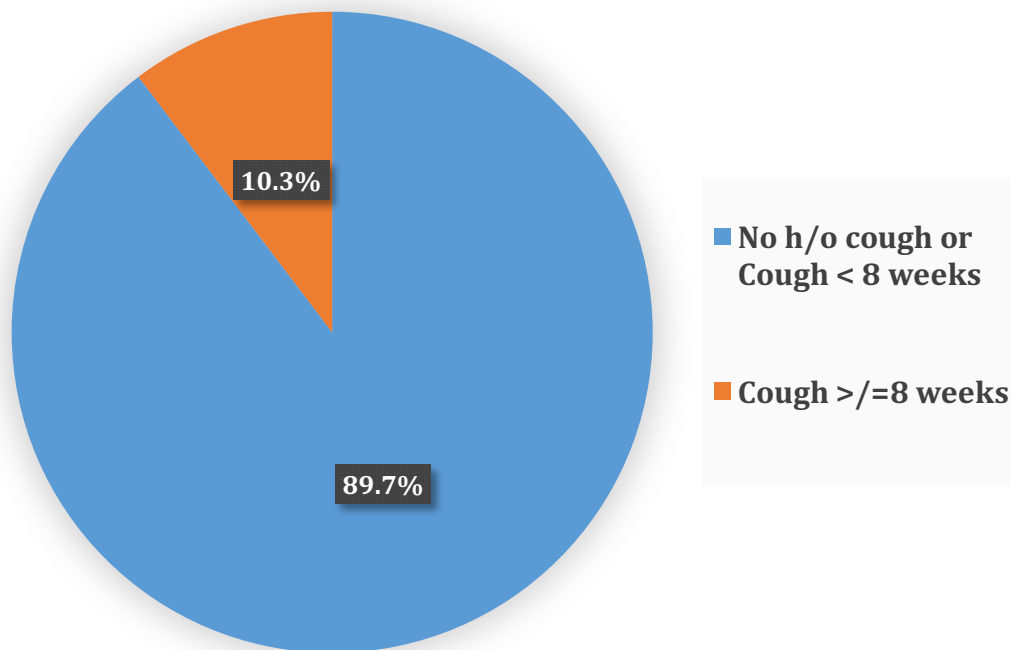


Figure 8 depicts the distribution of ex-miners based on the history of cough. 89.7% of the study participants reported of having no cough or cough with duration of less than 8 weeks. 57 (10.3%) of the ex-miners studied gave history of cough for a duration of more or equal to 8 weeks (95% CI 8.0 to 13.1).

Table 21: Distribution of ex-miners according to their pulmonary function (n=57).

PFT Impression	Frequency	Percentage
Normal PFT	42	73.7
Restrictive	09	15.8
Obstructive	02	3.5
Mixed	04	7.0

PFT-Pulmonary function test

Table 21 describes the distribution of ex-miners studied according to their pulmonary function test. Fifty seven study participants who gave history of cough of more than or equal to 8 weeks duration were subjected to pulmonary function testing. Among them, 42(73.7%) of them had normal spirometry findings, 9(15.8%) had restrictive, 2(3.5%) had obstructive and 4(7%) had mixed impairments on spirometry.

Table 22: Distribution of mean pulmonary function of study participants.

Pulmonary function	Mean	Standard deviation
FVC	2.8	0.31
FEV1	2.15	0.27
PEFR	7.9	0.45
FEV1/FVC	0.87	0.04

FVC-Forced vital capacity, FEV1-Forced expiratory volume in 1st second, PEFR-Peak expiratory flow rate.

Table 22 depicts the mean values of lung function in the study participants. The mean FVC, FEV1, PEFR and FEV1/FVC values were 2.8 ± 0.31 , 2.15 ± 0.27 , 7.9 ± 0.45 and 0.87 ± 0.04 respectively.

Table 23: Distribution of Lung function among the ex-miners by number of years of work in mining , n=57.

No. of years of work in mining Freq (%)		Lung function		P value
		Normal	Impaired	
≤25	46(100)	39(84.8)	7(15.2)	<0.001
>25	11(100)	3(27.3)	8(72.7)	

df -1, Fisher exact P value - <0.001

Table 23 describes the distribution of lung function among ex-miners by number of years of work in mining. Among those who had worked in the mining sector for less than or equal to 25 years, 7(15.2%) had some abnormality in lung function as compared to those who had worked in mining sector for more than 25 years where 8(72.7%) had abnormal lung function. In the ≤25 year category, 8.7%, 4.3% and 2.2% had restrictive, obstructive and mixed lung function abnormality respectively and in >25 year category, 45.4% and 27.3% had restrictive and mixed abnormality in pulmonary function. A statistically significant difference was observed in the pulmonary function tests between the ex-miners who had worked in the mining sector for ≤25 years and >25 years.

Table 24: Factors associated with Diabetes mellitus in ex-miners residing at Kolar Gold Fields (n=532).

Characteristic		Freq	DM Freq(%)	OR (95%CI)	P value
1. Age in years	<60	215	26(12.1)	1	-
	≥60	317	63(19.9)	1.8(1.1-2.9)	0.019
2. Gender	Male	515	86(16.7)	1	-
	Female	17	03(17.7)	1.1(0.3-3.8)	0.918
3. No. of yrs of work in mining	≤15	25	05(20.0)	1	-
	16-25	435	69(15.9)	0.8(0.3-2.1)	0.585
	>25	72	15(20.9)	1.1(0.3-3.3)	0.929
4. SES	Upper	24	06(25.0)	2.1(0.8-5.5)	0.132
	Middle	106	28(26.4)	2.3(1.4-3.8)	0.002
	Lower	402	55(13.7)	1	-
5. BMI	<18.5	13	01(7.7)	0.7(0.1-5.4)	0.705
	18.5-22.9	162	18(11.1)	1	-
	23.0-24.9	178	32(18.0)	1.8(0.9-3.3)	0.077
	25.0-29.9	173	27(21.4)	2.2(1.2-4.0)	0.012
	≥30	06	01(16.7)	1.6(0.2-14.5)	0.676
6. WHR	Normal	177	21(11.9)	1	-
	At risk	355	69(19.2)	1.8(1.0-3.0)	0.035
7. Current employment	Employed	153	26(17.0)	1	-
	Unemployed	379	63(16.6)	1.0(0.6-1.6)	0.917
8. Alcohol use	Yes	86	14(16.3)	1.0(0.5-1.8)	0.903
	No	446	75(16.8)	1	-
9. Type of family	Nuclear	379	52(13.7)	1	-
	Joint	29	09(31.0)	2.8(1.2-6.6)	0.015
	3 generation	124	28(22.6)	1.8(1.1-3.1)	0.020

DM – Diabetes mellitus, SES - Socio economic status, BMI – Body mass index, WHR – Waist hip ratio

Table 24 shows the association of characteristics of study participants with their diabetes status. Age ≥ 60 years, middle socio economic class, higher body mass index (25 to 29.9), higher waist hip ratio and living in a joint and three generation family had a higher risk of developing Diabetes mellitus among the ex-miners studied and this association was statistically significant. The factors which showed a higher odds of having diabetes mellitus among study participants on unadjusted analysis were, living in a joint family (2.8 times higher odds), middle and upper socio economic class (2.3 and 2.1 times higher odds respectively) and having a higher BMI (2.2 times higher odds). Those who had worked in mining sector for a duration of more than 25 years had 1.1 times higher odds of having diabetes mellitus compared to those who had worked for a duration of less than 15 years. However, this finding was not found to be statistically significant.

After adjusting for other variables, the factors which remained significantly associated with diabetes mellitus in study participants were age ≥ 60 years (adjusted OR:2.0, CI:1.2-2.5, P value:0.014), middle socio economic class (adjusted OR:2.4, CI:1.4-4.4, P value:0.003) and higher BMI (adjusted OR:2.2, CI:1.2-4.1, P value:0.017).

Table 25: Factors associated with Hypertension in ex-miners residing at Kolar Gold Fields (n=532).

Characteristic		Freq	HTN Freq(%)	OR (95%CI)	P value
1. Age in years	<60	215	41(19.1)	1	-
	≥60	317	103(32.5)	2.0(1.4-3.1)	0.001
2. Gender	Male	515	141(27.4)	1	-
	Female	17	03(17.7)	0.6(0.2-2.0)	0.380
3. No. of yrs of work in mining	≤15	25	07(28.0)	1	-
	16-25	435	108(24.8)	0.8(0.4-2.1)	0.722
	>25	72	29(40.3)	1.7(0.6-4.7)	0.277
4. SES	Upper	24	07(29.2)	1.1(0.5-2.7)	0.826
	Middle	106	28(26.2)	1.0(0.6-1.6)	0.885
	Lower	402	109(27.1)	1	-
5. BMI	<18.5	13	04(30.8)	1.3(0.4-4.3)	0.703
	18.5-22.9	162	42(25.9)	1	-
	23.0-24.9	178	44(24.7)	1.0(0.6-1.5)	0.798
	25.0-29.9	173	52(30.1)	1.3(0.8-2.0)	0.401
	≥30	06	02(33.3)	1.4(0.3-8.1)	0.687
6. WHR	Normal	177	36(20.3)	1	-
	At risk	355	108(30.4)	1.7(1.1-2.6)	0.014
7. Current employment	Employed	153	33(21.6)	1	-
	Unemployed	379	111(29.3)	1.5(1.0-2.3)	0.071
8. Tobacco consumption	Yes	125	33(26.4)	1.0(0.6-1.5)	0.848
	No	407	111(27.3)	1	-
9. Alcohol use	Yes	86	25(29.1)	1.1(0.7-1.9)	0.648
	No	446	119(26.7)	1	-
10. Type of family	Nuclear	379	30(23.8)	1	-
	Joint	29	12(41.4)	2.3(1.0-4.9)	0.039
	3 generation	124	42(33.9)	1.7(1.1-2.6)	0.027

HTN - Hypertension, SES - Socio economic status, BMI – Body mass index, WHR – Waist hip ratio

Table 25 shows the association of characteristics of study participants with their hypertension status. Age ≥ 60 years, higher waist hip ratio and living in a joint and three generation family had a higher risk of developing hypertension among the ex-miners studied and this association was statistically significant. The factors which showed a higher odds of having hypertension among study participants on unadjusted analysis were, age more than or equal to 60 years (2 times higher odds), living in a joint family (2.3 times higher odds), higher waist hip ratio (1.7 times higher odds) and higher BMI (1.4 times higher odds). Those who had worked in mining sector for a duration of more than 25 years had 1.7 times higher odds and those who were unemployed at the time of interview had 1.5 times higher odds of having hypertension comparatively. However, this finding was not found to be statistically significant.

After adjusting for other variables, the factors which remained significantly associated with hypertension in study participants were age ≥ 60 years (adjusted OR:1.8, CI:1.2-2.8, P value:0.010) and higher waist hip ratio (adjusted OR:1.7, CI:1.1-2.7, P value:0.016).

Table 26: Factors associated with Chronic cough in ex-miners residing at Kolar Gold Fields (n=552).

Characteristic		Freq	Chronic Cough Freq(%)	OR (95%CI)	P value
1. Age in yrs	<60	219	23(10.5)	1	
	≥60	333	34(10.2)	1.0(0.6-1.7)	0.912
2. No. of yrs of work in mining	≤25	479	46(9.6)	1	-
	>25	73	11(15.1)	1.7(1.0-3.4)	0.157
3. SES	Upper	24	02(8.3)	0.8(0.2-3.5)	0.759
	Middle	110	12(10.9)	1.1(0.5-2.1)	0.849
	Lower	418	43(10.3)	1	-
4. Current employment	Employed	154	14(9.1)	1	-
	Unemployed	398	43(10.8)	1.2(0.6-2.3)	0.554
5. Tobacco consumption	Yes	126	31(24.6)	5.0(2.9-8.9)	<0.001
	No	426	26(6.1)	1	-
6. Alcohol use	Yes	86	12(14.0)	1.5(0.8-3.0)	0.232
	No	466	45(9.7)	1	-
7. Type of work	Surface	196	16(8.2)	1	-
	Underground	295	35(11.9)	1.5(0.8-2.8)	0.190
	Both	61	06(9.8)	1.3(0.5-3.3)	0.684

SES - Socio economic status, BMI – Body mass index, WHR – Waist hip ratio

Table 26 shows the association of characteristics of study participants with chronic cough. Smokers had a higher risk of developing chronic cough among the ex-miners studied and this association was statistically significant. The factors which showed a higher odds of having hypertension among study participants on unadjusted analysis were tobacco smoking (5 times higher odds) and alcohol use (1.5 times higher odds). Those who had worked in mining sector for a duration of more than 25 years had 1.7 times higher odds, those who were unemployed at the time of interview had 1.2 times higher odds and those who worked as underground miners had 1.5 times higher odds of having chronic cough comparatively. However, this finding was not found to be statistically significant.

DISCUSSION

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DISCUSSION:

The study assessed the prevalence of chronic non-communicable diseases namely Diabetes mellitus, Hypertension and chronic lung disease among ex-miners of Kolar Gold Fields. The study found that majority of the ex-miners were married men aged between 50 to 69 years belonging mostly to a nuclear family. About three fourth of them were unemployed and belonged to lower socioeconomic class. Tobacco and alcohol consumption was reported by one fourth of study participants. More than half of those studied were either overweight or pre-obese and had higher waist circumference and waist-hip ratio.

Among the ex-miners studied, 13% were known diabetics while 4% of them had high blood sugar levels on examination. 21% were known hypertensives and about 6% of them had high blood pressure on examination. Approximately 10% of the study participants reported of cough of more than or equal to 8-week duration and when subjected to pulmonary function testing, one fourth of them were found to have abnormal lung function indicative of chronic lung disease. Age more than or equal to 60 years, middle socioeconomic status, higher body mass index, higher waist hip ratio and living in a joint or three generation family were significantly associated with diabetes mellitus in the study participants. Age more than or equal to 60 years, higher waist hip ratio, and living in a joint or three generation family were significantly associated with hypertension in the study participants. Similarly, tobacco smoking was found to be significantly associated with cough of more than or equal to 8 weeks in the ex-miners studied.

Socio demographic characteristics:

The mean age of the participants in this study was 61.9 years with a standard deviation of 7.6 years. Other studies done on working mine employees by Dhumne et al⁸² and Nandi et al⁴⁸ found the mean age of study participants to be 49.2 ± 6.8 years and 43.7 ± 7.86 years respectively. In contrast to these studies, the present study included the past mine workers and thus a higher mean age was observed in our study.

Majority (95.7%) of study participants in this study were male. Study done in Goa by Oliveira et al⁴⁵ reported only five female mining workers (1.6%), who worked as helpers. National estimate for metal miners by Yeoman et al⁸⁹ in the United States found that only 13.8% of the miners were female. International Labour Organization (ILO) has had a convention in place since 1935 prohibiting the employment of women in underground mining work. But the modern standards by ILO focus on risk assessment and risk management and provide for sufficient preventive and protective measures for mineworkers, irrespective of gender, whether employed in surface or underground sites.¹⁰⁴ In spite of this, the number of women workers in mines remains less as evident from this study and various other studies. This could be because of the hazardous, laborious and strenuous nature of the underground mining work which women generally are less likely to prefer.

In the present study, majority of the participants had low literacy level. 70.7% were educated upto high school or less and 11.3% were illiterates. Study by Nandi et al⁴⁸ in Rajasthan, reported lower educational status among miners with 42% of them either illiterate or educated only up to the primary school level, as compared to 7% in the non-miner control group.

Leung AMR et al⁴⁷ observed that 39% of the gold miners studied had education only upto high school level. Similar finding was observed in a study by Maepe LM and others⁸⁶ among South African gold miners who had lower educational status. Mining is strenuous job with majority of them working as labourers and there very few mine jobs which necessitate a higher educational status and thus it is not unusual to find higher proportion of miners with lower literacy rates.

In this study, majority (92.2%) were married and few (7.2%) were widows/widowers. Many (75.7%) of the study participants in the present study were living under poor socioeconomic conditions. Study done by Leung AMR and others⁴⁷ among gold miners in Philippines also found that a higher percentage of the miners were married (76%) and had poor socioeconomic status. About three fourth of the participants in the present study were unemployed with no constant source of income and were living in a nuclear family.

In India, underground mine to surface mine ratio is 20:80 with only 39 reporting underground mines in the year 2015-16. The national estimates for number of metal and nonmetal miners by primary work location in the United States by Yeoman KM and others (2008)⁸⁹ found that 47.5% of metallic miners worked in surface mines and 18% worked in underground mines. About half (53.4%) of the ex-miners in the current study were underground miners whereas 35.5% had never worked underground and 11.1% had worked both underground and on the surface. Gold mines in KGF carried out mainly underground mining work and a considerable number of workers had worked underground when it was functional.

Duration of mining work in study participants:

The mean number of years of employment in mining sector among the study participants was 22.1 ± 4.5 years. Majority (82.2%) of the ex-miners studied had worked in the mining sector for a duration of 16 to 25 years. Study done by Nandi et al⁴⁸ in Rajasthan (2009) also found a higher number of workers (77.9%) who had worked for duration of 15 to 30 years in mining. The mean duration of service among miners studied in China (Liu J et al, 2016)⁸⁴ was 22.9 ± 6.6 years. Study done by Leung AMR in Philippines (2016)⁴⁷ found that the miners had been working for an average of 10.3 ± 7.8 years, with the maximum of 30 years.

Tobacco and alcohol consumption among study population:

In the present study, 23.9% of the ex-miners reported of current tobacco smoking and 6.1% consumed chewable tobacco. Study done by Nandi et al⁴⁸ in Rajasthan (2009) found that a similar proportion of miners were smokers (28%) and were tobacco chewers (23%). Higher rates of smoking were observed among the miners in other countries. Study done by Leung AMR and others⁴⁷ among gold miners in Philippines found that majority (62%) of them were smokers, with at least 15 ± 12.97 pack-year smoking history and a total of 29% were betel nut chewers as well. Study done by Liu J et al (2016)⁸⁴ in Chinese miners and by Yeoman KM and others (2008)⁸⁹ in the United states reported a higher number of tobacco smokers (32.5% and 33.1% respectively) compared to the present study.

In the present study, 15.6% of the study participants reported of current alcohol consumption as compared to 19.7% in a study done by Liu J et al⁸⁴ among Chinese miners and 70.5% in a study by Yeoman KM et al⁸⁹ among US miners.

Nutritional status of study population:

The mean height and body weight of the study participants in present study was 169.6 ± 6.6 cms and 69.3 ± 9.6 kgs respectively which is similar to the findings by Dhumne et al⁸² among miners in Gujarat (height 164.1 ± 7.9 cms and body weight 68.3 ± 12) and by Nandi et al⁴⁸ among mine workers in Rajasthan (height 164 ± 7 cms and body weight 66.3 ± 11.6 kgs).

It was observed that 33.5% of the ex-miners studied in this study were overweight, 32.5% were pre-obese and 2.4% were underweight. The mean body mass index of study participants was 24 ± 2.5 . Study done by Dhumne et al⁸² among mine employees in Gujarat (2015) reported similar findings where 33.1% were overweight and 23.3% were obese. Study done by Nandi et al⁴⁸ among mine workers in Rajasthan (2009) found that the mean body mass index was 24.3 ± 3.7 which is similar to our study finding. Similar finding was also reported in a study by Liu J et al (2016)⁸⁴ in Chinese miners who had a mean body mass index of 23.8 ± 2.8 . A study done in the United States by Yeoman KM and others (2008)⁸⁹ found that 27% of the miners were obese. These findings indicate that although the mean body mass index of mine workers is within normal limits, a considerable number of workers are overweight or obese.

Distribution of study participants by blood pressure reading:

Participants of the present study had a mean systolic and diastolic blood pressure of 128.4 ± 12.1 mmHg and 82.8 ± 7.1 mmHg respectively. The prevalence of hypertension in this study was 27.1% (95% CI 23.4 to 31.0). 21.4% of them were known hypertensives and 5.7% of them had blood pressure of more than 140/90 mmHg on examination.

Majority of research on miners focuses on their respiratory health and not many studies have examined the non-communicable disease risk among miners. Other studies done elsewhere have found a similar proportion of miners with high blood pressure. Study done by Nandi et al⁴⁸, Yeoman KM et al⁸⁹ and Douine M et al⁴⁶ found the prevalence of hypertension among miners to be 22.7%, 23.2% and 37.1% respectively. Study by Liu J et al (2016)⁸⁴ in Chinese miners found similar mean systolic and diastolic blood pressure of 124.1 ± 15.7 and 81.5 ± 13.1 mmHg respectively with an overall hypertension prevalence of 29.2%. Study done by Leung AMR and others⁴⁷ among gold miners in Philippines reported that 41% were in prehypertension stage and 29% were in stage 1 hypertension.

In contrast, few other studies have reported a lower proportion of miners with hypertension. study done by Dhumne et al⁸² reported 15.6% with hypertension. But about half (45.7%) of them had prehypertension. Mean SBP and DBP values of the participants were 128.1 ± 8.3 and 83.2 ± 3.4 mmHg respectively. study done by Oliveira et al⁴⁵ reported a lower prevalence of hypertension (8.3%) and pre hypertension (11.8%) among miners in Goa. Periodic medical examination of employees of Rajasthan state Mines and Minerals by National Institute of Miners Health¹⁴ also reported a lower prevalence of 5.7%. This difference is mainly because of the younger age group of the study participants in these studies.

The proportion of hypertension among ex-miners in our study is comparable to that in general Indian population as reported by many studies. There are few factors specific to the mining workers which put them at a considerable risk of getting hypertension. In this study, the factors which were significantly associated with hypertension among ex-miners were age ≥ 60 years, higher waist hip ratio and living in a joint and three generation family. Those participants who were unemployed had higher odds of being hypertensive although this finding was not statistically significant. Other studies have also identified similar factors along with other factors such as occupational noise exposure, higher body mass index, chronic intoxication of gold miners to heavy metals such as lead and/or mercury and work stress.

In this study blood pressure measurements were taken using the OMRON HEM-7132, fully automatic blood pressure monitor which operates on the oscillometric principle. Validated oscillometric devices with digital displays have been demonstrated to be accurate and provide the possibility of removing inter-observer differences in blood pressure measurement. Studies have shown that mercury sphygmomanometers are not as unfailingly accurate as often expected. Random digit preference, observer bias, and white coat hypertension in manual devices, may lead to blood pressure readings that are not an accurate reflection of a patient's daily pressure.¹⁰⁵

Distribution of study participants by blood sugar values:

In the present study, 3.9% of the ex-miners studied had elevated fasting blood sugar levels. A total of 89 (16.7%) study participants had either a known history of Diabetes mellitus or had an elevated fasting blood sugar on examination (95% CI 13.7 to 20.1). 3.8% of them had impaired fasting blood sugar levels.

Study done by Oliveira A et al⁴⁵ in Goa found that the prevalence of diabetes and impaired glucose tolerance among miners was 5.1% and 24.2% respectively and 1.9% of them had glycosuria. The observed prevalence in this study was lower than that of general population, the reasons for which were identified as, the majority of the workers studied were in the younger age group and they were from a rural area and also probably because of the healthy worker effect. Periodic medical examination of employees of Rajasthan state Mines and Minerals by National Institute of Miners Health¹⁴ found that 4.9% workers had raised blood sugar levels indicative of Diabetes.

A study done by Yeoman KM and others (2008)⁸⁹ in the United States found that Diabetes mellitus was higher in metal and non metal miners (5.3%) as compared to all workers (3.9%). Study done by Leung AMR and others⁴⁷ among gold miners in Philippines found a mean random blood sugar of 96.4 ± 22.3 mg/dl. Random blood sugar level was within the normal limits in all the respondents. This was because the participants in the study were young miners with lesser mean age (36 years) as compared to our study.

Overall, the prevalence of Diabetes mellitus in India is on the rise. In the present study, majority of the study participants were elderly males with a mean age of 61.9 years and the general population prevalence for elderly in India reported by various studies range from 18% to 33%.^{106,107,108} Although the proportion of those with high blood sugar levels on examination was 3.9% in the present study, higher proportion of ex-miners (12.8%) were known diabetics. Thus, our study findings in ex-miners is comparable to general elderly population prevalence in the country. But there are multiple factors identified, which puts the mine workers at higher risk of type 2 diabetes mellitus.

In present study, age ≥ 60 years, middle socio economic class, higher body mass index, higher waist hip ratio and living in a joint and three generation family were significantly associated with Diabetes mellitus. Those who had worked in mining sector for a duration of more than 25 years had higher odds of having diabetes mellitus compared to those who had worked for a duration of less than 15 years. Study by Mahant SD and others in which 179 employees of National Mineral Development Corporation (NMDC) at Bachel, Chhattisgarh were studied, identified factors such as working in shifts outside standard daytime hours, particularly those covering the night or with early morning starts, unsystematic routine and work stress which were associated with diabetes mellitus among mine workers.⁸⁰

Distribution of study participants by pulmonary function:

In the present study, 10.3% of the ex-miners studied gave history of cough for a duration of more or equal to 8 weeks and on subjecting to pulmonary function testing, 15.8% had restrictive, 3.5% had obstructive and 7% had mixed abnormalities. Overall, 2.8% of the study participants had abnormal lung function. Those who worked in mining sector for >25 years had significantly higher lung function abnormalities compared to those who worked for ≤ 25 years. Tobacco smoking was also significantly associated with lung function abnormality in the ex-miners studied.

Periodic medical examination of employees of Rajasthan state Mines and Minerals by National Institute of Miners Health¹⁴ showed 3% employees with suspected pneumoconiosis and 2.3% employees with pneumoconiosis. Spirometry results showed 15.6% employees having restrictive impairments which is comparable to our study finding.

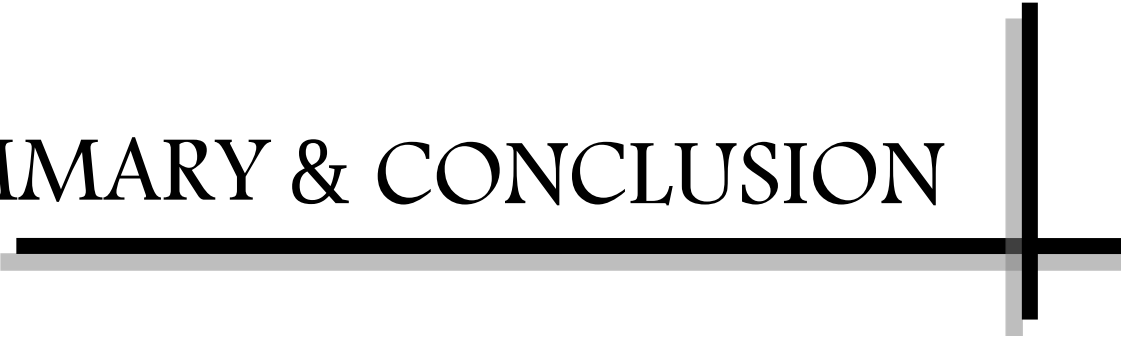
Study done by Oliveira A et al⁴⁵ in Goa also found a similar proportion (3.2%) of miners with abnormal lung function in spirometry. The study identified factors which contribute to development of pneumoconiosis among the mining workers such as the chemical composition of dust, fineness of dust, concentration of dust in the air, period of exposure and health status of the exposed worker.

Study done by Nandi et al⁴⁸ in Rajasthan reported a similar finding which showed that 10% had restrictive impairment and 3.33% had obstructive impairment among the miners. Pulmonary restrictive impairment was significantly higher in the smokers as compared to non-smokers.

In a study among 2586 miners from Rajasthan found comparable results as our study. The study reported 14.3% with restrictive impairment, 1.01% with combined restrictive and obstructive impairment, 2.78% with obstructive impairment.¹⁰⁹

Study done by Leung AMR and others⁴⁷ among gold miners in Philippines found a similar proportion (12%) of miners with frequent cough. The study identified factors such as exposure to dust, exposure to mercury and other chemicals, effects of poor ventilation (heat, humidity, lack of oxygen) and effects of overexertion, inadequate work space as having impact on the respiratory health of miners.

SUMMARY & CONCLUSION

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SUMMARY AND CONCLUSION:

Summary:

In view of their poor socio-economic conditions and continuous mental stress following closure of mines, the ex-miner population in KGF constitute a risk group for various chronic illnesses. This study assessed the prevalence of chronic non-communicable diseases namely Diabetes mellitus, Hypertension and chronic lung disease among the ex-miners of Kolar Gold Fields of Kolar district.

Three fourth of the ex-miners are unemployed and have poor socioeconomic status. More than half of them are either overweight or pre-obese and have higher waist circumference and waist-hip ratio. Around 13% are known diabetics and 4% of them were identified newly with high blood sugar levels on examination. 21% are known hypertensives and about 6% of them were identified newly with high blood pressure on examination. Around 10% of them have cough of more than or equal to 8 weeks and one fourth of them have features of chronic lung disease on pulmonary function test.

Age more than or equal to 60 years, middle socioeconomic status, higher body mass index, higher waist hip ratio, tobacco smoking and living in a joint or three generation family were the factors associated with diabetes mellitus and hypertension in the ex-miners. Tobacco smoking and higher number of years of work in mining were the factors which were found to be significantly associated with chronic lung disease in the ex-miners studied.

The past occupational exposure, stress of job loss, poor socio-economic conditions, lack of family support (as evident by higher number of nuclear families with ex-miners living alone or with their dependent partner), raising overall burden of non-communicable diseases along with the environmental risk of dust from mill tailings in KGF put these ex-miners at higher risk of chronic debilitating mental and physical illnesses, although all of which were not within the prospects of this study.

Conclusion and Recommendation:

The study reports a high prevalence of non-communicable disease risk factors among ex-miners of KGF and emphasises on the need for regular screening for non-communicable diseases like diabetes mellitus and hypertension in this risk group. Every mining company should have a clearly defined mine closure plan at the start of mining activity to which they should be legally adhering. These mine closure plans should not only address the environmental impacts but also the health and social status of the employees following mine closure. Since the development and manifestation of occupational illnesses among miners takes several years and often go unrecognized, a well defined rehabilitation scheme by the government for regular periodic screening, counselling and health education related to such diseases should be implemented.

BIBLIOGRAPHY

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BIBLIOGRAPHY:

1. Workers' health: Global plan of action, [Internet] Sixtieth World Health Assembly. 2007 [Cited 2016 Feb 9]. Available from: www.who.int/occupational_health/who_workers_health_web.pdf
2. Copper C, Palmer K. Mining and quarrying. In, Peter LB. Hunter's disease of the occupations, 10th edition. London, Hodder and Stoughton, 2010;28-44.
3. Metals & mining. India brand equity foundation [Internet]. Feb 2017 [Cited 2017 Feb 12]. Available from <https://www.ibef.org/industry/metals-and-mining.aspx>
4. Mining: Indian statistical year book 2017 [Internet]. Ministry of statistics and programme implementation [Cited 2016 June 20] Available from <http://mospi.nic.in/statistical-year-book-india/2017/184>
5. Miller G. Overview of Mining and its Impacts. [Internet] Guidebook for evaluating mining project EIAs. 1st ed. USA;2010:3-18. [Cited 2017 Oct 3]. Available from <https://www.elaw.org/files/mining-eia-guidebook/Chapter1.pdf>.
6. Dhatrik SV, Nandi SS. Risk assessment of chronic poisoning among Indian metallic miners. Indian J Occup Environ Med. 2009;13:60-4.
7. Eisler R. Arsenic hazards to humans, plants and animals from gold mining. Rev Environ Contam Toxicol 2004;180:133-66.
8. Akagi H, Castillo ES, Maramba NC, Francisco-Rivera AT, Timbang TD. Health assessment for mercury exposure among schoolchildren residing near a gold processing and refining plant in Apokon Tagum Davao del Norte Philippines. Sci Total Environ 2000;259:31-43.
9. Conant J, Fadem P. Mining and Health:A Community guide to environmental health [Internet]. Canada Hesperian.2008 [Cited 2017 Mar 7]. Available from: http://en.hesperian.org/hhg/A_Community_Guide_to_Environmental_Health.
10. Eisler R. Health risks of Gold miners. Environ Geochem Health 2003;25:325-45.

- 11.** Halsema CL, Chihota VN, Pittius NC, Fielding KL, Lewis JJ, Helden PD et al. Clinical relevance of Nontuberculous Mycobacteria isolated from sputum in a Gold mining workforce in South Africa:An observational, clinical study. *Biomed Res Int* 2014;15:1-10.
- 12.** Girdler-Brown BV, White NW, Ehrlich RI, Churchyard GJ. The burden of Silicosis Pulmonary tuberculosis and COPD among former Basotho gold miners. *Am J Ind Med* 2008;51:640-47.
- 13.** Ranganath BG. A survey on the health and social status of ex-miners of Kolar Gold Fields. In, National Institute of Miners Health. National Conference on miners' health. Kolar 2015;53-57.
- 14.** Annual report 2011-12 [Internet]. National Institute of miner's health Nagpur 2012 [Cited 2016 Jan 24]. Available from <http://www.nimh.gov.in/downloads/AnnualReports/Annual%20Report%202011-12%20English.pdf>
- 15.** Indian mineral year book 2016 [Internet]. Indian Bureau of Mines. Ministry of mines Nagpur 2016 [Cited 2017 Jun 17]. Available from [http://ibm.nic.in/writereaddata/files/10252017165654Foreign%20Trade%202016%20\(Advance%20Release\).pdf](http://ibm.nic.in/writereaddata/files/10252017165654Foreign%20Trade%202016%20(Advance%20Release).pdf)
- 16.** Indian minerals year book Part 1. State reviews:Karnataka [Internet]. Indian Bureau of Mines. Ministry of mines Nagpur 2016 [Cited 2017 Jun 17]. Available from [http://ibm.nic.in/writereaddata/files/03162016100105IMYB2016_Karnataka\(Adv\).pdf](http://ibm.nic.in/writereaddata/files/03162016100105IMYB2016_Karnataka(Adv).pdf)
- 17.** Gayatri C. Gold mining. In, Gayatri C. Grit and Gold, 1st edition. Gurgaon, Partridge publishing, 2015;18-39.
- 18.** Wikipedia.org [Internet]. Kolar Gold Fields. Interesting facts [Cited 2016 Sep 19]. Available from https://en.wikipedia.org/wiki/Kolar_Gold_Fields#Interesting_facts
- 19.** Bandh in KGF seeking BGML revival. The Hindu [newspaper on the Internet]. 2011 July 27 [Cited 2016 Mar 10]. Available from URL:<http://www.thehindu.com/todays-paper/tp-national/tp-karnataka/bandh-in-kgf-seeking-bgml-revival/article2297450.ece>

20. Gold mining again? KGF residents jittery. The Times of India [newspaper on the Internet]. 2015 July 3 [Cited 2016 Mar 10]. Available from URL: <http://timesofindia.indiatimes.com/city/bengaluru/Gold-mining-again-KGF-residents-jittery/articleshow/47918191.cms?>
21. Annika MH, Westerling R. Mortality in relation to employment status during different levels of unemployment. Scand J public health 2006;34:159-167.
22. Paul KI, Moser K. Unemployment impairs mental health, a meta-analyses. J Vocat Behav 2009;74:264-82.
23. Richard HP, Choi JN, Amiram DV. Links in the chain of adversity following job loss. J Occup Health Psychol 2002;7:302-12.
24. Sector-wise contribution of GDP of India [Internet]. Ministry of statistics and programme implementation. Government of India 2015 [Cited 2016 Mar 28]. Available from <http://mospi.nic.in/data>.
25. Mining industry in India – an overview [Internet]. Directorate general of mines safety 2016 [Cited 2017 Oct 4]. Available from http://www.dgms.net/mining_industry.
26. Indian mining and metals [Internet]. Indian chamber of commerce report 2015 [Cited 2017 Oct 4]. Available from <https://www.indianchamber.org/wp-content/uploads/2015/07/Background-Note-EY.pdf>
27. Annual report 2016-17 [Internet]. Ministry of mines. Government of India [Cited 2017 October 4]. Available from http://mines.nic.in/writereaddata/UploadFile/Mines_AR_2016-17_English.pdf
28. Mining Operation: Types, Impacts and Remedial Measures [Internet]. Mondal P:Your article library.2012 [Cited 2017 Sep 21] Available from <http://www.yourarticlelibrary.com/environment/natural-resources/mining-operation-types-impacts-and-remedial-measures/30038/>
29. Gold mining map [Internet]. World Gold Council 2016 [Cited 2017 October 5]. Available from <https://www.gold.org/about-gold/gold-supply/gold-mining/gold-mining-map>
30. Sverdrup HU, Ragnarsdottir KV. Natural resources in a planetary perspective. Geochem Perspect. 2014;3:129–341.

31. Environmental impacts and health aspects in the Mining Industry [Internet]. Nilsson JA, Randhem J Chalmers University of Technology Sweden. 2008 [cited 2017 Oct 7]. Available from <http://publications.lib.chalmers.se/records/fulltext/85984.pdf>
32. Mercury exposure and health impacts among individuals in the Artisanal and Small Scale Gold Mining (ASGM) community. [Internet]. World Health Organization 2013 [Cited 2017 Oct 8]. Available from http://www.who.int/ipcs/assessment/public_health/mercury_asgm.pdf?ua=1
33. Srikumar S. Gold mining in KGF. In, Srikumar S. Kolar Gold Field Unfolding the untold, 1st edition. Gurgaon, Patridge India, 2014;11-86.
34. White B. Glory days. In, White B. Kolar Gold Fields Down memory lane. 1st edition. United Kingdom, Author house UK Ltd, 2010;1-49.
35. Subbaraman JV. The mill tailings of Kolar gold mines. Current science 2001;81;631-2.
36. Health effects of unemployment [Internet]. Moller H. Wirral performance and public health intelligence 2012 [Cited 2017 Sep 27]. Available from <https://www.wirralintelligenceservice.org/media/1086/unemployment-2-sept-12.pdf>.
37. Pharr JR, Moonie S, Bungum TJ. The impact of unemployment on mental and physical health, access to health care and health risk behaviors. ISRN Public Health [Internet] 2011;12:1-7 [Cited 2016 Dec 6]. Available from <http://dx.doi.org/10.5402/2012/483432>.
38. Guidelines for preparation of mine closure plan [Internet]. Indian Bureau of Mines 2013 [Cited 2017 Oct 10]. Available from <http://ibm.gov.in/index.php?c=pages&m=index&id=214>.
39. Annual report 2015-16 [Internet]. Ministry of mines. Government of India [Cited 2017 October 4]. Available from http://mines.nic.in/writereaddata/UploadFile/Mines_AR_2015-16_English.pdf
40. Global Plan of Action on Workers' Health (2008-2017): Baseline for Implementation [Internet]. World health organization. Geneva 2013 [cited 2017 October 6]. Available from http://www.who.int/occupational_health/who_workers_health_web.pdf?ua=1.

41. Worker and Community Health Impacts Related to Mining Operations Internationally: A Rapid Review of the Literature [Internet]. Stephens C, Ahern M. International Institute for Environment and Development 2001 [Cited 2017 Oct 2]. Available from <http://pubs.iied.org/pdfs/G01051.pdf>
42. Kulkarni GK. Prevention and control of silicosis: A national challenge. *Indian J Occup Environ Med* 2007;11:95-96.
43. Charles E, Thomas DS, Dewey D, Davey M, Ngallaba SE, Konje E. A cross-sectional survey on knowledge and perceptions of health risks associated with arsenic and mercury contamination from artisanal gold mining in Tanzania. *BMC Public Health* 2013;13:74-82.
44. Green A, Jones AD, Sun K, Neitzel RL. The Association between Noise, Cortisol and Heart Rate in a Small-Scale Gold Mining Community-A Pilot Study. *Int J Environ Res Public Health* 2015;12:52-66.
45. Oliveira A, Cacodcar J, Motghare DD. Morbidity among iron ore mine workers in Goa. *Indian J Public Health* 2014;58:57-60.
46. Douine M, Mosnier E, Hingrat QL, Charpentier C, Corlin F, Hureau L. Illegal gold miners in French Guiana: a neglected population with poor health. *BMC Public Health* 2017;17:736-46.
47. Leung AMR and Lu JLD. Environmental Health and safety Hazards among indigenous small-scale gold miners using cyanidation in the Philippines. *Environmental Health Insights* 2016;10:125-131.
48. Nandi SS, Dhattrak SV, Chatterjee DM, Dhumne UL. Health survey in Gypsum mines in India. *Indian J Community Med* 2009;34:343-45.
49. Annual report 2011-12 [Internet]. National Institute of miner's health. Nagpur 2012 [Cited 2017 Sep 25]. Available from <http://www.nimh.gov.in/downloads/AnnualReports/Annual%20Report%202011-12%20English.pdf>
50. Narain JP, Kumar R. Non-communicable disease in India. In, Narain JP, Kumar R. Textbook of chronic noncommunicable disease. 1st edition. New Delhi, Jaypee brothers medical publishers Ltd, 2016;42-54.
51. Ahuja MMS. Epidemiological studies on diabetes mellitus in India. In, Ahuja MMS. Epidemiology of Diabetes in developing countries. 1st edition. New Delhi, Interprint, 1979;29-38.

52. Zargar AH, Khan AK, Masoodi SR. Prevalence of type 2 diabetes mellitus and impaired glucose tolerance in the Kashmir valley of the Indian subcontinent. *Diabetes Res Clin Pract.* 2000;47:135-46.
53. Prabhakaran D, Shah P, Chaturvedi V. Cardiovascular risk factor prevalence among men in a large industry of northern India. *Natl Med J India* 2005;18:59-65.
54. Mohan V, Deepa M. Secular trends in the prevalence of diabetes and impaired glucose tolerance in urban south India: the Chennai Urban Rural Epidemiology study (CURES-17). *Diabetologia* 2006;49:1175-8.
55. Ramachandran A, Mary S, Yamuna A. High prevalence of diabetes and cardiovascular risk factors associated with urbanization in India. *Diabetes care* 2008;31:893-8.
56. Vijayakumar G, Arun R, Kutty VR, et al. High prevalence of type 2 diabetes mellitus and other metabolic disorders in rural central Kerala. *J Assoc Physicians India* 2009;57:563-7.
57. Rao CR, Kamath VG, Shetty A, Kamath A. A study on the prevalence of type 2 diabetes in coastal Karnataka. *Int J Diabetes Dev Ctries* 2010;30:80-5.
58. Ravikumar P, Bhansali A. Prevalence and risk factors of diabetes in a community- based study in north India: the Chandigarh Urban Diabetes Study (CUDS). *Diabetes Metab* 2011;37:216-21.
59. Anjana RM, Pradeepa R, Deepa M. Prevalence of diabetes and prediabetes in urban and rural India: Phase I results of the ICMR-INDIAB study. *Diabetologia.* 2013;54:3022-27.
60. Murthy PD, Prasad KT. A survey for prevalence of coronary artery disease and its risk factors in an urban population in Andhra Pradesh. *J Assoc Physicians of India* 2014;60:17-20.
61. Preventing chronic disease: a vital investment [Internet]. World health organization 2010 [Cited 2017 Oct 5]. Available from http://www.who.int/chp/chronic_disease_report/full_report.pdf?ua=1
62. Raised blood pressure [Internet]. World health organization 2015 [Cited 2017 Oct 9]. Available from http://www.who.int/gho/ncd/risk_factors/blood_pressure_text/en/

63. A global brief on hypertension [Internet]. World health organization 2013 [Cited 2017 Oct 9]. Available from http://apps.who.int/iris/bitstream/10665/79059/1/WHO_DC_O_WHD_2013.2_eng.pdf?ua=1
64. Bhansali A, Dhandania VK, Deepa M, Anjana RM, Joshi SR, Joshi PP. Prevalence of and risk factors for hypertension in urban and rural India: the ICMR-INDIAB study. *J Hum Hypertension* 2015;29:204-209.
65. Anchala R, Kannuri NK, Pant H, Khan H, Franco OH, Angelantonio ED et al. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. *Journal of Hypertension* 2014;32:170-177.
66. Anand MP. Prevalence of hypertension amongst Mumbai executives. *J Asoc Physicians Ind* 2000;48:120-1.
67. Gupta R, Gupta VP. Prevalence of coronary heart disease and risk factors in an urban Indian population:Jaipur. *Indian Heart J* 2002;54:59-66.
68. Shanthirani CS, Pradeepa R, Deepa R. Prevalence and risk factors of hypertension in a selected south Indian population:the Chennai Urban Population Study. *J Assoc Physicians India* 2003;51:20-27.
69. Gupta PC, Gupta R, Pendnekar M. Hypertension prevalence and blood pressure trends in 88,653 subjects in Mumbai, India. *J Hum Hypertens* 2004;18:907-910.
70. Kusuma YS, Babu BV, Naidu JM. Prevalence of hypertension in some cross cultural populations of Vishakhapatnam district, South India. *Ethn Dis* 2004;14:250-259.
71. Reddy KS, Prabhakaran D, Chaturvedi V. Methods for establishing a system for cardiovascular diseases in Indian industrial populations. *Bull WHO* 2006;84:461-469.
72. Mohan V, Depa M, Farooq S. Prevalence, awareness and control of hypertension in Chennai:The Chennai Urban Rural Epidemiology Study. *J Asoc Physicians India* 2007;5:326-32.
73. Krishnan A, Shah B, Lal V. Prevalence of risk factors for non-communicable disease on a rural area of Faridabad district of Haryana. *Indian J Public Health* 2008;52:17-124.
74. Todkar SS, Gujarathi VV. Period prevalence and sociodemographic factors of hypertension in rural Maharashtra:a crosssectional study. *Indian J Com Med* 2009;34:183-187.

75. By Y, Mr NG, Ag U. Prevalence, awareness, treatment and control of hypertension in rural areas of Davengere. *Indian J Com Med* 2010;35:138-141.
76. Kaur P, Rao SRT, Radhakrishnan E. Prevalence, awareness, treatment and control and risk factors for hypertension in a rural population in south India. *Int J Public Health* 2012;57:87-94.
77. Haddad S, Mohindra KS, Siekmans K. Health divide between indigenous and non-indigenous populations in Kerala, India: population based study. *BMC Public Health* 2012;12:390-4.
78. Gupta R, Deedwania PC, Achari V. Normotension, prehypertension and hypertension in Asian Indians: prevalence, determinants, awareness, treatment and control. *Am J Hypertens* 2013;26:83-94.
79. Bhansali A, Dhandania VK, Deepa M, Anjana RM, Joshi SR, Joshi PP. Prevalence of and risk factors for hypertension in urban and rural India: the ICMR-INDIAB study. *J Hum Hypertension* 2015;29:204-209.
80. Mahant SD, Kolay SK. Type 2 Diabetes; affecting factor & prevalence among mining workers of NMDC Bachel, Dantewada. *IOSR Journal of Humanities and Social Science*. 2015;20:55-8.
81. Annual report 2011-12. [Internet] National Institute of miner's health. Nagpur 2012 [Cited 2017 Oct 7]. Available from <http://www.nimh.gov.in/downloads/AnnualReports/Annual%20Report%202011-12%20English.pdf>
82. Dhumne UL, Dhatri SV, Nandi SS. Effect of age and body mass index on the status of prehypertension and hypertension among mine employees. *Int J Clin Exp Physiol* 2015;2:165-8.
83. Wang L, Cui L, Wang Y, Vaidya A, Chen S. Resting heart rate and the risk of developing impaired fasting glucose and diabetes: the Kailuan prospective study. *International Journal of Epidemiology* 2015;44:689-99.
84. Liu J, Xu M, Ding L, Zhang H. Prevalence of hypertension and noise-induced hearing loss in Chinese coal miners. *J Thorac Dis* 2016;8(3):422-9.
85. Rajae M, Sánchez BN, Renne EP, Basu N. An Investigation of Organic and inorganic Mercury exposure and blood pressure in a small-scale gold mining community in Ghana. *Int J Environ Res Public Health* 2015;12:120-38.

- 86.** Maepe LM, Outhoff K. Hypertension in goldminers. *S Afr Med J* 2012;102:30-33.
- 87.** Qi D, Nie XL, Wu S, Cai J. Vitamin D and hypertension: Prospective study and meta- analysis. *PLoS ONE* [Internet]. 2017 [cited 2017 Sep 20];12:[6 pages]. Available from <https://doi.org/10.1371/journal.pone.0174298>.
- 88.** Greenberg MI, Waksman J, Curtis J. Silicosis: A review. *Dis Mon.* 2007;53:394-416.
- 89.** Yeoman KM, Halldin CN, Wood J, Storey E, Johns D, Laney AS. Current knowledge of US metal and nonmetal miner health: Current and potential data sources for analysis of miner health status. *Archives of environmental & occupational health* 2016;71:119–126.
- 90.** Ehrlich RI, Myers JE, Water Naude JM, Thompson ML, Churchyard GJ. Lung function loss in relation to silica dust exposure in South African gold miners. *Occup Environ Med* 2011;68:96-101.
- 91.** Steen TW, Gyi KM, White NW, Gabosianelwe T, Ludick S, Mazonde GN et al. Prevalence of occupational lung disease among Botswana men formerly employed in South African mining industry. *Occup Environ Med* 1997;54:19-26.
- 92.** Pulse and blood pressure procedures for household interviews [Internet]. Center for disease control [Cited 2017 Aug 27]. Available from <https://wwwn.cdc.gov/nchs/data/nhanes3/manuals/pressure.pdf>.
- 93.** Smith L. Practice Guidelines:New AHA recommendations for blood pressure measurement. *Am Fam Physician.* 2005;7:1391-1398.
- 94.** James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C. Evidence-based guideline for the management of high blood pressure in adults:report from the panel members appointed to the eighth Joint National Committee (JNC 8). *JAMA* [Internet]. 2013 [Cited 2016 Dec 10]. Available from <http://csc.cma.org.cn/attachment/2014315/1394884955972.pdf>.
- 95.** The assessment of the nutritional status of the community [Internet].World health organization 1966 [Cited 2017 Aug 14].Available from <http://apps.who.int/iris/handle/10665/41780>.

96. WHO Stepwise approach to surveillance (STEPS) [Internet]. World health organization [Cited 2015 Jun 03]. Available from: <http://www.who.int/chp/steps/en/>
97. Waist circumference and waist-hip ratio:report of a WHO expert consultation [Internet]. World health organization 2008 [Cited 2017 Oct 07]. Available from http://apps.who.int/iris/bitstream/10665/44583/1/9789241501491_eng.pdf.
98. Barba C, Manila M, Cavalli-Sforza T, Cutter J, Darnton-Hill I, Deurenberg P. Appropriate body mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004;363:157-63.
99. American Diabetes Association Clinical Practice Recommendations. Standards of medical in Diabetes. *Diabetes care* 2012;35:11-63.
100. Pellegrino R, Viegi G, Brusasco V, Crapo RO, Burgos F, Casaburi R et al. Interpretative strategies for lung function tests. *Eur Respir J* 2005;26:948-968.
101. Spirometry for health care providers [Internet]. Global Initiative for Chronic Obstructive Lung Disease [Cited 2015 Jun 03] Available from http://goldcopd.org/wp-content/uploads/2016/04/GOLD_Spirometry_2010.pdf
102. Skilled, semi skilled and unskilled as per minimum wages [Internet]. Minimum wages act [Cited 2015 Jun 03] Available from <http://hrsuccesstalk.com/forum/Thread-Definition-of-Skilled-Semi-Skilled-and-Unskilled-as-per-Delhi-Minimum-Wages>.
103. Singh T, Sharma S, Nagesh S. Socio-economic status scales updated for 2017. *Int J Res Med Sci* 2017;5:264-7.
104. Underground work (women) convention, 1935 [Internet]. International Labour Organization [Cited 2017 Nov 03]. Available from http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_INSTRUMENT_ID:312190
105. The accuracy of alternatives to mercury sphygmomanometer [Internet]. Buchanan S. University of Illinois 2009 [Cited 2016 Jun 16]. Available from https://noharm-uscanada.org/sites/default/files/documents-files/827/Accuracy_Alts_Mercury_Sphyg_rev10-09.pdf

- 106.** IDF Diabetes Atlas 8th edition [Internet]. International Diabetes Federation 2017 [Cited 2017 Nov 16. Available from <https://www.idf.org/e-library/epidemiology-research/diabetes-atlas.html>
- 107.** Kirkman MS, Briscoe VJ, Clark N, Florez H, Haas LB, Halter JB, et al. Diabetes in older adults. *Diabetes Care*. 2012;35:2650–64.
- 108.** Chentil F, Azzoug S, Mahgoun S. Diabetes mellitus in elderly. *Indian J Endocrinol Metab*. 2015;19:744-752.
- 109.** Health status evaluation of miners in Rajasthan [Internet]. Khanik A. National Insstitute of Miners Health 2010 [Cited 2017 Oct 6]. Available from <http://www.nimh.gov.in/Publications.html>
- 110.** Chronic respiratory diseases [Internet]. World Health Organization [Cited 2016 Nov 10]. Available from http://www.who.int/respiratory/about_topic/en/
- 111.** Cough [Internet]. National heart, lung and blood institute. National Institutes of Health [Cited 2016 Nov 10]. Available from <https://www.nhlbi.nih.gov/health/health-topics/topics/cough>
- 112.** Madl AK. Respiratory toxicology Silica and silicosis In, Charlene Am. *Comprehensive toxicology* 2nd ed. California:Elsevier;2010.p 421-51.

ANNEXURES

A decorative graphic consisting of a thick horizontal line and a thick vertical line intersecting at a right angle. The horizontal line is positioned below the word 'ANNEXURES' and extends across the width of the page. The vertical line is positioned to the right of the horizontal line and extends upwards and downwards from the intersection point.

ANNEXURE – I

PROFORMA FOR DATA ACQUISITION

Investigator:

Date:

SECTION A

Sl no.	Question	Response						
1	Name							
2	Date of birth							
3	Sex	Male/Female						
4	Address							
5	Municipal ward							
6	Contact number							
7	Employment status	Employed/Unemployed						
8	Occupation (if employed)							
9	Year of joining BGML							
10	Year of retirement/termination							
11	Income per month (in Indian Rupees)							
12	Education							
13	Marital status	Married / Unmarried / Separated / Divorced / Widower / Widow						
14	Religion	Hindu/Muslim/Christian/Other						
15	Type of family	Nuclear/Joint/Three generation						
16	Number of household members							
17	Total family income per month (in Rs)							
18	Household composition:							
Sl. No	Name of HH member	Relation to Head of HH	A g e	S e x	Education	Marital Status (married/Divorced/separated/Widow)	Occupation	Monthly income

SECTION B:

19	History of Chronic Diseases	Chronic Disease	Present/ Absent	Duration	Follow up in last 6 months	Advice : Reg/Irreg Diet Exercise Yoga Other			
		Diabetes							
		High BP							
		C H D							
		Asthma							
		T.B							
20	Tobaco Consum ption	Type Cigarette Beedi Ghutka Hoge Soppu Kaddi Pudi Snuff (neshe) Hans Others	Freq	Quantity	No of yrs Consumed	Any attempt made to quit Y / N	Wants to quit Y / N		
21	Alcohol consumption	Type Beer Wine Brandy Whisky Rum Gin Vodka Others	Freq (Daily ,Alt days, Twice a week , Once a week , Ocassionaly)	Quantity (30ml , 60ml ,90 ml , 1 quarter , Others)	No of yrs Consumed	Any attempt made to quit Y / N	Wants to quit Y / N		
22	Betel leaf , Betel nut and Lime								
23	History of Cough			Present/Absent					
24	If Present								
	a. Duration of cough								
	b. Do u bring out phlegm with cough?			Yes/No					
25	Do you have difficulty in breathing?			Yes/No					
26	Do you have shortness of breath?			Yes/No					

27	Do you have any other health complaint?	Yes/No		
		If Yes, What is the complaint?		
28	Were u sick for anytime in the past 6 months?	Yes/No		
		If Yes, What was/is the sickness?		
29	Did you take any treatment for your illness?	Yes/No		
30	Where did you go for treatment?	Private clinic/Government hospital/Private hospital/ ritualistic treatment		
31	If not taken treatment/delayed treatment, What is the reason?	Not affordable/Very far/No transport available/No one to accompany/Other		
Examination				
32	Pulse			
33	Blood Pressure			
34	Weight (kgs)			
35	Height (cms)			
36	Body Mass Index			
37	Waist circumference (cms)			
38	HIP circumference (cms)			
39	Waist-Hip ratio			
SECTION C				
40	Fasting Blood Sugar			
41	Pulmonary Function Test			
	a. Forced Vital Capacity (FVC)			
	b. Forced Pulmonary Expiratory Volume in 1 st second (FEV ₁)			
	c. Peak Expiratory Flow rate (PEF):			
	d. FEV ₁ /FEV			

ANNEXURE – II
INFORMATION SHEET

Title of the study: A study of prevalence of diabetes mellitus, hypertension and chronic lung disease among ex-miners of KGF.

My name is **Dr.Vishwas.S**, Post graduate in the department of Community Medicine, Sri Devaraj Urs Medical College, Kolar. We are carrying out a study on health of ex-miners residing at Kolar Gold Fields. The study has been reviewed by the local ethical review board and has been started only after their formal approval.

Mining has always been among the most hazardous occupations. There are studies which suggest that there is increased risk of certain disease such as COPD, Diabetes, Hypertension among the miners. In this regard, I will ask you some questions about your household and the members staying at your household. You need not have to answer any questions that you do not want to answer and you may end this interview at any time you want to. However, your honest answer to these questions will help us better understand the health status of this area. We would greatly appreciate your help in responding to this survey. The survey will take about half an hour.

Participation in this study doesn't involve any cost for you. This study is not only beneficial to you but also to the community at large. The results gathered from this study will be beneficial in estimating the burden of certain chronic illnesses in this population. All the information collected from you will be strictly confidential and will not be disclosed to any outsider unless compelled by law. This information collected will be used only for research.

I request you to kindly give consent for the clinical examination, and allow me to carry out your Blood sugar estimation test and your lung function test. For lung function test, you just have to serially blow air into the instrument. And For blood sugar estimation, I will collect 1-2 drop of blood after a finger prick under aseptic conditions.

There is no compulsion to participate in this study. You will be no way affected if you don't wish to participate in this study. You are required to sign only if you voluntarily agree to participate in this study. Further, you are at a liberty to withdraw from the study at any time, if you wish to do so. Be assured that your withdrawal will not affect your treatment by the concerned physician in any way. It is up to you to decide whether to participate.

For any further clarification you are free to contact the principal investigator,

Dr. Vishwas.S; Mobile No: 9663613766

ANNEXURE – III
INFORMATION SHEET – KANNADA

ಮಾಹಿತಿ ಪತ್ರ

ಶೀರ್ಷಿಕೆ: ಕೆ.ಜಿ.ಎಫ್‌ನಲ್ಲಿ ವಾಸವಿರುವ ಮಾಜಿ ಗಣಿಗಾರರಲ್ಲಿ ಮಧುಮೇಹ, ಅತಿಯಾದ ರಕ್ತದೊತ್ತಡ ಮತ್ತು ದೀರ್ಘಕಾಲದ ಶ್ವಾಸಕೋಶದ ಕಾಯಿಲೆಯ ಬಗ್ಗೆ ಸಂಶೋಧನೆ.

ನನ್ನ ಹೆಸರು ಡಾ. ವಿಶ್ವಾಸ್.ಎಸ್, ಶ್ರೀ ದೇವರಾಜ್ ಅರಸ್ ವೈದ್ಯಕೀಯ ಮಹಾವಿದ್ಯಾಲಯದ ಸಮುದಾಯ ಶಾಸ್ತ್ರ ವಿಭಾಗದ ವಿದ್ಯಾರ್ಥಿ. ನಾನು ಕೋಲಾರದ ಕೆ.ಜಿ.ಎಫ್‌ನಲ್ಲಿ ವಾಸವಿರುವ ಮಾಜಿ ಗಣಿಗಾರರಲ್ಲಿ ಮಧುಮೇಹ, ಅತಿಯಾದ ರಕ್ತದೊತ್ತಡ ಮತ್ತು ದೀರ್ಘಕಾಲದ ಶ್ವಾಸಕೋಶದ ಕಾಯಿಲೆಯ ಬಗ್ಗೆ ಸಂಶೋಧನೆ ನಡೆಸುತ್ತಿದ್ದೇನೆ. ಈ ಸಂಶೋಧನೆಯು ಸ್ಥಳೀಯ ನೈತಿಕ ಸಮಿತಿಯ ಮನ್ನಣೆಯನ್ನು ಪಡೆದಿರುತ್ತದೆ.

ಗಣಿಗಾರಿಕೆಯು ಅತ್ಯಂತ ಅಪಾಯಕಾರಿ ಉದ್ಯೋಗಗಳಲ್ಲಿ ಒಂದು. ಗಣಿಗಾರರಲ್ಲಿ ಶ್ವಾಸಕೋಶದ ತೊಂದರೆ, ರಕ್ತದೊತ್ತಡ, ಸಕ್ಕರೆ ಕಾಯಿಲೆ, ಅಂಧತ್ವ ಇತ್ಯಾದಿಗಳಂತಹ ಹಲವಾರು ಕಾಯಿಲೆಗಳು ಹೆಚ್ಚಾಗಿರುತ್ತವೆಂದು ಕೆಲವು ಸಂಶೋಧನೆಗಳ ಮೂಲಕ ತಿಳಿದುಬಂದಿರುತ್ತದೆ. ಆದ್ದರಿಂದ ನಾನು ತಮಗೆ ಮತ್ತು ತಮ್ಮ ಮನೆಯ ಸದಸ್ಯರಿಗೆ ಕೆಲವೊಂದು ಪ್ರಶ್ನೆಗಳನ್ನು ಕೇಳುತ್ತೇನೆ. ತಾವು ಪ್ರಾಮಾಣಿಕವಾಗಿ ಈ ಪ್ರಶ್ನೆಗಳಿಗೆ ಉತ್ತರಿಸಿದರೆ ನನ್ನ ಸಂಶೋಧನೆಗೆ ಬಹಳ ಸಹಕಾರಿಯಾಗುತ್ತದೆ. ಈ ಸಮೀಕ್ಷೆಯು ಅಂದಾಜು ಅರ್ಧ ತಾಸಿನಷ್ಟು ಸಮಯವನ್ನು ಹಿಡಿಯುತ್ತದೆ.

ಈ ಸಮೀಕ್ಷೆಯಿಂದ ತಮಗೆ ಯಾವುದೇ ಖರ್ಚು ತಗುಲುವುದಿಲ್ಲ ಬದಲಿಗೆ ಈ ಸಮೀಕ್ಷೆಯಲ್ಲಿ ಬಾಗವಹಿಸುವುದರಿಂದ ತಮಗೆ ಹಾಗೂ ಇಡೀ ಸಮುದಾಯಕ್ಕೆ ಉಪಯೋಗವಾಗಲಿದೆ. ಈ ಸಮೀಕ್ಷೆಯ ಮೂಲಕ ಪಡೆದ ತಮ್ಮ ಮಾಹಿತಿಯನ್ನು ಕೇವಲ ಸಂಶೋಧನೆಗೆ ಹೊರತು ಮತ್ತೆಲ್ಲಿಯೂ ಬಹಿರಂಗ ಪಡಿಸುವುದಿಲ್ಲ (ಕಾನೂನಿನ ಬಲವಂತಕ್ಕೆ ಹೊರತು ಪಡಿಸಿ). ಆದ್ದರಿಂದ ತಾವು ಈ ಸಮೀಕ್ಷೆಯಲ್ಲಿ ಬಾಗವಹಿಸಿ, ವೈದ್ಯಕೀಯ ಪರೀಕ್ಷೆಗೆ ಒಳಪಡಲು ಹಾಗೂ ಕೆಲವು ಪರೀಕ್ಷೆಗಳನ್ನು ನಡೆಸಲು(ರಕ್ತದ ಸಕ್ಕರೆ ಪ್ರಮಾಣದ ಪರೀಕ್ಷೆ & ಶ್ವಾಸಕೋಶದ ಕಾರ್ಯದ ಪರೀಕ್ಷೆ) ತಮ್ಮ ಸಮ್ಮತಿಯನ್ನು ನೀಡಬೇಕಾಗಿ ವಿನಂತಿಸುತ್ತೇನೆ. ರಕ್ತದ ಸಕ್ಕರೆ ಪ್ರಮಾಣದ ಪರೀಕ್ಷೆಗೆ ತಮ್ಮಿಂದ ೨-೩ ತೊಟ್ಟು ರಕ್ತವನ್ನು ಪಡೆಯಲಾಗುವುದು ಮತ್ತು ಶ್ವಾಸಕೋಶದ ಕಾರ್ಯದ ಪರೀಕ್ಷೆಗೆ ಒಂದು ಸಲಕರಣೆಯಲ್ಲಿ ತಾವು ಹಲವು ಬಾರಿ ಶ್ವಾಸವನ್ನು ಉದಬೇಕಾಗುತ್ತದೆ.

ಈ ಸಮೀಕ್ಷೆಯಲ್ಲಿ ಬಾಗವಹಿಸಲು ಯಾವುದೇ ಬಲವಂತವಿಲ್ಲ. ತಾವು ಸ್ವೇಚ್ಛೆಯಿಂದ ಇದರಲ್ಲಿ ಬಾಗವಹಿಸಲು ಒಪ್ಪಿಗೆ ನೀಡಬೇಕಾಗಿದೆ ಮತ್ತು ಯಾವುದೇ ಸಮಯದಲ್ಲಾದರೂ ತಾವು ಇದರಿಂದ ಹೊರಉಳಿಯಲು ಬಯಸಿದಲ್ಲಿ ತಮಗೆ ಸಂಪೂರ್ಣ ಸ್ವಾತಂತ್ರ್ಯವಿರುತ್ತದೆ.

ತಮಗೆ ಹೆಚ್ಚಿನ ಮಾಹಿತಿ ಅಥವಾ ಸ್ಪಷ್ಟೀಕರಣ ಬೇಕಾದಲ್ಲಿ ನನ್ನನ್ನು ಸಂಪರ್ಕಿಸಿ. ಡಾ. ವಿಶ್ವಾಸ್.ಎಸ್ ಮೊಬೈಲ್:9663613766

ANNEXURE – IV
INFORMED CONSENT FORM

Sl. no:

Title of the study: A study of prevalence of diabetes mellitus, hypertension and chronic lung disease among ex-miners of Kolar Gold Fields

I, the undersigned, agree to participate in this study and to undergo clinical examination, blood glucose estimation (Glucometry) and Pulmonary Function Test as outlined.

I have been read out/ explained in my local language i.e. in _____ and understand the purpose of this study and the confidentiality of the information that will be collected during the study. I have had the opportunity to ask questions regarding the various aspects of this study and my questions have been answered to my full satisfaction. The information collected will be used only for research.

I understand that I remain free to withdraw from this study at any time. Participation in this study is under my sole discretion and does not involve any cost to me.

Subject's name and signature /thumb impression

Date:

Name and signature of interviewer:

Date:

Principal Investigator: Dr.Vishwas.S

Contact No: 9663613766

ANNEXURE - V
INFORMED CONSENT FORM - KANNADA

ಒಪ್ಪಿಗೆ ಪತ್ರ

ಕ್ರಮ ಸಂ.

ಶೀರ್ಷಿಕೆ: ಕೆ.ಜಿ.ಎಫ್‌ನಲ್ಲಿ ವಾಸವಿರುವ ಮಾಜಿ ಗಣಿಗಾರರಲ್ಲಿ ಮಧುಮೇಹ, ಅತಿಯಾದ ರಕ್ತದೊತ್ತಡ ಮತ್ತು ದೀರ್ಘಕಾಲದ ಶ್ವಾಸಕೋಶದ ಕಾಯಿಲೆಯ ಬಗ್ಗೆ ಸಂಶೋಧನೆ.

ಈ ಕೆಳಗೆ ಸಹಿ ಮಾಡಿರುವ ನಾನು ಈ ಸಮೀಕ್ಷೆಯಲ್ಲಿ ಬಾಗವಹಿಸಿ, ವೈದ್ಯಕೀಯ ಪರೀಕ್ಷೆಗೆ ಒಳಪಡಲು ನನ್ನ ಸಂಪೂರ್ಣ ಸಮ್ಮತಿಯನ್ನು ನೀಡುತ್ತಿದ್ದೇನೆ.

ನನಗೆ ಈ ಸಂಶೋಧನೆಯ ಉದ್ದೇಶ ಹಾಗೂ ಇನ್ನಿತರ ಮಾಹಿತಿಗಳನ್ನು ಸ್ಪಷ್ಟವಾಗಿ ನನಗೆ ಅರ್ಥವಾಗುವ ಭಾಷೆಯಲ್ಲಿ ತಿಳಿಸಿರುತ್ತಾರೆ ಹಾಗೂ ನನಗೆ ಈ ಬಗ್ಗೆ ಯಾವುದೇ ಸಂದೇಹಗಳಿರುವುದಿಲ್ಲ. ಇದರಲ್ಲಿ ಬಾಗವಹಿಸಲು ಬಲವಂತವಿಲ್ಲ ಮತ್ತು ಯಾವುದೇ ಸಮಯದಲ್ಲಾದರೂ ನಾನು ಇದರಿಂದ ಹೊರಲುಳಿಯಲು ಬಯಸಿದಲ್ಲಿ ನನಗೆ ಸಂಪೂರ್ಣ ಸ್ವಾತಂತ್ರ್ಯವಿರುತ್ತದೆಂದು ತಿಳಿದಿದ್ದೇನೆ.

ಈ ಸಮೀಕ್ಷೆಯಲ್ಲಿ ಬಾಗವಹಿಸುವುದು ನನ್ನ ಸ್ವಯಂಪ್ರೇರಿತ ನಿರ್ಣಯವಾಗಿದ್ದು ಇದರಲ್ಲಿ ಬಾಗವಹಿಸಲು ನನಗೆ ಯಾವುದೇ ಖರ್ಚು ತಗುಲುವುದಿಲ್ಲ ಎಂದು ತಿಳಿದಿದ್ದೇನೆ.

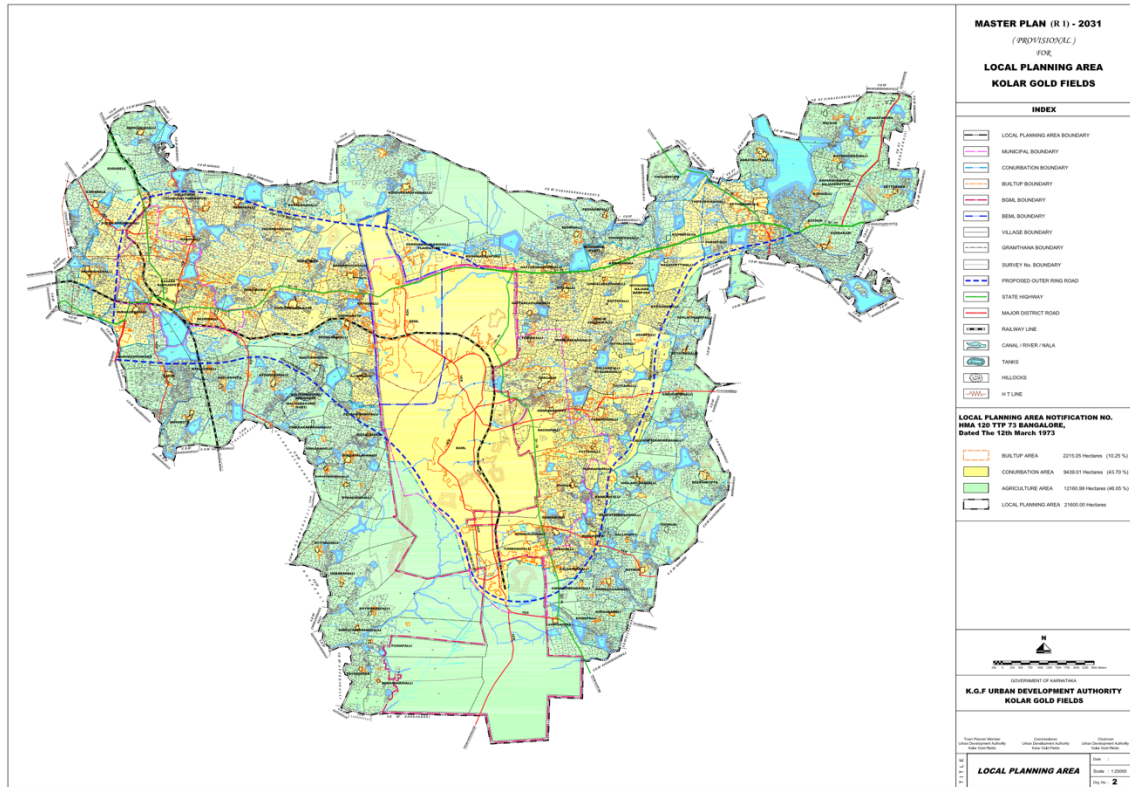
ಹೆಸರು: _____

ಸಹಿ: _____

ದಿನಾಂಕ: _____

ANNEXURE – VI

MAP OF KOLAR GOLD FIELDS



ANNEXURE - VII

MAP OF MINING WARDS OF KGF



ANNEXURE – VIII
DATA ACQUISITION IMAGES



Questionnaire administration by the investigator



Pulmonary function testing

ANNEXURE – IX

GANTT CHART

	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17
Proforma preparation																			
Proforma validation																			
Training of the investigator to perform spirometry																			
Field survey and planning the days for data collection																			
Data collection																			
Data check for errors and missing data																			
Data entry																			
Data analysis																			
Dissertation writing																			
Dissertation editing and submission																			