# Health of Kiln Workers and Exposure to Emissions

*Research Study as part of the Project:*

Empowering CSOs for Decent Work and Green Bricks in India's Brick Kilns

Dr. Ashish Mittal

Centre for Education and Communication
New Delhi

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Funded by the European Union

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# Preface

Brick remains one of the most important building materials for construction activities in India as in any other developing countries. Data shows that India is the second-largest producer of clay-fired bricks through an estimated number of more than 115,000 brick-making units. It is one of the largest employment-generating industries, providing jobs to about 1.5 million workers in India, comprising mainly Dalits and Adivasis, of which more than 40 per cent are women. Yet, the brick-kiln industry in India is characterised as one of the most unorganised sectors, without any centralised regulatory body. Beginning with the technology used in the industry and going on to the recruitment of workers, the wage payment systems or ensuring decent working conditions—the industry follows a very primitive and informal procedure.

Brick-making in India has also been identified as one of the air and land-polluting industries in the small-scale sector by the Central Pollution Control Board (CPCB). With traditional firing technologies (mostly Clamp and Fixed Chimney Bull Trench Kiln—FCBTK) and a low mechanization rate, the brick-kiln industry is estimated to consume roughly 35 million tonnes of coal per year (along with a huge quantum of biomass), the highest among the industrial consumers of coal in the country. As a result, it leads to relatively high emission of fine particulate matter (PM: 0.18 g/kg), sulphur dioxide ($SO_2$: 0.66 g/kg) and carbon dioxide ($CO_2$: 115 g/kg).

Despite these revelations, limited data and information are available, to understand the impact of the ambient air induced by traditional brick manufacturing technology, on the occupational safety and health (OSH) of workers in brick kilns.

Against this backdrop, in 2016, the Centre for Education and Communication (CEC) conducted a research study to understand the relationship between the health of the workers and their exposure to emissions; and to highlight the existing gaps between the conceptual framework of OSH and its relative practices in the industry. The aim was to use the findings to design and develop better strategies for improving the working conditions of workers engaged in kilns. The study was conducted as part of CEC's ongoing project on 'Empowering CSOs for Decent Work and Green Bricks in India's Brick Kilns' and was funded by the European Union.

Tripura, one of the project locations, was selected for the study, considering the concentration of brick kilns in the state and its barrenness in terms of availability of any empirical data to substantiate the impact of traditional brick manufacturing technology on the OSH of workers. Further, to ensure the accuracy of findings, a well-thought-out methodology was adopted to collect the required information, which was then systematically analysed. The report has incorporated minute details of the methodology adopted in collecting the required information, the process adopted to analyse them and, finally, to arrive at the findings and recommendations to address the situation.

As a first step to inform relevant stakeholders about the situation, CEC shared the findings of the study in a formal gathering in Delhi and gathered recommendations. These have been incorporated in this volume. We are sure this report in the current form will be of tremendous value to inform stakeholders about the impact of traditional technology on the OSH of workers in brick kilns in India and will be instrumental in generating discussion on alternatives towards ensuring a decent work place for the brick kiln workers.

The study was conducted by Dr. Ashish Mittal, with support from our Tripura Project Officer Anima Debbarma. We also received valuable support from Mr. J. John, the then ED of CEC. Considerable support was also received from apex agencies such as Tripura State Pollution Control Board in conducting the study.

**Arati Pandya**
Executive Director
Centre for Education and Communication

3rd March 2018

# Executive Summary

India, the second largest producer of clay-fired bricks, produces 200–250 billion clay bricks annually in 150,000 to 200,000 brick kilns, accounting for more than 10 per cent of the global production (*Labour File*, 2014). Each brick kiln employs between 250–300 workers, bringing the total number of workers to approximately 20 million (*Labour File*, 2014), which is roughly 4 per cent of a total of 459 million (NSSO, 2002) workers in India, of which almost 40 per cent are women. NSSO data show a decrease in agricultural employment (10 per cent point between 2004–05 and 2011–12) and an increase in non-farm employment in rural areas, construction and brick kilns being among the main absorbents. The production of bricks is estimated to be growing at a rate of 4 per cent per year.

In India, brick-making is typically a manual process. The brick-kiln industry is seasonal and operates from October/ November to June/July; the production process ceases before the arrival of monsoon every year. The workers are usually migrants, who stay at the kilns during the entire operational season.

India's brick sector, characterized by traditional firing technologies, mostly Clamp and Fixed Chimney Bull Trench Kiln (FCBTK), and a low mechanization rate, is estimated to consume roughly 35 million tonnes of coal per year, the highest among the industrial consumers of coal in the country. The energy consumption of FCBTK is 1.22 MJ/kg, the second highest among the four available technologies for brick manufacturing (Maithel, Lalchandani, Malhotra, & Bhanware, 2002). As a result, the high use of energy leads to relatively high emission of fine particulate matter (PM: 0.18 g/kg), sulphur dioxide ($SO_2$: 0.66 g/kg) and carbon dioxide ($CO_2$ – 115 g/kg) as revealed in the Brick Kiln Assessment Report, 2014.

Very limited data on the occupational health status of brick-kiln workers is available in India. To substantiate the health effects on a worker in the brick kilns, this study was conducted in Tripura, a state in Northeast India. No health impact study was ever done in this state; and most of the stakeholders were ready to cooperate. The study was primarily focused on assessing the impact of the traditional brick manufacturing technology on the health of the workers. A convenient available sample of 94 workers from 4 brick kilns, who had worked for 5 years or more, was taken from a total population of 280 (including children) in these kilns. The workers were interviewed to obtain information on the demography and their personal habits such as smoking and alcohol consumption, followed by a general physical medical examination, blood test for complete haemogram, random blood sugar levels and pulmonary function test (PFT). The data was analysed using MS Office Excel 2007 & Epi. Info 7.2.1.0 version.The salient findings of the study are as follows.

Of the 94 workers, 25 (27 per cent) were women and 69 (73 per cent) were men. For women workers, the minimum age was 18 years and the maximum was 50 years, the average age being 28.6 years. For men workers, the minimum age was 18 years and maximum was 64 years, the average age being 35.6 years. However, the average age of the studied population was 34 years.

Seventy-five per cent of the workers were migrant workers. The maximum number of 48 (51 per cent) workers, that is, 30 (32 per cent) men and 18 (19.15 per cent) women were from Jharkhand state. Twenty-four per cent of the workers were local, that is, they belonged to Tripura state. Fifty-eight (61.7 per cent) workers were illiterate. Significantly, 80 per cent of the women (20 out of 25), as compared to 55 per cent of the men (38 out of 69) were illiterate. Eighty-seven per cent of the workers (23 of 25 women, and 59 of 69 men) were married. Sixty-three per cent (35 of 55 respondents) were smokers, 20 men being regular smokers, and 14 men and 1 woman being occasional smokers. Nine (16.98 per cent) men workers confirmed that they were regular drinkers whereas 31 (58.49 per cent) men workers were occasional or social drinkers. No woman worker admitted to consuming alcohol.

Fifty-two (55 per cent) of the workers (34, or 36.17 per cent, men and 18, or 19.15 per cent, women) are loaders (*bharai* workers); 27 (29 per cent) workers, that is, 21 men and 6 women, are moulders (*pathai* workers) and 7 (7.4 per cent) workers, all men, are fire-workers (*jalai* workers). Eight (8.6

per cent) workers, 7 men and 1 woman are doing miscellaneous work in the kilns.

Overall, 49 per cent workers are underweight: 64 per cent of the women (16 out of 25) and 44 per cent of the men (30 out of 68). Fifty-one per cent of the workers were anaemic—20 (80 per cent) of 25 women have a haemoglobin level below 12 g/dl; 40 per cent of the men (25 out of 63) have a haemoglobin level less than 13 g/dl.

The corrected p value of 0.019 (after applying the Fischer–Exact test) is less than 0.05 for anaemic women *bharai* workers; this is statistically significant establishing the work as cause for their low HB. The p value for women *pathai* workers is 0.007, again establishing the cause-effect relationship.

Seventy-eight per cent (69 out of 88) of the workers studied had a high eosinophil count—80 per cent of the women (20 out of 25) and 78 per cent of the men (49 out of 63). The maximum eosinophil count of 37.6 was in a male *pathai* worker. **Chi Square for linear trend (Extended Mantel-Haenszel) is 4.16063 for men workers with a p value of 0.04, establishing the correlation of eosinophilia with age, that is, high eosinophilia count in the younger years is more than in elderly.**

Of 91 Pulmonary Function Test (PFTs) done, 71 per cent were normal; 11 women workers and 15 men performed less than the normal predicted values. Nine of 11 women workers and 9 of 15 men have either mild obstruction or mild restriction.

Sixty-six per cent of the workers, 47 (68 per cent) men and 15 (60 per cent) women complained of low back pain whereas 33 per cent workers have significant arm pain (23, that is, 33 per cent, men and 8, that is, 32 per cent, women).

Brick-kiln workers suffer from high morbidity because of their work. This demands urgent attention to the health and safety program, which must include regular in-service training of workers, emphasizing the health risks in brick-kiln work, preventive measures, technological interventions, etc. A health surveillance of workers will be highly beneficial for achieving a better health status.

# 1. Introduction

## 1.1. An Overview of the Brick Kiln Industry in India

India, the second-largest producer of clay fired bricks, produces 200–250 billion clay bricks annually in 150,000 to 200,000 brick kilns[1], accounting for more than 10 per cent of the global production. Each brick kiln employs between 250–300 workers, bringing the total number of workers to approximately 20 million[1], which is roughly 4 per cent of a total of 459 million[2] workers in India, of which almost 40 per cent are women. NSSO data also show a decrease in agricultural employment (10 per cent point between 2004–05 and 2011–12) and an increase in rural non-farm employment in rural areas, with construction and brick kilns being among the main absorbents. The Indo-Gangetic plains of North India, comprising the states of Assam, Bihar, Haryana, Punjab, Uttar Pradesh (UP), and West Bengal, account for about 65 per cent of the total brick production of India. Peninsular and coastal India has the remaining 35 per cent of brick kilns.

The brick industry is a major source of livelihood in these states and enjoys significant political influence despite being a major contributor to air pollution coupled with being the industry with major violation of labour laws[3]. India is the second largest brick producer after China. Of the total production, 74 per cent is through Bull Trench Kilns and 21 per cent through Clamps Kilns. Coal and biomass is the main fuel used to fire the bricks in India.

*The brick industry in India is characterized by traditional methods of production technology that contribute to the prevalence of labour employment practices involving bondage and modern-day slavery.* The 2016 Global Slavery Index estimates[4] that 45.8 million people in the world are engaged in some form of modern slavery and 58 percent of those are living in India, China, Pakistan, Bangladesh and Uzbekistan. The estimated number of people living in modern slavery in India is 18,354,700; moreover, 51 out of 100 people in India are vulnerable to modern slavery.

In India, brick-making is typically a manual process;99 per cent brick production is through hand moulding. The brick-kiln industry is seasonal and operates between October/ November and June/July; the production process ceases before the arrival of monsoon every year. Most of the workers migrate with their families from backward and poor regions of the country. Families, including young children, work in harsh, low-paying conditions. There is typically a lack of basic facilities, such as access to clean drinking water and sanitation.

## 1.2. Rationale for Choosing the Tripura Brick Kiln Cluster for the Study

The study was conducted in Tripura. Although the overall project area includes the states of Rajasthan, Tripura and Uttar Pradesh, Tripura was chosen for the Occupational Safety and Health (OSH) study primarily because no study has ever been done or available in Tripura. A preliminary visit in November 2016 gave clarity about the feasibility of the study, the infrastructure needed, the willingness of workers and owners to participate, the roles and participation of state institutions such as Tripura Small Industries Corporation (TSIC), Tripura State Pollution Control Board (TSPCB) for the environmental exposure assessment of the participating brick kilns. In an initial dialogue, TSPCB Chairman, Mr. Amitabha Debroy, assured us help with the environmental tests. The MD of TSIC, Mr. Sunil Debbarma, was also happy to explore the health requirements of workers health in the kiln in Mainama, Dhalai. He extended the support of his team wherever required. Private owners such as Dr. Partho Debbarma of Tripura Brick Industries had no objections any kind of test being conducted in their kilns.

1 John, J. (2014). Brick Kilns and Slave Labour: Observations from Punjab. Labour File, pp. 15–25.
2 NSSO, 2002.
3 Vajpayee, Y. (2016, May 8). Shift towards Cleaner, Greener Technology, One Brick Kiln at a Time.New Indian Express
4 www.globalslaveryindex.org: http://www.globalslaveryindex.org/country/india/

## 1.3. Activities Involved in Making Bricks in Tripura

Much of the brick-making process in India is manual; some of the processes are state-specific, with the involvement of some traditional processes or modified according to the need or availability of resources such as machines, labour or climatic conditions. However, the basic activities specific to Tripura are as follows.

### a. Digging (*Khudai*)

Although manual digging of earth is not very common these days in Tripura, there are some kilns where soil for manufacturing the bricks has to be manually dug up by the labour. In many places nowadays, however, machines are used to dig earth; the soil is then provided to *pathers* (brick moulders) at their place of work.

**Manual Digging**

**Mechanical *Putai* 1**

### b. Beating the soil (*putai*)

To soften the soil and to make it appropriate for moulding work, the '*pather*' needs to beat the soil. *Putai* is not considered a separate activity; those who are doing *patheri* (moulding bricks) are responsible for the *putai* work also. Pathers and their families beat the soil, make raw material to mould bricks,

**Manual *Putai***

**Mechanical *Putai* 2**

mould the bricks, dry these in sunlight for a specific period. In Tripura, many places have mechanical mixing machines to beat the soil and the *patheri* gets the clay to mould the bricks.

## c. Moulding bricks (*pather*)

*Patheri* is considered to be preliminary activity in the entire process of bricks moulding, and is usually done in a nearby brick kiln. Every season, the employer employs at least 15–20 families for *patheri* work through a contractor. *Patheri* work is done by a 'family', comprising at least two members and a maximum of eight to ten members. The head of the family, usually a man, is counted as the 'labour' and he gets the wages; wages are not paid to individual members of the family; women and children are not recognized as labour. A *pather* works for 10–12 hours a day and he get Rs 550 to 600 for moulding 1,000 bricks.

**Brick Moulding (*Patheri*work)**

**Rotating bricks for drying *(Thalana)***

They are provided the required raw material, moulds (or casts) and houses for living in the brick kiln. The makeshift *kuchcha* houses, provided to these workers, are usually of very poor quality. Because the *patheri* work may shift to another place the following season, employers do not want to provide *pucca* or semi-*pucca* houses.

*Pathers* work in the mud, exposing their skin to clay, dust and direct sun. They squat on bent knees throughout thereby putting relentless strain on the legs, knees and lower back, resulting in musculoskeletal trauma and injuries to the worker.

## d. Rotating bricks for drying (*Thalana*)

*Thalana* is done usually by young children in the age group of 3–9 years in a *pather's* family. The children work approximately for 2–3 hours a day; their work is not recognized as formal work; instead, it is considered as 'sports/play' for young children. Many children above nine years start moulding bricks with parents.

## e. Placing bricks in the kiln (*Bharai*)

*Bharai* means placing bricks in a systematic way inside a kiln so that the bricks bake evenly. *Bharai* workers transport dried bricks from 'patheri' site (sometimes the patheri work is done at a distnace from Kiln) to the kiln, usually 10–12 bricks at a time (on the head) or with the help of a '*reddi*' (wooden equipment) or on a tractor or on cycle; *Bharai* labourers, usually above the age of 14–15 years, work for 10–12 hours. Although this work is mainly 'male-dominated', women *bharai* workers are not an exception.

*Bharai* labourers get Rs 100 or 110 for laying 1,000 bricks in

**Manual *Bharai***

***Bharai* with Tractor Trolley**

the kiln. The wages are collected by the 'head' of the family, usually a man. *Bharai* labourers work long hours in awkward postures—bending for loading and unloading, carrying heavy loads on the head or using mechanical means and on uneven surfaces. They work in direct sun, heat and dust without using any personal protective equipment.

*Rabishaha*, another known nomenclature for *bharai* workers, do the particular task of arranging bricks and dismantling the layer of ash/*rabish* from the arranged bricks, before and after they are burnt in the kiln. This work is also performed mainly by men and, sometimes, by women.

## f. *Jalai*

Bricks are fired to a temperature of 700–1100ºC, requiring a large amount of fuel for the firing operation. A group of 10–12 labourers handle the *jalai*, meaning the 'baking of the bricks' work. Ten or twelve labourers are provided rooms near the '*chimany*' of the kiln. *Jalai* work is continuous, non-stop, and 12 workers work in two shifts each day. *Jalai* workers' wages are not by piece rate; they earn between Rs 7000 and 9000 a month. *Jalai* work is done by men only.

Jalai workers work on top of the kiln, which has fire inside to bake the bricks, thereby exposing them to extreme high temperatures from inside the kiln; in addition, they endure

***Jalai* Work**

**Accomodation for *Jalai* Workers**

the heat of the sun also. These workers usually wear wooden footwear but have no other protection from the heat or sunshine. The type of accommodation they are provided, the nature of their work and their working hours have a very detrimental effect on their health.

## g. Collecting the processed bricks (*Nikasi*)

A *nikasi* worker is engaged in collecting the processed bricks from the *mori* (a narrow passage used for firing bricks). *Nikasi* work is done by both men and women for usually 10–12 hours a day and the workers get Rs 100–110 per 1,000 bricks. Most of the women in the *nikasi* work are engaged in removing the coal residue from the bricks. *Nikasi* workers are exposed to heat, sunlight, dust, etc., and have no safety measures when working. *Nikasi* work also involves long hours of continuous standing, bending and kneeling, resulting in body pain, back pain, etc.

**Removing Coal Residue**

***Nikasi* Work**

## 1.4. Harmful Agents and Pollutants in Brick Kilns

India's brick sector, characterized by traditional firing technologies, mainly FCBTK, and low mechanization rate, is estimated to consume roughly 35 million tonnes of coal per year, the highest among the industrial consumers of coal in the country. The energy consumption of FCBTK is 1.22 MJ/kg of fired bricks, the second highest amongst the four available technologies for brick manufacturing. As a result, the high use of energy leads to relatively high emission of fine particulate matter (PM2.5: 0.18 g/kg of fired bricks), sulphur dioxide ($SO_2$: 0.66 g/kg of fired bricks) and carbon dioxide ($CO_2$: 115 g/kg of fired bricks) in FCBTK technology[5].

The assessment of the process of brick production indicated that this process is very energy intensive. Most of the emissions to the environment are attributed to energy use, directly at the site, with the combustion of coal in kiln and diesel combustion in transportation. The $CO_2$ emissions constitute the biggest percentage of all releases to the atmosphere. When it comes to the effect of environmental impact, acidification is the highest. This is mainly due to the fact that at the manufacturing stage, low-grade fuel with high sulphur content is being used. The combustion of this fuel produces large amounts of $SO_2$ and particulate matter[6].

According to a study conducted by Greentech Knowledge Solutions (2012), the incomplete combustion of coal and other biomass fuels in the brick production process is mainly attributed to the emission of such gaseous substances, which in turn has an adverse impact on human health and ecology. In recent years, higher costs and shortage of good quality bituminous coal have resulted in the increased use of high-ash, high-sulphur coal, as well as use of industrial wastes and loose biomass fuels in brick kilns[5]. All of these have resulted in new air emission challenges.

Sources of emission in a typical FCBTK kiln are:

- Stack emissions
- Fugitive emission during the charging of fuel
- Crushing of coal
- Clay excavation
- Loading and unloading of bricks
- Laying and removal of the dust/ash layer *keri* over brick setting
- Cleaning of the bottom of the trench/side flues during high winds

Stack emissions are high with thick smoke in kilns with shorter combustion zone and poor operating practices.

5 Maithel S., D. Lalchandani, G. Malhotra, P. Bhanware. 2012.'Monitoring of brick kilns & strategies for cleaner brick production in India', Brick Kilns Performance Assessment; 13–15

6 Shridhar Kumbhar, Nitin Kulkarni, Anand B. Rao and BakulRao. 2013.'Environmental Life Cycle Assessment ofTraditional Bricks in Western Maharashtra, India'.4th International Conference on Advances in Energy Research, ICAER. Elsevier: Energy Procedia 54 (2014)pp. 260–269.

**Fugitive Emissions at a Brick Kiln**

Suspended Particulate Matter (SPM) levels upto 1375 mg/Nm3 during the fuel charging period were observed in kilns with poor operating practices, and high CO levels observed in kilns using biomass as fuel. The emission of SPM and $SO_2$is mainly due to the quality of the fuel and its feeding and operating practices.

The average emission factor for SPM in FCBTK with zigzag firing was 0.37 g/kg of fired bricks due to the longer combustion zone, in comparison to conventional FCBTKs and good combustion practices adopted in the process. The emission factor is almost comparable with the High Draft Kiln.

The emission factors for $SO_2$ were mainly due to the sulphur content in the fuels used. Low emission factors of 0.03 to 0.23g/kg of fired bricks were observed in biomass fired brick kilns whereas, in the case of coal-fired kilns, this varied from 0.04 to 0.67 g/kg of fired bricks. The average emission factor for NOx was generally low and was found in the range of 0.03 to 0.32g/kg of fired bricks[7].

### i) Suspended Particulate Matter

SPM is a term used for airborne particles of diameter less than 100 µm. In coal-fired brick kilns, the average emission factor for SPM was in the range of 0.79 to 1.85 g/kg of fired bricks, wherein the brick firing temperature is above 950$^0$C. FCBTK using biomass has lesser emission factors as compared to coal-fired FCBTKs (The SPM emission factor is in the range of 0.78 to 1.19 g/kg of fired bricks).

### ii) Particulate Matter (PM 2.5)

Particulate matter is frequently monitored because of its environmental and health effects. Fine particulate matter (diameters less than 2.5 µm) can penetrate deeper into lungs than larger particles. It also has a longer atmospheric lifetime and a disproportionately greater effect on visibility and climate, relative to larger particles. The emission factor for PM in FCBTK was 0.18 g/kg.

### iii) Gaseous Pollutants

The incomplete combustion of fuel results in the emission of harmful gases like $SO_2$, oxides of Nitrogen ($NO_x$), carbon monoxide (CO) and carbon dioxide ($CO_2$). The emission factors for $SO_2$, $CO_2$ and CO were 0.66g/kg, 2.25 g/kg and 115 g/kg, respectively.

### iv) Black and Organic Carbon

Black carbon (BC) is a combustion product predominantly composed of strongly bonded graphitic-like carbon rings. The traditional FCBTK also results in the production of black carbon. The chemical composition of black carbon makes it thermally stable at high temperatures, strongly absorbing visible light, causing warming.

## 1.5. Harmful Effects on Human Health

The Central Pollution Control Board (CPCB) has recognised the brick production industry as one of the highly polluting and hazardous industries in India. Kilns in India produce clay-fired bricks, using traditional firing technologies, usually FCBTK. With a low mechanization rate, it is estimated to consume roughly 18 tonnes of coal per 100,000 bricks, and altogether consumes about 8 per cent of the total coal consumption of the country (the third largest consumer after the power and steel sectors)[8]. In addition, it also consumes several million tonnes of biomass fuels. Incomplete combustion of coal and other biomass fuels in brick kilns results in the emission of several harmful agents. Coal leaves behind bottom ash as residue.

Air pollution and bottom ash lead to several health problems. Occupational health risks and the reduction in work productivity are linked to the combined influences of energy

7 Maithel S., D. Lalchandani, G. Malhotra, P. Bhanware. 2012.'Monitoring of brick kilns & strategies for cleaner brick production in India', Brick Kilns Performance Assessment.

8 http://www.ecobrick.in/challenges_Issues_in_the_Indian_Brick_Sector.aspx

expenditure required for a job and workplace heat conditions. *Studies from developing countries such as India show that workers in the brick kilns suffer from assorted health problems due to awkward posture, carrying heavy loads, exposure to heat and harmful emissions.*

There are hazards in the working environment because of the high ambient temperature as well as hazards associated with manual load lifting, which are well above the recommended limit. There are vulnerable postures the workers are engaged in for long periods, which further increase the risk of injury. The complete absence of any personal protective device renders workers vulnerable to all sorts of injury associated with material handling[9].

Pain is the most common symptom associated with work-related musculoskeletal disorders (WMSDs). In some cases, there may be joint stiffness, muscle tightness, redness and swelling of the affected area. Some workers may also experience sensations of 'pins and needles', numbness and changes in skin colour[10].

The commonest posture adopted at work is squatting (67 per cent) followed by standing (14 per cent). Majority of workers (87 per cent, $n$ = 269) reported having symptoms of pain currently, of which 51 per cent ($n$ = 158) had pain during work. Chronic low back ache (LBA) (1-year prevalence 59per cent) and acute LBA (1-week prevalence33 per cent) were the commonest, followed by chronic knee pain. More than 10 years of work was significantly associated ($P < 0.05$) with acute LBA and acute and chronic knee pain[11].

Another study describes the findings as, first, workers suffer from a serious problem in both the shoulders. They suffer pain (45.5 per cent–nearly 50 per cent workers) and a large percentage of workers have experienced shoulder symptoms (up to 72.7 per cent in the earlier 7 days and up to 90.0 per cent in the previous 1 year). Second, workers complained of problems in the back, especially lower back (more than 50 per cent workers had severe pain and more than 80 per cent experienced lower back pain symptoms in the past year)[12].

Brick field workers suffered from pain especially in the lower back (98 per cent), hands (93 per cent), knees (86 per cent), wrists (85 per cent), shoulders (76 per cent) and neck (65 per cent). Of all brick-making activities, brick field workers felt discomfort when 'spading' for mud collection (98 per cent), carrying bricks (95 per cent) and moulding (87 per cent)[13].

A study by Sheta S. on the brick-kiln industry and workers' chronic respiratory health problems in Mit Gham District, Dakahli Governorate in Egypt, and published in the *Egyptian Journal of Occupational Medicine* 2015, showed that brick-kiln workers had significant higher frequency of chronic respiratory problems compared to their control group; the most common chronic respiratory symptoms were cough followed by dyspnoea, chest wheeze, bronchitis and asthma. Moreover, 39.91 per cent of brick-kiln workers complained of more than one respiratory symptom, compared to 11.70 per cent from their control group[14].

Respiratory problems in workers with less than 10 years' work were reported by 13 per cent, which increased to 25 per cent with more than 10 years' work. About 14 per cent workers reported musculoskeletal health problems with less than 10 years' work whereas 44 per cent participants with more than 10 years' work in the study reported the same. Weakness was reported by 6 per cent workers with less than 10 years' work and 28 per cent workers reported to have weakness after having worked for more than 10 years[15].

The following are the effects of brick-kiln work on various systems in the body.

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9 Mukhopadhyay P.'Risk factors in manual brick manufacturing in India'.*HFESAJournal*. *Ergonomics Australia*,Vol 22, Number 1, March–June 08; 16–25.

10 Gahlot N., K. Rana, S. Gandhi.'Prevalence of Musculoskeletal Discomfort among the Workers at Manual Brick Kiln Units'.*International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 5, Issue 9, September 2016.

11 Alex R.G. et al. 2013. 'Prevalence of musculoskeletal disorders among brick kiln workers in rural Southern India'; *Indian J Occup Environ Med*. May–Aug; 17(2): 71–75.

12 *Sett &Sahu. 2008.'Ergonomics study on female workers in manual brick manufacturing units in West Bengal, India'.Asian-Pacific Newsletter on Occupational Health and Safety; 15 (3):59-60.*

13 Das B. 2014. 'Assessment of occupational health problems and physiological stress among the brick field workers of West Bengal, India'. *International Journal of Occupational Medicine and Environmental Health*. 27(3):413–425.

14 Sheta S. and N. El Laithy. 2015.'Brick kiln industry and workers' chronic respiratory health problems in MitGhamr District, Dakahlia Governorate'.E*gyptian Journal of Occupational Medicine*. 39 (1): 37–51.

15 Prasad et al.June 2016. 'Assessment of health status of the brick industry workers in Wardha District'.*Journal of Academia and Industrial Research(JAIR)*,Vol5, Issue 1.

### a) Cardiovascular effects

Compelling evidence indicates that the combination of intense whole-body exercise and environmental heat stress or dehydration-induced hyperthermia result in significant cardiovascular strain preceding exhaustion, characterized by reduction in cardiac output, stroke volume, arterial pressure and blood flow to the brain, skin and exercising muscle (C. G. Crandall. August 2010. 'Cardiovascular function in the heat-stressed human'. *Acta Physiol*. Oxford, 199(4): 407–423., Published online.) In a study conducted on the effects of occupational health hazards on women brick-kiln workers in West Bengal, India, it was found that each degree rise in temperature caused about a 1.81 per cent loss of productivity in women workers. Exposure to heat and work continuously cause fatigue and exhaustion, decreasing productivity and increasing the workload of women brickfield workers[16]. The workers slow down and increase the cycle time, to cope with the additional stress of the workload; this hampers productivity and consequently their own income. There is a linear decline in productivity with an increase in maximum air temperature above 34.9°C, and the lost productivity for every degree rise in temperature is about 2 per cent.

### b) Musculoskeletal Effects

Musculoskeletal disorders (MSDs) result from frequent bending of the body at the waist, twisting and carrying bricks. Bricks are usually carried on the head. About 9 to 12 bricks are carried at a time in this manner. Carrying head loads over a period of time causes health problems, especially in women. Some studies even report that women have a higher prevalence of work related MSDs than men[17]&[18], due to the different work-related postures, also leading to various urinary diseases. Women comprise almost half the work force engaged in the industry. Women work to earn money, and continue to do household chores and the job of bearing and rearing children.

### c) Heat exhaustion

Brick-making involves crude techniques causing considerable worker drudgery[19](Srivastava & Mathur, 2007). Brick workers, especially moulders, are exposed to the sun for long hours. They are exposed to a high concentration of dust during the manual breaking of coal. There is also a risk of exposure to gas/dust (from bottom ash spread on the kiln) and open fire during manual coal feeding. Workers have to walk on the hot surface (the top of the furnace) when monitoring and regulating the fire.

### d) Respiratory effects

The main environmental chemical hazards in brick kilns are gases such as carbon monoxide (CO), sulphur dioxide ($SO_2$) and silica dust. Respiratory diseases, mainly chronic bronchitis, pulmonary tuberculosis and respiratory tract infections, are usually observed among brick-kiln workers. Besides chronic bronchitis and chronic obstructive pulmonary disease (COPD), many workers suffer from the early stages of silicosis.

### e) Effects on skin

Skin diseases such as painful callosities, eczema and dermatitis are predominant. *Nikasi* workers suffer from callosities due to the handling of bricks without safety gear. Itching and eye complaints were most common in *pathai* workers.

### f) Injures

Many injuries result out of accidents caused by vehicular movement around the kiln, manual loading and unloading, uneven and unkept/slippery surfaces and when using the equipment in a kiln. Falling on uneven or slippery surfaces or from a height is an occupational hazard as are injuries sustained during the excavation of clay because the excavation equipment can cause permanent disabilities. Burns injuries happen during the firing of bricks. In February 2017, three *jalai* workers died when they were engulfed by fire when trying to aerate the manhole near the chimney in Jaunpur area of Uttar Pradesh. The spectrum of injures can vary from minor or major, short-term or permanent disability, partial or complete disability, resulting in an impact on work ability, efficiency or productivity of a worker.

16 Sett, Moumita, SAHU, Subhashis. February 2014. 'Effects of occupational heat exposure on woman brick workers in West Bengal,India'. *Global Health Action*,Vol. 7, ISSN 1654–9880.

17 Treaster, D.E. and D. Burr. 2004.'Gender differences in prevalence of upper extremity musculo-skeletal disorders'. *Ergonomics*, 47, 495–526.

18 Basu, K., S. Sahu, &G. Paul. 2008. 'Ergonomic Evaluation of Work stress among woman labourers of the unorganized sectors of the Construction Industry in India'. *Asian Pacific Newsletter on Occupational Health and Safety*, pp. 57–58.

19 Srivastava A. K.,&N. Mathur. September 2007. 'Occupational diseases among migrant labour in traditional brick kilns of India'.*Asian Pacific Newsletter on Occupational Health and Safety*, pp. 40–42.

## 1.6. Ecological Effects

Brick-kiln enterprises are usually clustered together, mainly around river basins, rural and peri-urban centres, for easy transportation of raw material as well as finished goods, increasing the polluting impact manifold. A rapid increase in brick production and the clustering of brick kilns has given rise to environmental concerns. It is common to find large brick-making clusters located close to towns and cities, which are the large demand centres for bricks. Some of these clusters have up to several hundred kilns.

Continuous emissions (as elaborated above in Section 1.3 on Harmful Agents and Pollutants in Brick Kilns) from brick-kiln clusters endanger the population in and around the area while causing damage to land and agricultural production and contributing to global climate change. The use of good quality agriculture soil in large quantities for brick-making is also a grave area of concern. In geographical regions that have thin topsoil, this results in reduction in the productivity of land and, in extreme cases, the land does not remain fit for agriculture use. Areas with a large concentration of brick kilns suffer from land degradation.

One of the important reasons for air pollution is incomplete combustion of fuel. Roughly about 10 per cent of the fuel supplied to a BTK remains unburnt or partially burnt.

The harmful effects of air pollution are not only confined to living beings directly exposed to pollutants but are also felt over a large area around the source of pollution. Acid rain, a cause of concern in heavily industrialized areas, is one such phenomenon. Acid rain is caused when $SO_2$ and oxides of nitrogen combine with water vapour in the atmosphere to form mild acids. These acids then return to earth as rain that is called acid rain. It causes extensive damage to plants and buildings and pollutes lakes and rivers. Fog is another phenomenon, the effect of which can extend to nearby areas. Fog formation is accelerated by air pollution. Normal life, particularly transportation, gets seriously hit due to fog, and the growth of crops is affected by the reduction in sunlight reaching the fields.

Some of the effects of air pollution are not confined to the local or regional environment but have the potential to affect all of humanity. One such effect is global warming, resulting in permanent change in the global climate. Scientists believe that the increase in the concentration of carbon dioxide ($CO_2$) is mainly due to the burning of fossil fuels (coal, petroleum products) and causes a global rise in the temperature of the atmosphere and the earth's surface. Even a few degrees' rise in temperature can cause change in climate patterns worldwide, such as melting of the ice in the polar regions, resulting in a rise in sea-water levels, which will then submerge low-lying coastal areas, change in rainfall pattern, etc. Realising the threat from global warming, control of greenhouse gases ($CO_2$, methane, etc.) has now become an important issue in global diplomacy and is expected to gain importance in the near future.

Waste from kilns leaches or flows into nearby water bodies, increasing the total solids, suspended solids, calcium hardness, total hardness, etc.

**Environmental Pollution from Multiple Stack Emissions in a Kiln Cluster**

The Supreme Court of India issued directives discontinuing movable chimney kilns and ordering all brick kilns to conform to new environmental norms by 30 June 2001; however, slack monitoring has resulted in continuing environmental degradation. New technology options, such as zig-zag firing technology in the production of hollow clay-fired bricks and non-fired non-clay bricks reduce energy consumption and emission rates; however, there is hardly any awareness regarding these methods, particularly among the medium and small-scale brick manufacturers.

## 1.7. Existing OSH Framework

Workers enter the brick-kiln labour market in a condition of vulnerability that is exploited by the industry (John, 2014). *Despite the fact that brick kilns provide seasonal employment to large numbers of migrant workers, their working and living conditions are still harsh, with scant health and safety provisions. Employers fail to recognize the fact that investment in OSH means investment in productivity. Section 7A of Chapter II of the Factories Act specifically mentions that "Every Occupier (Employer) shall ensure the* ***health***, ***safety*** *and* ***welfare*** *of the workers".* Section 10 of Factories Act mentions that the state government may also appoint qualified medical professionals as Certifying Surgeons, to examine and certify young persons

and persons engaged in dangerous operations or processes and to exercise medical supervision in a factory. The various provisions relating to safety are mentioned from Sec.21 (fencing of machinery) to Sec.41H (Right of workers to warn about imminent danger) in the Factories Act of 1948.

Section 40B (1) of the Factories Act states that a Safety Officer has to be appointed in every factory, where there is any manufacturing process or operation that involves any risk of bodily injury, poisoning or disease, or any other hazard to health to the persons employed in the factory. However, field insights from various studies suggest that the greater number of the brick kilns in India do not conform to the applicable regulations of the Factories Act.

The issue of OSH for workers deployed under the unorganized sector is still not a priority for the state. Certain guidelines have been prepared; however, their implementation and effective monitoring are still questionable. The International Labour Organisation (ILO) has developed a wide array of OSH instruments—more than 70 Conventions and Recommendations, and over 30 codes of practice, covering general provisions, specific risks and special economic sectors in which migrant workers are largely employed (for example, agriculture, construction, mines and the hotel industry). Implementation of ILO Conventions on OSH in realizing better working condition is a key component for decent work.

*Hence, in this backdrop, this study aims to understand the relationship between the health of the workers and their exposure to emission. It will help us to design and develop better strategies for improving the working conditions of workers engaged in kilns. It will also highlight the existing gaps between conceptual framework of OSH and its relative practices in the industry.*

# 2. About the Project and Purpose of the Study

Decent work and the production of green bricks are the two pillars of the project called '***Empowering CSOs for Decent Work and Green Bricks in India's Brick Kilns***'**;** these are not mutually exclusive but complementary. It envisages creative engagement between these two perspectives in theory and in practice. This project will work towards enabling CSOs become harbingers of positive and transformative change, encompassing social, economic and environmental concerns through: (i) structured knowledge creation and knowledge dissemination relating to factors that perpetuate slave-like conditions and prevent inclusion in brick kilns (ii) build CSO capacities on aspects of decent work and social protection. The project attempts to promote green bricks through addressing issues of pollution, encouraging energy efficient designs and top soil conservation. It addresses diversity, by affirming inclusion not by homogenizing but by acknowledging and respecting diversity, and countering aspects that make diversity grounds for exclusion. The project seeks transformative change to be supported by a conducive policy ecosystem. The project demonstrates institutional mechanisms for promoting decent work and green bricks that are comprehensive, sustainable and replicable. The objectives of this action are:

(i) **Overall objective**: To usher sustainable change through decent work and green technology in India's brick kilns.

(ii) **Specific objective**: To increase the capacity of CSOs, including human rights groups, labour organizations, child rights organizations, groups working on green technology, brick-kiln manufacturers' associations, workers' associations and local authorities, to perform their roles more effectively, ensuring inclusive 'decent work' in brick kilns and producing 'green' bricks.

## 2.1. The Research Study

The research study will inform as well indicate what actions need to be carried out for the prevention and control of emissions from the kilns that cause an adverse impact on human health and ecology. Existing studies by CSOs, academics, etc., have either looked at labour conditions or have discussed the technological improvements that are possible to reduce emissions. This study will highlight the synergy between these approaches; look at the common health problems of those working in this sector over a period of 5–10 years, along with the identification of the existing gaps between the regulatory framework pertaining to the OSH aspect in the Factories Act and its implementation in the brick-kiln industry; and the impact on the kiln workers due to the existing gaps.

## 2.2. Research Objectives of the Study "Health of Kiln Workers and Exposure to Emissions"

The objectives of the research study on OSH are to:

- Assess the impact of the traditional brick manufacturing technology on the (i) OSH of the workers; and (ii) the ecology.
- Identify and highlight the existing gaps between the legal provisions of OSH under the Factories Act and their implementation in the brick kilns in India.

## 2.3. Significance of the Research

This study will look at the common health problems of those working in this sector over a period of 5–10 years. Some of the health risks that people face, other than those related to exposure to emissions, are the poor condition of housing, the non-availability of drinking water and sanitation facilities, poor nutrition, and poor access to health services for the migrant workers. The children are more vulnerable without the facility of a crèche and a school, and living in the workplace environment exposes these children to high doses of hazardous material for their body mass index. Detailed measurement of all these confounders is not possible; however, an overview will be given.

In recent years, a rapid increase in brick production and the clustering of brick kilns have given rise to environmental concerns. The emission of pollutants has an adverse effect on the health of workers and the vegetation around the kilns. Higher costs and a shortage of good quality bituminous coal have resulted in an increased use of high-ash, high-sulphur coal, as well as in the use of industrial wastes and loose biomass fuels in brick kilns. All of these have resulted in new air emission challenges. Areas with a large concentration of brick kilns also suffer from land degradation because the top soil is used for brick-making. Technology transformation has been initiated as an experiment. The drivers for this transformation to green technology usually focus on their efficiencies, cost and economic viability, better energy control capabilities, higher production and processing capacities and improved product quality.

This approach, however, is devoid of any emphasis on decent skilled work and social protection. Crucial risks can be mitigated and a smoother transition to the new technologies facilitated through a capacitated, empowered and skilled workforce. Existing studies by CSOs, academics, etc., have either looked at labour conditions or have discussed the technological improvements that are possible to reduce emissions. There is need, therefore, to ensure a synergy between these two apparently mutually exclusive areas—green bricks and decent work. The project will highlight the synergy between these approaches.

# 3. The Study

The study was conducted in the state of Tripura. Although the overall project area includes the states of Rajasthan, Tripura and Uttar Pradesh, Tripura was chosen for the OSH study primarily because no study has ever been conducted in Tripura. A preliminary visit was made in November 2016 to understand the feasibility of the study, the infrastructure needed, the willingness of workers and owners to participate in the study, the role and participation of state institutions such as Tripura Small Industries Corporation (TSIC) and Tripura State Pollution Control Board (TSPCB), to carry out an environmental exposure assessment of the selected brick kilns. The initial dialogue with TSPCB Chairman, Mr. Amitabha Debroy, ensured help with environmental tests. The MD of TSIC, Mr. Sunil Debbarma, was also happy to explore the requirements of workers' health in their kiln in Mainama, Dhalai. He also extended the support of his team wherever required. Private owners such as Dr. Partho Debbarma of Tripura Brick Industries (TBI) also had no objection to conducting any test in their kilns.

## 3.1. Method

### 3.1.1. Population

A convenient available sample of 94 workers from four brick kilns, as described below, was the subjects for the study. These 94 workers were chosen from a total population of 280 (including children), who reported to the health camps in these kilns. The criterion for inclusion in the survey was that a worker must have worked for 5 or more years in a brick kiln anywhere in India. The rest of the workers and children were registered, details of their main complaints taken and medicines supplied accordingly.

The following kilns were chosen, based on the willingness of the owner to carry out the study in his kiln.

1. Mainama **TSIC** (Tripura Small Industries Corporation, a government kiln), Manu, Longtarai valley, Dhalai District, Tripura
2. Tripura Brick Industries **(TBI)** (Owner: Dr.Partho Debbarma and Subimal Debbarma), Jirania Khola, Birendranagar, Jirania, West District
3. A.V. Industries **(AVI)** (Owner: Sabyasachi Chaudhary), Uttar Joynagar, Jirania, West District
4. Baba Lokenath Bricks **(BLB)** and Lokenath Bricks **(LNB)** (Owner: Sibu Saha), Champaknagar, West District

### 3.1.2. Questionnaire

The participants of the study were interviewed, using a schedule designed to obtain information on the demography, personal habits (smoking/drinking/food habits), occupational exposure history, and health seeking behaviour. Specific questions/symptoms were asked on the effects of exposure such as eye irritation, upper respiratory tract irritation, headache and excessive fatigue.

### 3.1.3. Medical Examination

Each individual underwent a general physical examination and the basic parameters of height, weight, blood pressure were recorded. Laboratory investigations included a complete haemogram and random blood sugar (RBS) for the willing

**Table 1: Total Coverage of the Health Camps in Four Kilns**

| Date | Brick Kiln | Women (i) | Men (ii) | Girls (iii) | Boys (iv) | Total Children (v = iii + iv) | Total (i + ii + v) | No. of Workers in the Study |
|---|---|---|---|---|---|---|---|---|
| **10.1.17** | **TSIC** | **25** | **47** | 04 | 09 | **13** | **85** | **20** |
| **11.1.17** | **TBI** | **25** | **33** | 04 | 03 | **07** | **65** | **22** |
| **12.1.17** | **AVI** | **22** | **32** | 06 | 12 | **18** | **72** | **29** |
| **13.1.17** | **BLB, LNB** | **20** | **25** | 07 | 06 | **13** | **58** | **23** |
| **Total** | | **92** | **137** | **21** | **30** | **51** | **280** | **94** |

participant to estimate the burden of anaemia, infections and diabetes mellitus.

### 3.1.4. Spirometry [Pulmonary Function Test (PFT)]

Spirometry, or PFT, was performed by the participants to estimate the lung capacity of each worker and to understand the burden of respiratory incapacitation. The largest values for the forced exploratory volume in one second (FEV1) and forced vital capacity (FVC) were recorded and compared with predicted values.

### 3.1.5. Statistical Analyses

The evaluation focused on the age group of the participants and the main work done by them in the brick kiln. All the collected data were analysed with the help of Microsoft Office Excel 2007 and the WHO software package, Epi Info 7.2.1.0 version. The symptoms were analysed, with reference to the age group and main work performed by these workers. Chi square test/Fischer's exact test was applied for evaluating the significance. Differences were considered statistically significant at p value of <0.05.


**Medical Camp at TSIC**

## 3.2. Analysis and Results

### 3.2.1. Demographic Profile

**Table 2 represents** the age group of the studied population of a total of 94 workers and the respective number of men and women in the group. Of the 94 workers, 25 (27 per cent) were women and 69 (73 per cent) were men. For women workers, the minimum age was 18 years and maximum 50 years, the average age being 28.6 years. For men, the minimum age was 18 years and maximum was 64 years, the average age being 35.6 years. However, the average age of the studied population was 34 years. As evident from Table 2, the maximum percentage of women {12 (48.00 per cent)} and men {28 (40.58 per cent)} is in the age group of 21–30 years, with the overall number of 40 (42.55 per cent) in this age group clearly indicating that more workers in the younger age work in kilns because they are better able to carry out much of the intensive manual work. Only one man was above 60 years of age. Twelve (12.77 per cent) workers—5 (20.00 per cent) women and 7 (10.14 per cent) men—were in the age group of 16–20 years. This represents double the percentage of women workers than men in the age group of 16–20 years. Evidently, the number of women workers is very low in the age group of 41–50 years with no woman worker above this age group. However, the men have a significant number, 11 (16 per cent), in the age group of 51–60 years. The laborious work prevents elderly women from continuing with brick-kiln work.

**Table 3** is the compilation of the age group according to the state to which a worker belongs, that is, the place of their permanent residence and from where they have migrated to work in the brick kilns of Tripura. The maximum number

**Table 2: Gender According to Age Groups**

| Age Group (in Years) | Gender | | Grand Total |
|---|---|---|---|
| | Women | Men | |
| 16–20 | 5 (20.00%) | 7 (10.14%) | 12 (12.77%) |
| 21–30 | 12 (48.00%) | 28 (40.58%) | 40 (42.55%) |
| 31–40 | 6 (24.00%) | 14 (20.29%) | 20 (21.28%) |
| 41–50 | 2 (8.00%) | 8 (11.59%) | 10 (10.64%) |
| 51–60 | - | 11 (15.94%) | 11 (11.70%) |
| 60+ | - | 1 (1.45%) | 1 (1.06%) |
| **Grand Total** | **25 (100.00%)** | **69 (100.00%)** | **94 (100.00%)** |

**Table 3: Age group, Gender and State to which the Workers Belong**

| Age Group (in Years) | Women | | | | Men | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Assam | Bihar | Jharkhand | Tripura | Assam | Bihar | Jharkhand | Tripura | U.P. | |
| **16–20** | 1 (8.33 per cent) | - | 4 (33.33 per cent) | - | - | - | 7 (58.33 per cent) | - | - | 12 (12.77 %) |
| **21–30** | 1 (2.50%) | 2 (5%) | 8 (20%) | 1 (2.5%) | 1 (2.5%) | 5 (12.5%) | 12 (30%) | 5 (12.5%) | 5 (12.50%) | 40 (42.55%) |
| **31–40** | - | 1 (5%) | 4 (20%) | 1 (5%) | 2 (10%) | - | 7 (35%) | 4 (20%) | 1 (5.00%) | 20 (21.28%) |
| **41–50** | - | - | 2 (20%) | - | 1 (10%) | - | 3 (30%) | 4 (40%) | | 10 (10.64%) |
| **51–60** | - | - | - | - | 1 (9.09%) | 1 (9.09%) | 1 (9.09%) | 7 (63.64%) | 1 (9.09%) | 11 (11.70%) |
| **60+** | - | - | - | - | - | - | - | 1 (100%) | - | 1 (1.06%) |
| **Grand Total** | **2 (2.13%)** | **3 (3.19 %)** | **18 (19.15%)** | **2 (2.13%)** | **5 (5.32%)** | **6 (6.38%)** | **30 (31.91%)** | **21 (22.34%)** | **7 (7.45%)** | **94 (100.00%)** |

**Table 4: Age Group, Gender and Education**

| Age Group (in Years) | Women | | | Men | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Illiterate | Middle | Matriculation | Illiterate | Middle | Matriculation | XII | Graduation | |
| **16–20** | 2 (2.13%) | 2 (2.13%) | 1 (1.06%) | 4 (4.26%) | 3 (3.19%) | - | - | - | 12 (12.77%) |
| **21–30** | 11 (11.70%) | 1 (1.06%) | - | 16 (17.02%) | 12 (12.77%) | - | - | - | 40 (42.55%) |
| **31–40** | 5 (5.32%) | 1 (1.06%) | - | 7 (7.45%) | 6 (6.38%) | 1(1.06%) | - | - | 20 (21.28%) |
| **41–50** | 2 (2.13%) | - | - | 5 (5.32%) | 3 (3.19%) | - | - | - | 10 (10.64%) |
| **51–60** | - | - | - | 6 (6.38%) | 4 (4.26%) | - | - | 1 (1.06%) | 11 (11.70%) |
| **60+** | - | - | - | - | - | - | 1 (1.06%) | - | 1 (1.06%) |
| **Grand Total** | **20 (21.28%)** | **4 (4.26%)** | **1 (1.06%)** | **38 (40.43%)** | **28 (29.79%)** | **1 (1.06%)** | **1 (1.06%)** | **1 (1.06%)** | **94 (100.00%)** |

of 48 (51 per cent) workers, of which 30 (32 per cent) men and 18 (19.15 per cent) women, were from Jharkhand. The maximum percentage of these workers from Jharkhand, both men and women, were in the age group of 16–20 years, and of a total of 12 workers in this age group, 11 belong to Jharkhand.

In the age groups of 21–30 years and 31–40 years also, the maximum percentage of both men and women in the respective age groups also belongs to Jharkhand. In the age group of above 40 years, the maximum percentage of men was local, that is, they belong to Tripura. A total of 23 (24 per cent) workers, 21 men and 2 women are from Tripura. Nine (9 per cent) workers (6 men, 3 women) are from Bihar, and 7 (7 per cent) workers (5 men, 2 women) are from Assam. All the 7 (7 per cent) workers from Uttar Pradesh are men.

**Table 4** is about the education levels of the surveyed population. As evident, 58 (61.7 per cent) of the total of 94 workers are illiterate—80 per cent women (20 of 25), and 55 per cent men (38 of 69). The corrected 2 tailed p value after applying Fisher-Exact test is 0.05, indicating a significant variation between the education levels of men and women, that is, women are significantly illiterate statistically.

Only 16 per cent (4 of 25) women workers below 40 years age have passed the 8th class, and only one woman has passed the 10th class in the 16–20 years age group. Forty per cent men (28 of 69) have passed the 8th class and one each has passed 10$^{th}$ and 12$^{th}$and one is a graduate.

**Table 5** records the duration the workers' stay in the brick kilns. 76 (80.8 per cent) of the workers—23 (24.46 per cent) women and 53 (56.38 per cent) men—have come to the particular kilns recently and have been there for less than 6 months. Eleven (11.70 per cent) workers have been there for 6–12 months and only 7 (7.44 per cent) workers have been staying at these kilns for more than one year. Significantly noteworthy is that all of them have worked in brick kilns for more than 5 years; most of them, however, have come to Tripura for the first time.

**Table 6** represents the marital status of the participating workers. Overall 82 (87 per cent) workers, 23 (92 per cent) women of 25, and 59 (85 per cent) men of 69 are married. Only 11 workers (9 men and 2 women) are unmarried. The women are in the early age groups are unmarried and 1 man each is unmarried in the age groups of 31–40 and 41–50 years. One man is a widower in the age group of 41–50 years.

**Table 7** records the number of children the workers have. This ranges from 1–8 although only one man in the age group of 51–60 has 8 children. The maximum number of workers (36.47 per cent), 19 men and 12 women, have two children. Next, are those with three children—13 men and 6 women (22.35 per cent) followed by 10 men and 3 women (15.29 per cent) with 1 child. As is clear from the table, the older workers have more children and the young workers, still in the reproductive age, may have more children with time.

**Table 5: Age Group, Gender and Duration of Stay in Respective Kilns**

| Age Group (in Years) | Woman | | | Man | | | Grand Total |
|---|---|---|---|---|---|---|---|
| | Up to 6 months | 6–12 months | > 12 months | Up to 6 months | 6–12 months | > 12 months | |
| **16–20** | 4 (4.25%) | 1 (1.06%) | - | 6 (6.38%) | 1 (1.06%) | - | **12 (12.77%)** |
| **21–30** | 11 (11.70%) | - | 1 (1.06%) | 26 (27.65%) | 1 (1.06%) | 1 (1.06%) | **40 (42.55%)** |
| **31–40** | 6 (6.38%) | - | - | 11 (11.70%) | 1 (1.06%) | 2 (2.12%) | **20 (21.28%)** |
| **41–50** | 2 (2.12%) | - | - | 4 (4.25%) | 4 (4.25%) | - | **10 (10.64%)** |
| **51–60** | - | - | - | 5 (5.31%) | 3 (3.19%) | 3 (3.19%) | **11 (11.70%)** |
| **60+** | - | - | - | 1 (1.06%) | - | - | **1 (1.06%)** |
| **Grand Total** | **23 (24.46%)** | **1 (1.06%)** | **1 (1.06%)** | **53 (56.38%)** | **10 (10.63%)** | **6 (6.38%)** | **94 (100%)** |

**Table 6: Age Group, Gender and Marital Status**

| Age Group (in Years) | Women | | Men | | | Total |
|---|---|---|---|---|---|---|
| | Married | Unmarried | Married | Unmarried | Widower | |
| **16–20** | 4 (4.17%) | 1 (1.04%) | 3 (3.13%) | 4 (4.17%) | - | **12 (12.50%)** |
| **21–30** | 12 (12.50%) | 1 (1.04%) | 24 (25.00%) | 3 (3.13%) | - | **40 (41.67%)** |
| **31–40** | 6 (6.25%) | - | 13 (13.82%) | 1 (1.04%) | - | **20 (21.28%)** |
| **41–50** | 1 (1.04%) | - | 7 (7.29%) | 1 (1.04%) | 1 (1.04%) | **10 (10.42%)** |
| **51–60** | - | - | 11 (11.70%) | - | - | **11 (11.70%)** |
| **60+** | - | - | 1 (1.04%) | - | - | **1 (1.04%)** |
| **Total** | **23 (23.96%)** | **2 (2.08%)** | **59 (63.54%)** | **9 (9.38%)** | **1 (1.04%)** | **94 (100%)** |

**Table 7: Age Group, Gender and No. of Children**

| Age Group (in Years) | Women | | | | Men | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of Children | | | | No. of Children | | | | | | | | |
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| 16–20 | 1 | 2 | - | - | 1 | - | - | - | - | - | - | - | 4 (4.71%) |
| 21–30 | 2 | 8 | 3 | - | 6 | 13 | 5 | - | - | 1 | - | - | 38 (44.71%) |
| 31–40 | - | 1 | 3 | 2 | 1 | 3 | 3 | 5 | - | 1 | 1 | - | 20 (23.53%) |
| 41–50 | - | 1 | - | 1 | 1 | - | 4 | 1 | 2 | | | - | 10 (11.76%) |
| 51–60 | - | - | - | - | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | 12 (14.12%) |
| 60+ | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 (1.18%) |
| Total | 3 (3.53 %) | 12 (14.12%) | 6 (7.06%) | 3 (3.53 %) | 10 (11.76%) | 19 (22.35%) | 13 (15.29%) | 8 (9.41 %) | 4 (4.71%) | 4 (4.71%) | 2 (2.35%) | 1 (1.18%) | 85 (100%) |

**Table 8: Age Group and No. of Family Members Working in the Same Kiln**

| Age Group (in Years) | 1–2 Members | 3–5 Members | 6–9 Members | Total |
|---|---|---|---|---|
| 16–20 | 7 (9.46%) | - | 1 (1.35%) | 8 (10.81%) |
| 21–30 | 25 (33.78%) | 5 (6.76%) | 1 (1.35%) | 31 (41.89%) |
| 31–40 | 16 (21.62%) | 2 (2.70%) | - | 18 (24.32%) |
| 41–50 | 7 (9.46%) | 2 (2.70%) | - | 9 (12.16%) |
| 51–60 | 6 (8.11%) | 2 (2.70%) | - | 8 (10.81%) |
| Total | 61 (82.43%) | 11 (14.86%) | 2 (2.70%) | 74 (100%) |

Children in the Kiln

**Table 8** is summary of the number of family members working in the same kiln. Seventy-four workers have their family members working in the same kiln; 61 have 1–2 members whereas 11 have 3–5 members in the same kiln. Two young workers have 6–9 family members in the same kiln. One or two members in the same kiln usually indicate a couple working together. Younger workers have their parents and siblings working in the same kiln.

**Smoking:** Fifty-five workers responded to the question on smoking. Of them, 20 (36.36 per cent) men affirmed that they smoke *bidi* regularly; 15 workers (14 men and 1 woman) are occasional smokers and 20 (11 men and 9 women) said they have never smoked. Of the men who smoke, 13 said they have been smoking for 5 years, 9 for 6–10 years, 7 for 11–15 years, and 5 for more than 16 years. Twenty-two smokers (11 each) belong to the age groups of 21–30 and 31–40 years.

**Alcohol Intake:** Sixty-two workers (53 men and 9 women) responded to the question on alcohol intake. Nine (16.98 per cent) of the men said that they are regular drinkers; 31 (58.49 per cent) men are occasional or social drinkers and 22 (13 men and 9 women) said they had never taken alcohol. Of

Row of Rooms near a Kiln

Inside a Room

those who consume alcohol, 27 belong to the age groups of 21–30 (16 workers) and 31–40 years (11 workers).

Many of the migrant workers are provided with *kuchcha*(makeshift) rooms near the kiln to stay during the working season. The workers cook their food and stay in these small rooms with their families.

| **Highlights 1** | |
|---|---|
| Total number of workers in the study: | 94 |
| No. of women workers: | 25 |
| No. of men workers: | 69 |
| Minimum age: | 18 |
| Maximum age: | 64 |
| Average age: | 34 |
| Migrant workers: | 75% |
| Maximum migrants: | 51% from Jharkhand |
| Illiterate Workers | 62% |

### 3.2.2. Occupation and Health Profile Data

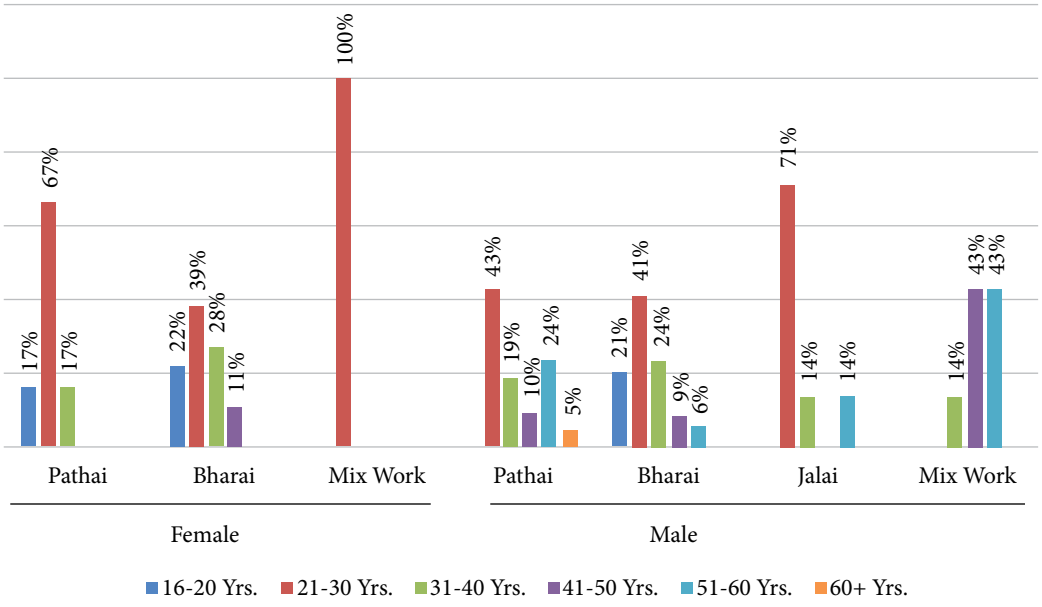
**Table 9** depicts the age-wise distribution of men and women participants according to their occupation, that is, the specific or major work assigned to them in the brick kiln. The use of nomenclature of work many a times varies with the brick kiln or the language of the migrant worker or the prevalent use in the specific area. Many a times, various works in the kiln overlap or are part of or are ancillary to a major activity, for example, ***pathai***, a major activity, involves the mixing of clay with sand and water in very precise proportions, using wooden measures; moulding the clay and aligning these so as to dry. The other works involved in the *pathai* are *dunda*, *goratop*, *karigar*, moulder, mud mixing, *rinjaru*, *zanzari*, or the bullocks man. For the purpose of analyses, *pathai* represents all these nomenclatures, used by the workers during their interview.

According to Table 9, 28 per cent workers, 6 women workers and 21 men, are engaged in *pathai* work. Women from the

**Table 9: Age group, Gender and Occupation**

| Age Group (in Years) | Women | | | Men | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | ***Pathai*** | ***Bharai*** | **Mix Work** | ***Pathai*** | ***Bharai*** | ***Jalai*** | **Mix Work** | |
| **16–20** | 1 (1.06%) | 4 (4.26%) | - | - | 7 (7.45%) | - | - | **12 (12.77%)** |
| **21–30** | 4 (4.26%) | 7 (7.45%) | 1 (1.06%) | 9 (9.57%) | 14 (14.89% | 5 (5.32%) | - | **40 (42.55%)** |
| **31–40** | 1 (1.06%) | 5 (5.32%) | - | 4 (4.26%) | 8 (8.51%) | 1 (1.06%) | 1 (1.06%) | **20 (21.28%)** |
| **41–50** | - | 2 (2.13%) | - | 2 (2.13%) | 3 (3.19%) | - | 3 (3.19%) | **10 (10.64%)** |
| **51–60** | - | - | - | 5 (5.32%) | 2 (2.13%) | 1 (1.06%) | 3 (3.19%) | **11 (11.70%)** |
| **60+** | - | - | - | 1 (1.06%) | - | - | - | **1 (1.06%)** |
| **Total** | **6(6.38%)** | **18(19.15%)** | **1 (1.06%)** | **21 (22.34%)** | **34 (36.17%)** | **7 (7.45%)** | **7 (7.45%)** | **94 (100%)** |

**Table 9: Age group, Gender and Occupation**




younger age groups are involved in *pathai* work whereas men across all the age groups do *pathai* work. The highest percentage of both men and women *pathai* workers is in the age group of 21–30 years.

The second major activity in a kiln is *bharai*. The term ***bharai*** (transport 10–12 dried bricks at a time on the head to the kiln) includes *bharai*, *nikasi*, cycle-*wala*, loader, etc. In some kilns, cycles are used to carry the dried bricks from the *pathai* area to the kiln.

Table 9 also indicates that the maximum number of 52 workers (55 per cent) are doing *bharai*—34 (36.17 per cent) men and 18 (19.15 per cent) women workers. The proportion of younger women(up to 30 years) in *bharai* is more, as compared to the numbers between 31 and 50 years. Similarly, the maximum percentage of men workers doing *bharai* is in the age group of 21–30 years.

***Jalai*** involves firing of bricks in the kilns as well as supervising the fire. Work is performed only by men and they work in shifts of 6 hours each, with the firemen taking turns for their duty. The limited hours of work are intended to give the workers a break from exposure to continuous heat. No other words are used to describe *jalai* work in the surveyed kilns. In the study, all the 7 *jalai* workers are men, 5 of them being in the age group of 21–30 years.

Brick kilns require a variety of workers such as the daily wage labour, also called *hazira*; the driver who brings mud for the bricks; the carpenter, or *kathmistri*, who makes small carts for loading; the maintenance worker (staff that looks after the machines such as the JCB), or the manager, who is assigned the overall responsibility of the kiln.

Eight workers (7 men and 1 woman) do the mix work and all the works elaborated above. Relatively elderly men (3 each) in the age groups of 41–50 and 51–60 work as supervisors in these kilns.

**Table 10** is compilation of the nature of work, gender and their state of residence. Most workers (15 out of 27) engaged in the work of *pathai* are local residents (13 men and 2 women), that is, from Tripura. The remaining 12 *pathai* workers are from Assam and Bihar (6 each), comprising 4 men and 2 women from each state. None of the *pathai* worker is from Jharkhand or Uttar Pradesh.

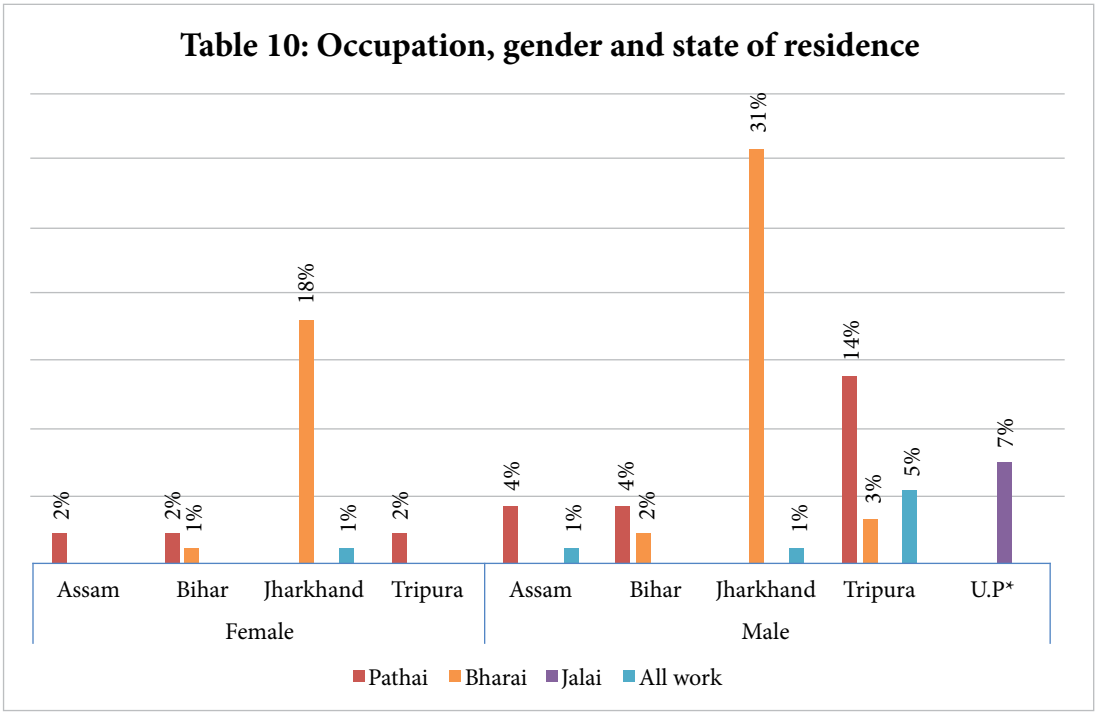
The 46 *bharai* workers (29 men, 17 women) were from Jharkhand; 3 men from Tripura, and 2 men and 1 woman from Bihar are also engaged in the work of *bharai*.

The work of *jalai* is monopolized by 7 men workers from Uttar Pradesh. Five men from Tripura handled the miscellaneous work, or all the supervisory work, as did one man and one woman from Jharkhand and one man from Assam.

**Table 10: Occupation, Gender and State of Residence**

| Work | Women | | | | Men | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Assam | Bihar | Jharkhand | Tripura | Assam | Bihar | Jharkhand | Tripura | U.P.* | |
| ***Pathai*** | 2 (2.12%) | 2 (2.12%) | - | 2 (2.12%) | 4 (4.25%) | 4 (4.25%) | - | 13 (13.82%) | - | **27 (28,72%)** |
| ***Bharai*** | - | 1 (1.06%) | 17 (18.08%) | - | - | 2 (2.12%) | 29 (30.85%) | 3 (3.19%) | - | **52 (55.32%)** |
| ***Jalai*** | - | - | - | - | - | - | - | - | 7 (7.45%) | **7 (7.44%)** |
| **All work** | - | - | 1 (1.06%) | - | 1 (1.06%) | - | 1 (1.06%) | 5 (5.32%) | - | **8 (8.51%)** |
| **Total** | **2 (2.13%)** | **3 (3.19%)** | **18 (19.15%)** | **2 (2.13%)** | **5 (5.32%)** | **6 (6.38%)** | **30 (31.91%)** | **21 (22.34 %)** | **7 (7.45%)** | **94 (100 %)** |

* U.P. = Uttar Pradesh




The height and weight of 93 workers were recorded during the medical examination, and the body mass index of each was calculated. The interpretation was done using the standard categories of BMI as follows.

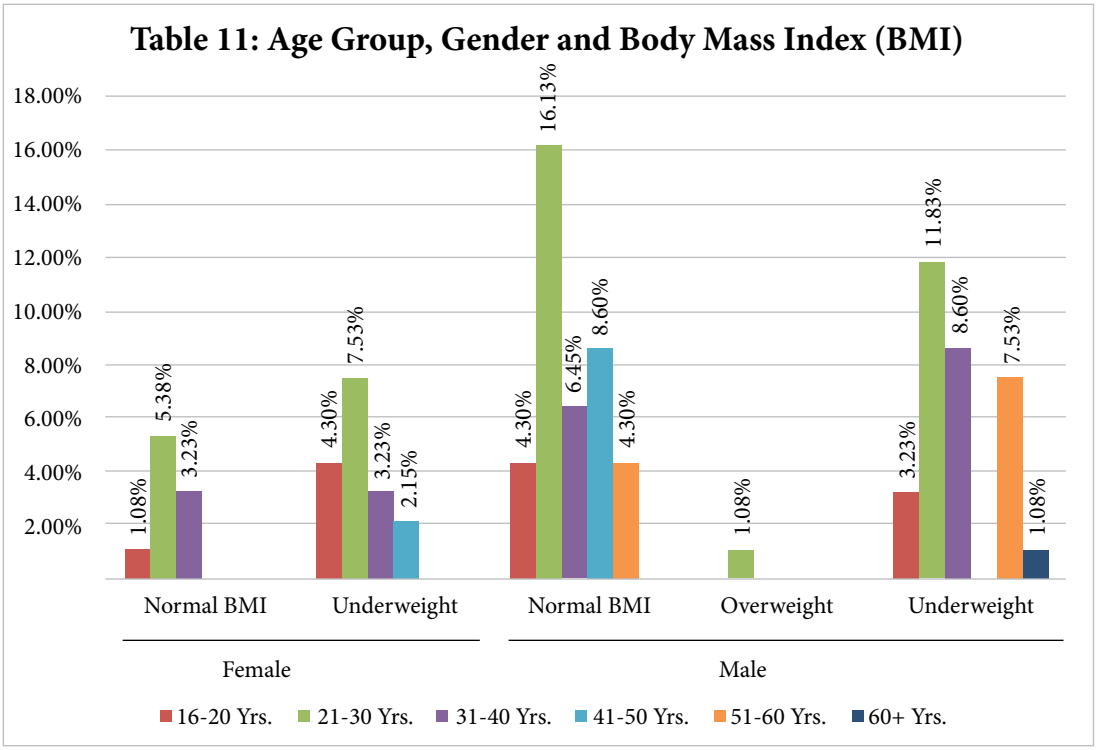
| | | |
|---|---|---|
| Underweight (low BMI) | BMI range | Below 19 |
| Normal BMI | BMI range | 19 to 24.99 |
| Overweight (high BMI) | BMI range | Above 25 |

Of the women, 64 per cent (16 out of 25) were underweight whereas 44 per cent of the men (30 out of 68) were underweight. This is quite high, compared to the national percentage of low BMI for men being 26.1 per cent and 31 per cent for women. Nationally, the number one state to represent low BMI for men is Tripura (36.3 per cent) and for women is Bihar (41 per cent). Poor nutrition and heavy manual work are leading to such high frequency of low BMI.

Seventy-two per cent of women (13 out of 18) working as *bharai* worker were underweight whereas 47 per cent men (16 out of 34) working as *bharai* workers were underweight. Fifty per cent *pathai* women (3 out of 6) and 45 per cent *pathai* men were also underweight. 57 per cent *jalai* men (4 out of 7) were underweight. Only one of the 7 men and one woman in

**Table 11: Age Group, Gender and Body Mass Index (BMI)**

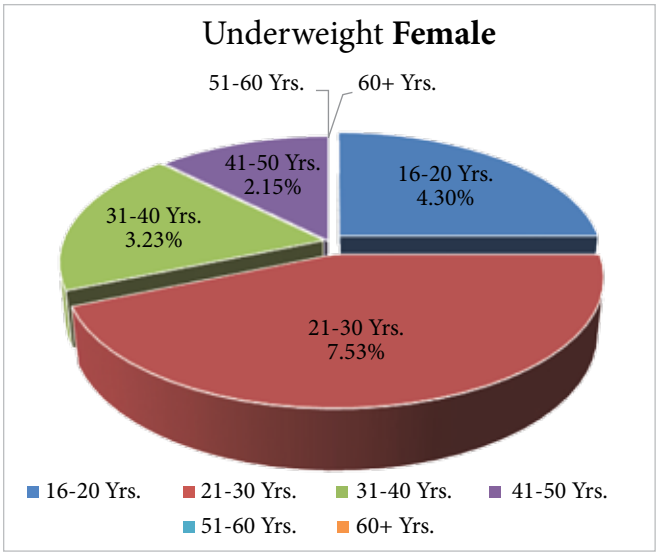
| Age Group (in Years) | Women | | Men | | | Total |
|---|---|---|---|---|---|---|
| | Normal BMI | Underweight | Normal BMI | Overweight | Underweight | |
| **16–20** | 1 (1.08%) | 4 (4.30%) | 4 (4.30%) | - | 3 (3.23%) | **12 (12.90%)** |
| **21–30** | 5 (5.38%) | 7 (7.53%) | 15 (16.13%) | 1 (1.08%) | 11 (11.83%) | **39 (41.94%)** |
| **31–40** | 3 (3.23%) | 3 (3.23%) | 6 (6.45%) | - | 8 (8.60%) | **20 (21.51%)** |
| **41–50** | - | 2 (2.15%) | 8 (8.60%) | - | - | **10 (10.75%)** |
| **51–60** | - | - | 4 (4.30%) | - | 7 (7.53%) | **11 (11.83%)** |
| **60+** | - | - | - | - | 1 (1.08%) | **1 (1.08%)** |
| **Total** | **9 (9.68%)** | **16 (17.20%)** | **37 (39.78%)** | **1 (1.08%)** | **30 (32.26%)** | **93 (100%)** |



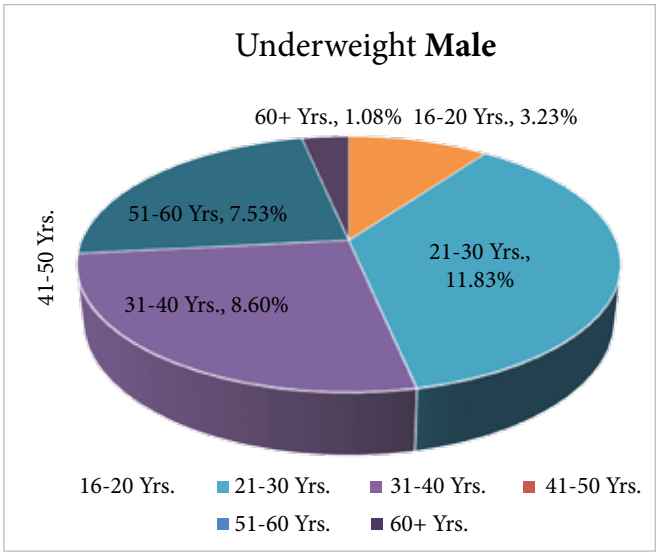

all work categories was underweight, thereby indicating that strenuous manual work is possibly responsible for low BMI in most work categories.

The blood pressure of 93 of the workers was recorded. Normal blood pressure was taken as below 140/90 mm of Hg. Any recording above 140 for systolic pressure and above 90 for diastolic pressure was considered high. Only 3 (12 per cent) women out of a total of 25 woman workers had high blood pressure. Twelve out of 68 (17.6 per cent) of the men recorded high blood pressure. Here 5 (41.6 per cent) of the high blood pressure recorded men were in the age group of 51–60 years. None of the workers had a history of high blood pressure; therefore, a single high recording does not indicate the diagnosis of high blood pressure. These workers were advised to decrease their salt intake and have their blood pressure monitored by the doctor and, if required, take anti-hypertensive medicines under guidance and supervision.

Three *bharai* women workers had high blood pressure reading; none of the other women worker categories had high blood




Age-wise Low BMI in Woman Workers




Age-wise Low BMI in Men Workers

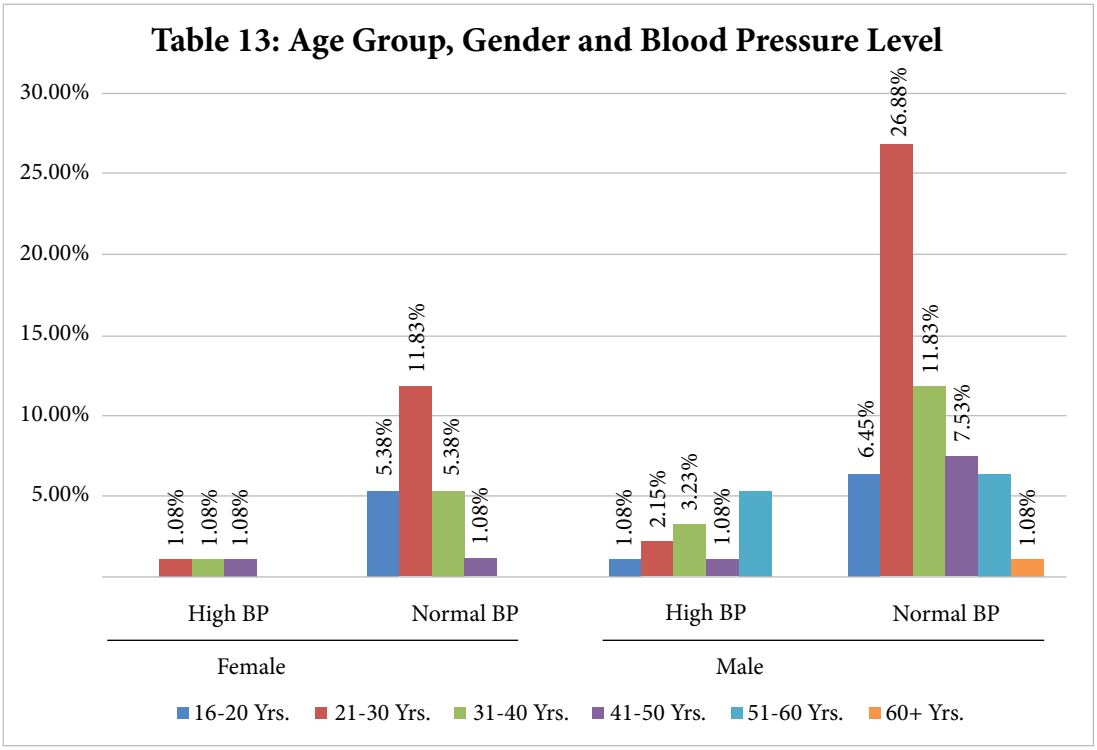
Recording Height and Weight of the Workers

**Table 12: Occupation, Gender and Body Mass Index (BMI)**

| Occupation | Women | | Men | | | Total |
|---|---|---|---|---|---|---|
| | Normal BMI | Underweight | Normal BMI | Overweight | Underweight | |
| *Pathai* | 3 (3.23%) | 3 (3.23%) | 10 (10.76%) | 1 (1.08%) | 9 (9.68%) | 26 (27.95%) |
| *Bharai* | 5 (5.38%) | 13 (13.98%) | 18 (19.35%) | - | 16 (17.20%) | 52 (55.91%) |
| Jalai | - | - | 3 (3.23%) | - | 4 (4.30%) | 7 (7.53%) |
| All work | 1 (1.08%) | - | 6 (6.45%) | - | 1 (1.08%) | 8 (8.61%) |
| Total | 9 (9.68%) | 16 (17.20%) | 37 (39.78%) | 1 (1.08%) | 30 (32.26%) | 93 (100%) |

**Table 13: Age Group, Gender and Blood Pressure Level**

| Age Group in Years | Woman | | Male | | Total |
|---|---|---|---|---|---|
| | High BP | Normal BP | High BP | Normal BP | |
| **16–20** | - | 5 (5.38%) | 1 (1.08%) | 6 (6.45%) | **12 (12.90%)** |
| **21–30** | 1 (1.08%) | 11 (11.83%) | 2 (2.15%) | 25 (26.88%) | **39 (41.94%)** |
| **31–40** | 1 (1.08%) | 5 (5.38%) | 3 (3.23%) | 11 (11.83%) | **20 (21.51%)** |
| **41–50** | 1 (1.08%) | 1 (1.08%) | 1 (1.08%) | 7 (7.53%) | **10 (10.75%)** |
| **51–60** | - | - | 5 (5.38%) | 6 (6.45%) | **11 (11.83%)** |
| **60+** | - | - | - | 1 (1.08%) | **1 (1.08%)** |
| **Total** | **3 (3.23%)** | **22 (23.66%)** | **12 (12.90%)** | **56 (60.22%)** | **93 (100.00%)** |




pressure. The maximum number of men with high blood pressure is 5 in the *pathai* category whereas three are doing all the work in the kilns.

**Table 15** is a compilation of the screening for near vision testing of 89 workers with the help of a near vision reading chart. Each eye was tested for any deviation. Five women working in *bharai* have bilateral decrease in near vision as do 4 women in the 31–40 years age group. Twenty women workers have normal near vision. Decrease in near vision with advancing age is common but other reasons for low near vision such as cataract or glaucoma should be ruled out. However, any change in the near visual acuity should be corrected with reading glasses.

Fourteen men (5 *pathai*, 5 *bharai*, 1 *jalai* and 3 all work) have bilateral decrease in near vision, with 10 of them being in the age group of 51–60 years and 3 in the 41–50 years of age group. Forty-one men have the normal near vision acuity. Six men (2 each from *pathai*, *bharai* and *jalai*) have low near vision in the left eye and 3 (all *bharai* workers) have low near vision in right eye. They need a detailed examination by an

**Table 14: Occupation, Gender and Blood Pressure Level**

| Age Group in Years | Woman | | Men | | Total |
|---|---|---|---|---|---|
| | High BP | Normal BP | High BP | Normal BP | |
| ***Pathai*** | - | 6 (6.45%) | 5 (5.38%) | 15 (16.13%) | **26 (27.95%)** |
| ***Bharai*** | 3 (3.23%) | 15 (16.13%) | 2 (2.15%) | 32 (34.41%) | **52 (55.91%)** |
| ***Jalai*** | - | - | 2 (2.15%) | 5 (5.38%) | **7 (7.53%)** |
| **All work** | - | 1 (1.08%) | 3 (3.23%) | 4 (4.30%) | **8 (8.61%)** |
| **Total** | **3 (3.23%)** | **22 (23.66%)** | **12 (12.90%)** | **56 (60.22%)** | **93 (100.00%)** |

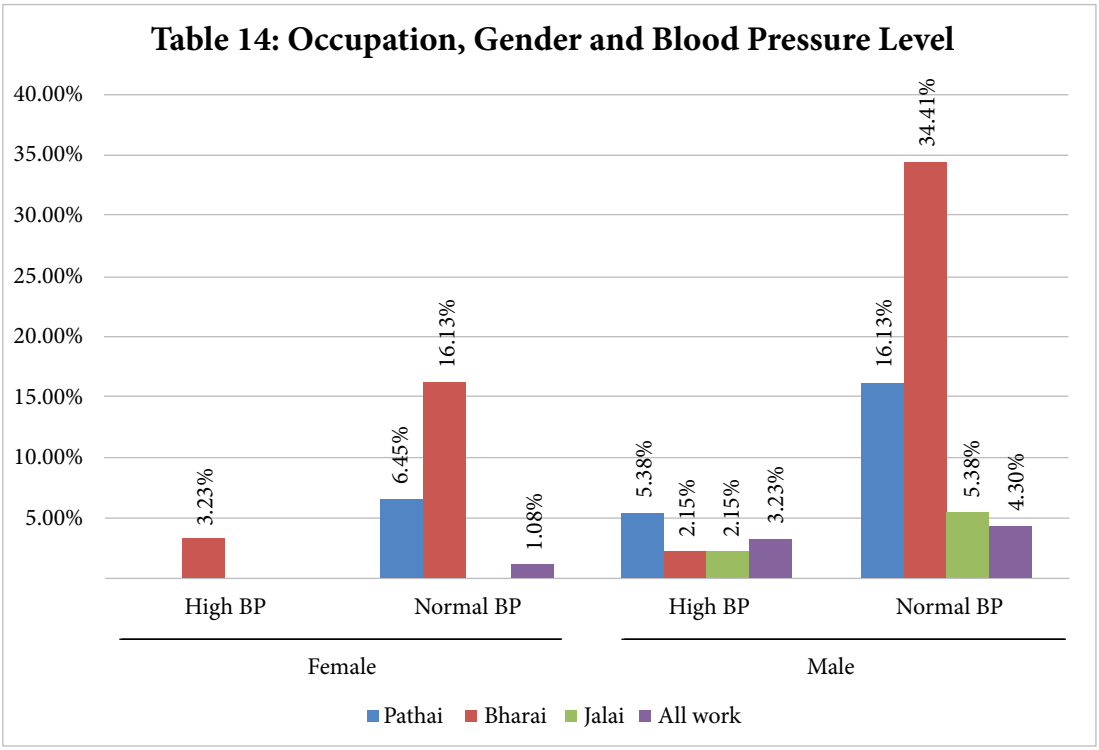



**Table 15: Age Group, Gender and Near Vision (NV) Testing**

| Age Group in Years | Women | | Men | | | | Total |
|---|---|---|---|---|---|---|---|
| | B/L Low NV | Normal NV | B/L Low NV | Low Left NV | Low Right NV | Normal NV | |
| **16–20** | - | 5 (5.62%) | - | - | - | 7 (7.87%) | **12 (13.48%)** |
| **21–30** | 1 (1.12%) | 11 (12.36%) | 1 (1.12%) | 2 (2.25%) | 1 (1.12%) | 21 (23.60%) | **37 (41.57%)** |
| **31–40** | 4 (4.49%) | 2 (2.25%) | - | 3 (3.37%) | 2 (2.25%) | 9 (10.11%) | **20 (22.47%)** |
| **41–50** | - | 2 (2.25%) | 3 (3.37%) | 1 (1.12%) | - | 3 (3.37%) | **9 (10.11%)** |
| **51–60** | - | - | 10 (11.24%) | - | - | 1 (1.12%) | **11 (12.36%)** |
| **Total** | **5 (5.62%)** | **20 (22.47%)** | **14 (15.73%)** | **6 (6.74%)** | **3 (3.37%)** | **41 (46.07%)** | **89 (100.00%)** |

eye specialist to rule out other reasons for their uni-ocular low near vision.

**Table 16** is compilation of the screening for far vision testing for 88 workers with the help of a far vision reading chart known as **Snellen chart**. Each eye was tested for any deviation.

Five woman (3 working in *bharai* and 2 in *pathai*) have bilateral decrease in far vision, 3 of them being in the age group of 21–30 years. Eighteen women workers have normal distance vision. One woman worker has low far vision in the right eye and one woman worker has low far vision in the left eye.

Decrease in far vision in childhood is common, and usually remains undiagnosed if the person does not complain about it. Any deviation in far vision acuity must be corrected with appropriate glasses.

Fifteen men (7 *pathai*, 5 *bharai*, 1 *jalai* and 2 all work) have bilateral decrease in far vision; 39 have normal far vision acuity; 7 men (2 *pathai*, 3 *bharai* and 1 each in *jalai* and all work) have low far vision in the left eye and 2 (one *bharai* and one *jalai* worker) have low far vision in the right eye. They need further examination by the eye specialist, to rule out other reasons for uni-ocular low far vision.

**Table 17** is a compilation of random blood sugar levels of

**Blood Pressure being Taken**

**Near vision being assessed**

**Table 16: Age Group, Gender and Far Vision (FV) Testing**

| Age Group in Years | Women | | | | Men | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | B/L Low FV | Low Left FV | Low Right FV | Normal FV | B/L Low FV | Low Left FV | Low Right FV | Normal FV | |
| **16–20** | - | - | - | 5 (5.68%) | 2 (2.27%) | 1 (1.14%) | - | 4 (4.55%) | **12 (13.64%)** |
| **21–30** | 3 (3.41%) | (0.00%) | - | 9 (10.23) | 4 (4.55%) | 1 (1.14%) | - | 20 (22.73%) | **37 (42.05%)** |
| **31–40** | 2 (2.27%) | 1 (1.14%) | - | 3 (3.41%) | 2 (2.27%) | 1 (1.14%) | 1 (1.14%) | 9 (10.23%) | **19 (21.59%)** |
| **41–50** | - | - | 1 (1.14%) | 1 (1.14%) | 3 (3.41%) | 1 (1.14%) | - | 4 (4.55%) | **10 (11.36%)** |
| **51–60** | - | - | - | - | 4 (4.55%) | 3 (3.41%) | 1 (1.14%) | 2 (2.27%) | **10 (11.36%)** |
| **Total** | **5 (5.68%)** | **1 (1.14%)** | **1 (1.14%)** | **18 (20.45%)** | **15 (17.05%)** | **7 (7.95%)** | **2 (2.27%)** | **39 (44.32%)** | **88 (100.00%)** |

**Table 17: Age Group, Gender and Random Blood Sugar (RBS) Level**

| Age Group in Years | Women | | Men | | Total |
|---|---|---|---|---|---|
| | High RBS | Normal RBS | High RBS | Normal RBS | |
| **16–20** | - | 5 (6.10%) | - | 6 (7.32%) | **11 (13.41%)** |
| **21–30** | - | 10 (12.20%) | - | 24 (29.27%) | **34 (41.46%)** |
| **31–40** | 3 (3.66%) | 2 (2.44%) | - | 12 (14.63%) | **17 (20.73%)** |
| **41–50** | - | 2 (2.44%) | 1 (1.22%) | 6 (7.32%) | **9 (10.98%)** |
| **51–60** | - | - | 1 (1.22%) | 9 (10.98%) | **10 (12.20%)** |
| **60+** | - | - | - | 1 (1.22%) | **1 (1.22%)** |
| **Total** | **3 (3.66%)** | **19 (23.17%)** | **2 (2.44%)** | **58 (70.73%)** | **82 (100.00%)** |

**Distant vision screening**

**Blood Samples Being Taken**

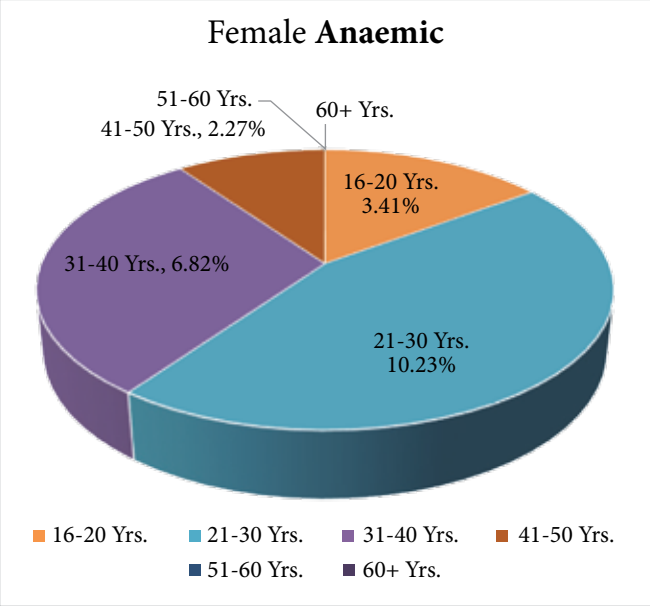
82 workers assessed with the help of glucometer. Only three women workers in the age group of 31–40 years and two men, one each in the age groups of 41–50 and 51–60 years, have high blood sugar levels recorded. None of them has a prior history of Diabetes Mellitus, a single random reading is just indicative of deranged sugar metabolism; all of them were advised to undergo further investigations to establish the diagnosis.

**Table 18** is a compilation of haemoglobin levels of 88 workers. The blood samples were taken in EDTA vial and complete haemogram was assessed for each of the workers in the laboratory with the help of an automatic cell counter machine. The results were grouped, based on normal haemoglobin levels for women at above 12 g/dl and for men at above 13 g/dl.

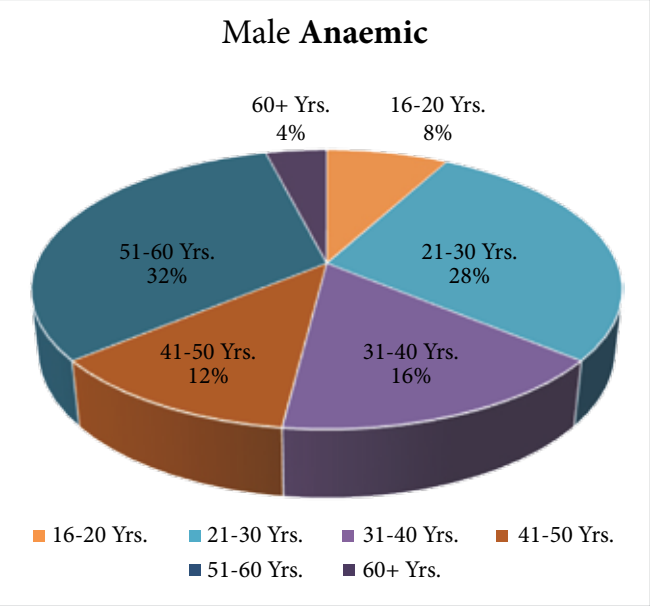
An analyses of the data shows that 20 (80 per cent) of 25 woman workers are anaemic, with a haemoglobin level of below 12 g/dl. In the men, however, the prevalence of low HB was half that of woman workers, that is, only 40 per cent (25 of 63) have a haemoglobin level less than 13 g/dl. Significantly, there are anaemic workers in men and women

**Table 18: Age Group, Gender and Hemoglobin Level**

| Age Group in Years | Women | | Men | | Total |
|---|---|---|---|---|---|
| | Anaemic | Normal HB | Anaemic | Normal HB | |
| **16–20** | 3 (3.41%) | 2 (2.27%) | 2 (2.27%) | 5 (5.68%) | **12 (13.64%)** |
| **21–30** | 9 (10.23%) | 3 (3.41%) | 7 (7.95%) | 18 (20.45%) | **37 (42.05%)** |
| **31–40** | 6 (6.82%) | - | 4 (4.55%) | 8 (9.09%) | **18 (20.45%)** |
| **41–50** | 2 (2.27%) | - | 3 (3.41%) | 4 (4.55%) | **9 (10.23%)** |
| **51–60** | - | - | 8 (9.09%) | 3 (3.41%) | **11 (12.50%)** |
| **60+** | - | - | 1 (1.14%) | - | **1 (1.14%)** |
| **Total** | **20 (22.73%)** | **5 (5.68%)** | **25 (28.41%)** | **38 (43.18%)** | **88 (100.00%)** |




**Age-wise Low Haemoglobin in Women Workers**




**Age-wise Low Haemoglobin in Men Workers**

of all the age groups.

The high prevalence of anaemia in brick-kiln workers can be attributed to nutritional deficiency, worm infestation, gynaecological reasons, etc.

**Table 19** is about occupation, gender and haemoglobin levels. Forty-two per cent *pathai* workers, 57 per cent *bharai* workers, 16 per cent *jalai* workers and 37 per cent of the mixed workers are anaemic. Further analysis reveals that only 43.3 per cent *bharai* men workers (13 out of 30) are anaemic as compared to 94 per cent woman *bharai* workers. However, a proportion of the anaemic *pathai* men (45 per cent) is more as compared to women *pathai* workers (33 per cent). The minimum HB reported was 7.6 g/dl in a *bharai* woman worker.

The comparatively low prevalence of anaemia in *jalai* workers may be due to adaptation of these workers to their job of working at high temperatures and exposure to smoke. Smokers do tend to have a higher haemoglobin levels.

The corrected p value of (0.019) after applying the Fischer-Exact test, which is less than 0.05, for anaemic women *bharai* workers is statistically significant, establishing work as the cause for their low HB. The p value is also 0.007 for woman *pathai* workers, again establishing the cause-effect relationship. The p value for men *pathai* workers, at a value of 0.755, is not significant. Similarly, the p value for men *bharai*

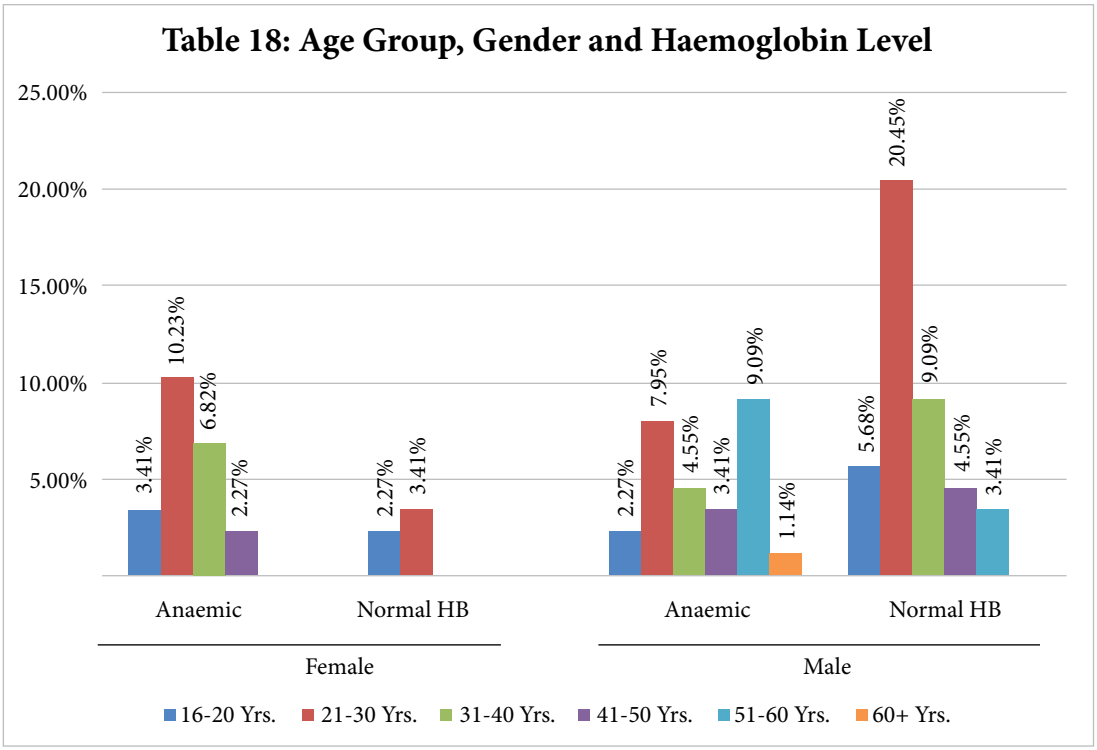



**Table 19: Occupation, Gender and Haemoglobin Level**

| Occupation | Women | | Men | | Total |
|---|---|---|---|---|---|
| | Anaemic | Normal HB | Anaemic | Normal HB | |
| ***Pathai*** | 2 (2.27%) | 4 (4.55%) | 9 (10.23%) | 11 (12.50%) | **26 (29.55%)** |
| ***Bharai*** | 17 (19.32%) | 1 (1.14%) | 13 (14.77%) | 17 (19.32%) | **48 (54.55%)** |
| ***Jalai*** | - | - | 1 (1.14%) | 5 (5.68%) | **6 (6.82%)** |
| **All work** | 1 (1.14%) | - | 2 (2.27%) | 5 (5.68%) | **8 (9.09%)** |
| **Total** | **20 (22.73%)** | **5 (5.68%)** | **25 (28.41%)** | **38 (43.18%)** | **88 (100.00%)** |

workers is not significant at 0.758.

To correct the high prevalence of anaemia among kiln workers, all the workers need to be provided with iron supplements, de-worming tablets and improvement in the general nutrition of the workers. This is particularly important for woman workers of the child bearing age.

The union government has initiated a programme under the National Programme for the Control and Prevention of Anaemia in adolescents, to reduce the prevalence and severity of anaemia while also controlling it in the adolescent population. All workers must be made aware of this program and be guided to access and avail of the services in their respective geographical location.

**Table 20** records the eosinophil count as a component of differential leukocyte count (DLC) in a complete haemogram. Eosinophils are a type of white blood cells present in peripheral blood. The normal eosinophil level, for both men and women, is equal to or less than 6 per cent of the circulating leukocytes. Counts more than 6 are known as eosinophilia and are indicative of some allergic phenomenon or parasitic infection in the body. The contamination of skin and food with raw mud, which has the ova and cysts of various worms, heavy metal contamination and exposure

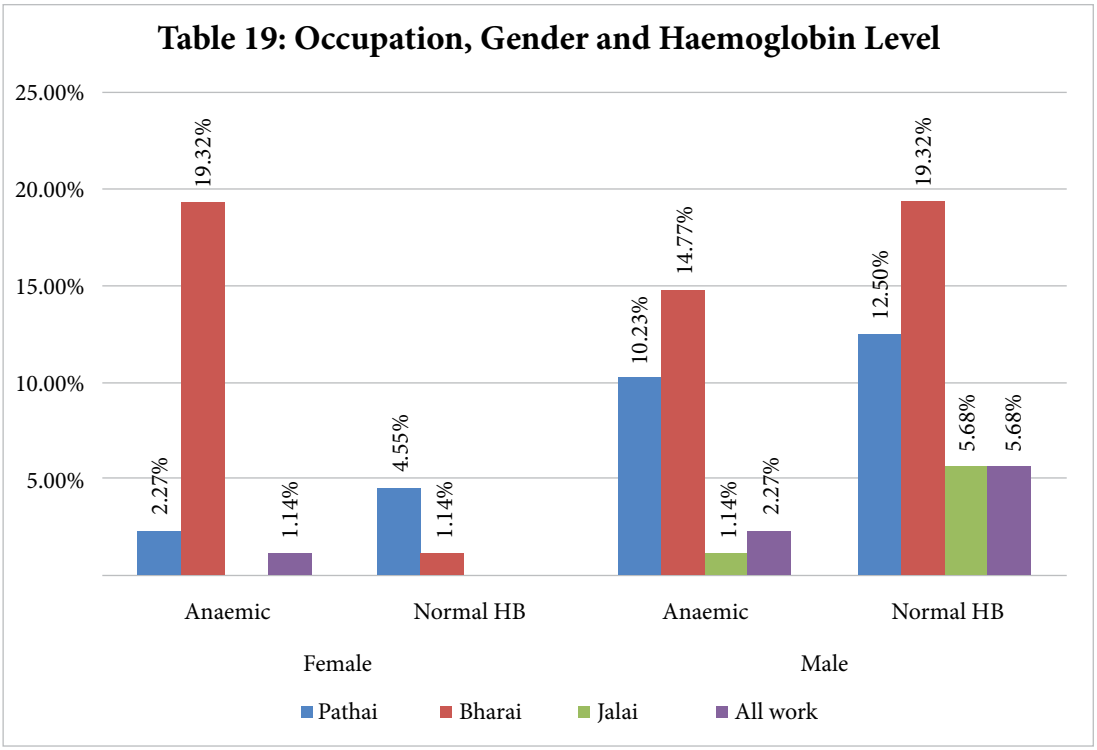



**Table 20: Age Group, Gender and Eosinophilia**

| Age Group in Years | Women | | Men | | Total |
|---|---|---|---|---|---|
| | Eosinophilia | Normal | Eosinophilia | Normal | |
| **16–20** | 4 (4.55%) | 1 (1.14%) | 6 (6.82%) | 1 (1.14%) | **12 (13.64%)** |
| **21–30** | 10 (11.36%) | 2 (2.27%) | 22 (25.00%) | 3 (3.41%) | **37 (42.05%)** |
| **31–40** | 5 (5.68%) | 1 (1.14%) | 8 (9.09%) | 4 (4.55%) | **18 (20.45%)** |
| **41–50** | 1 (1.14%) | 1 (1.14%) | 6 (6.82%) | 1 (1.14%) | **9 (10.23%)** |
| **51–60** | - | - | 7 (7.95%) | 4 (4.55%) | **11 (12.50%)** |
| **60+** | - | - | - | 1 (1.14%) | **1 (1.14%)** |
| **Total** | **20 (22.73%)** | **5 (5.68%)** | **49 (55.68%)** | **14 (15.91%)** | **88 (100%)** |

to allergens such as black carbon in the environment can cause eosinophilia.

Clearly, the table shows that 78 per cent (69 of 88) of the workers have established eosinophilia. The maximum eosinophil count was 37.6 in a male *pathai* worker. Eighty per cent women workers (20 of 25) and 78 per cent men (49 of 63) have a high eosinophil count.

**The Chi Square for linear trend (Extended Mantel-Haenszel) is 4.16063 for the men, with a p value of 0.04, establishing the correlation of eosinophilia with age, that is, eosinophilia in younger men is more than in elderly men. This may be due to the body adapting to allergic reactions with advancing age.**

**The Chi Square for linear trend (Extended Mantel-Haenszel) is 0.75 for women, with a p value of 0.38, which is not significant.**

**Table 21** relates the incidence of eosinophilia with the occupation of the worker. Forty (83 per cent) of 48 *bharai* workers and 18 (69 per cent) *pathai* workers have eosinophilia. The p value for both men and women workers is not significant

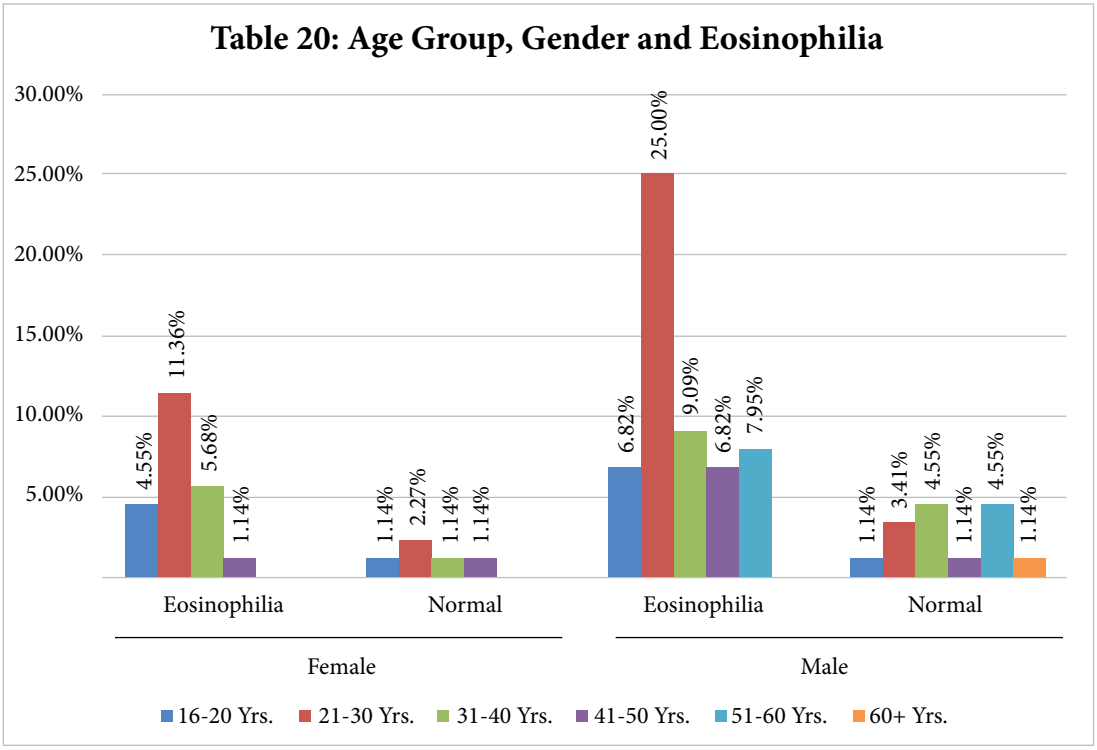
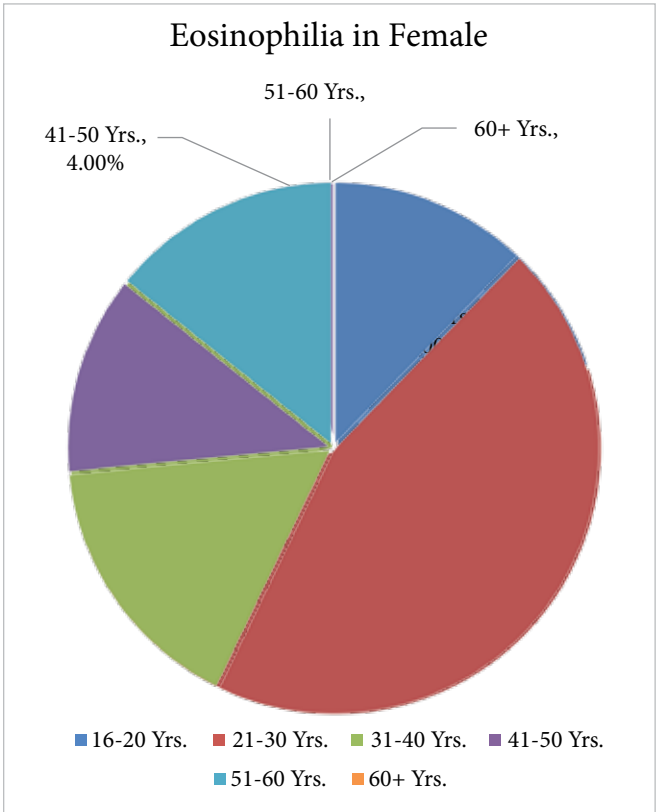


Table 20: Age Group, Gender and Eosinophilia
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
4.55%
11.36%
5.68%
1.14%
1.14%
2.27%
1.14%
1.14%
6.82%
25.00%
9.09%
6.82%
7.95%
1.14%
3.41%
4.55%
1.14%
4.55%
1.14%
Eosinophilia
Normal
Eosinophilia
Normal
Female
Male
16-20 Yrs.
21-30 Yrs.
31-40 Yrs.
41-50 Yrs.
51-60 Yrs.
60+ Yrs.


Eosinophilia in Female
51-60 Yrs.,
41-50 Yrs.,
4.00%
60+ Yrs.,
16-20 Yrs.
21-30 Yrs.
31-40 Yrs.
41-50 Yrs.
51-60 Yrs.
60+ Yrs.

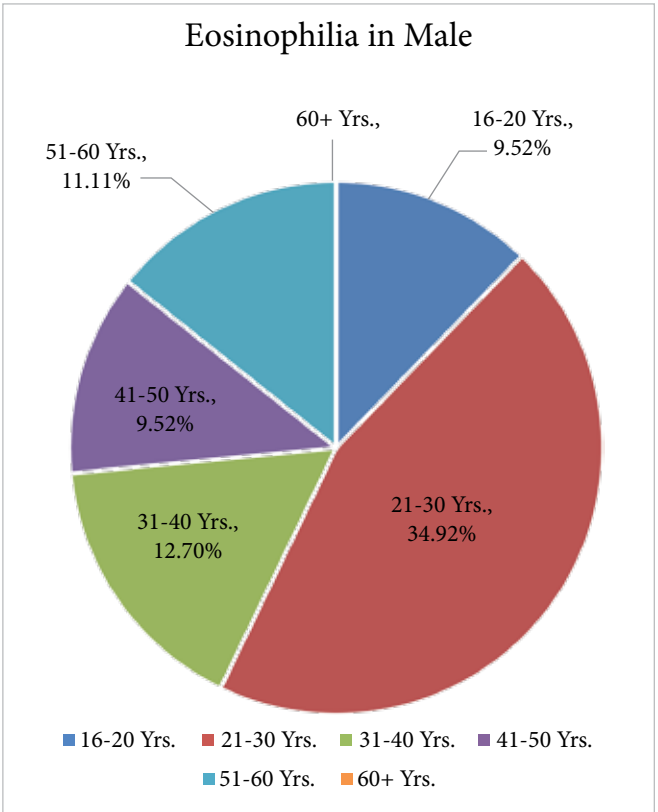
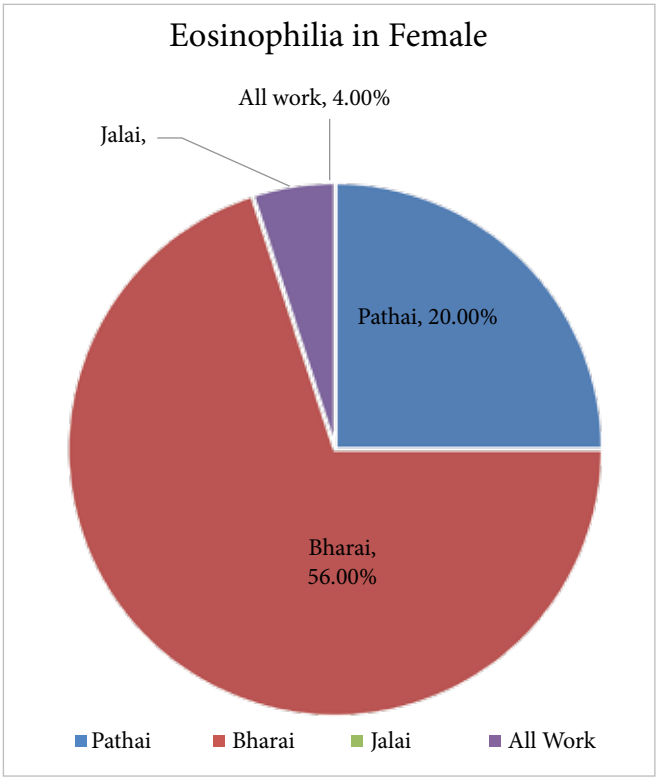
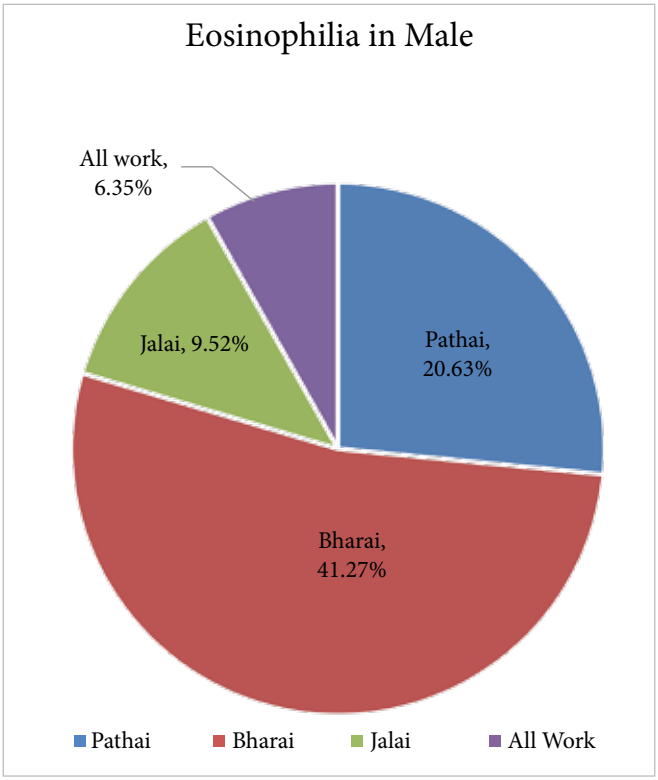

Eosinophilia in Male
60+ Yrs.,
16-20 Yrs.,
9.52%
51-60 Yrs.,
11.11%
41-50 Yrs.,
9.52%
31-40 Yrs.,
12.70%
21-30 Yrs.,
34.92%
16-20 Yrs.
21-30 Yrs.
31-40 Yrs.
41-50 Yrs.
51-60 Yrs.
60+ Yrs.

**Table 21: Occupation, Gender and Eosinophilia**

| Occupation | Women | | Men | | Total |
|---|---|---|---|---|---|
| | Eosinophilia | Normal | Eosinophilia | Normal | |
| ***Pathai*** | 5 (5.68%) | 1 (1.14%) | 13 (14.77%) | 7 (7.95%) | **26 (29.55%)** |
| ***Bharai*** | 14 (15.91%) | 4 (4.55%) | 26 (29.55%) | 4 (4.55%) | **48 (54.55%)** |
| ***Jalai*** | - | - | 6 (6.82%) | - | **6 (6.82%)** |
| **All work** | 1 (1.14%) | - | 4 (4.54%) | 3 (3.41%) | **8 (9.09%)** |
| **Total** | **20 (22.73%)** | **5 (5.68%)** | **49 (55.68%)** | **14 (15.91%)** | **88 (100.00%)** |




for *pathai* and *bharai* workers. All the 6 *jalai* workers have eosinophilia, but the p value is 0.389, thereby discarding the cause-and-effect relation of high eosinophil to *jalai* work. Probably, the low number of participants is responsible for this.

The causative correlation of this high prevalence of eosinophilia is required to be established so as to remove or modify those factors in the workplace environment, or to give definitive treatment to these workers. However, all the workers must be given a course of deworming medicines at regular intervals. Pre-employment blood examination and a blood sample during the non-working period (non-exposure period) of June-July till September-October can help in verifying chronic eosinophilia.

ESR is measured along with the complete blood count. Forty-seven per cent (41 of 86) workers have high ESR, which is an indicator of low haemoglobin, acute or chronic inflammatory process or an infection in the body.

The normal ESR range for the men is 0–10 and for the women is 0–15 mm in the first hour. The p value for all the work categories is not significant for cause-and-effect correlation.

**Table 23** is compilation of the pulmonary function test (PFT), which is an evaluation of the lung capacity of individuals and the severity of pulmonary impairment. It is done to assess

**Table 22: Occupation, Gender and Erythrocyte Sedimentation Rate (ESR)**

| Occupation | Woman | | | Male | | | Total |
|---|---|---|---|---|---|---|---|
| | High ESR | Normal ESR | SNS* | High ESR | Normal ESR | SNS* | |
| ***Pathai*** | 2 (2.27%) | 4 (4.55%) | - | 11 (12.50%) | 9 (10.23%) | - | **26 (29.55%)** |
| ***Bharai*** | 10 (11.36%) | 7 (7.95%) | 1 (1.14%) | 12 (13.64%) | 18 (20.45%) | - | **48 (54.55%)** |
| ***Jalai*** | - | - | - | 1 (1.14%) | 4 (4.55%) | 1 (1.14%) | **6 (6.82%)** |
| **All Work** | - | 1(1.14%) | - | 5 (5.68%) | 2 (2.27%) | - | **8 (9.09%)** |
| **Total** | **12 (13.64%)** | **12 (13.64%)** | **1 (1.14%)** | **29 (32.95%)** | **33 (37.50%)** | **1 (1.14%)** | **88 (100.00%)** |

*SNS = Sample not Sufficient.

**Table 23: Age Group, Gender and Pulmonary Function Test (PFT) Evaluation**

| Age Group in Years | Women | | | | | Men | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MO | MR | MSR | SR | Normal | MO | MR | MoO | MSR | OPR | SO | Normal | |
| **16–20** | 1 (1.10%) | 1 (1.10%) | - | - | 3 (3.30%) | - | - | - | 1 (1.10%) | - | - | 6 (6.59%) | **12 (13.19%)** |
| **21–30** | - | 4 (4.40%) | - | 1 (1.10%) | 7 (7.69%) | 3 (3.30%) | - | - | 1 (1.10%) | - | - | 22 (24.18%) | **38 (41.76%)** |
| **31–40** | - | 1 (1.10%) | 1 (1.10%) | - | 4 (4.40%) | 2 (2.20%) | 2 (2.20%) | 1 (1.10%) | - | - | - | 9 (9.89%) | **20 (21.98%)** |
| **41–50** | 2 (2.20%) | - | - | - | - | - | - | - | - | - | - | 7 (7.69%) | **9 (9.89%)** |
| **51–60** | - | - | - | - | - | 1 (1.10%) | 1 (1.10%) | - | - | 1 (1.10%) | 2 (2.20%) | 6 (6.59%) | **11 (12.09%)** |
| **60+** | - | - | - | - | - | - | - | - | - | - | - | 1 (1.10%) | **1 (1.10%)** |
| **Total** | **3 (3.30%)** | **6 (6.59%)** | **1 (1.10%)** | **1 (1.10%)** | **14 (15.38%)** | **6 (6.59%)** | **3 (3.30%)** | **1 (1.10%)** | **2 (2.20%)** | **1 (1.10%)** | **2 (2.20%)** | **51 (56.04%)** | **91 (100.00%)** |

the extent of airway obstruction to air movement in and out of the lungs. Poor performance in this test reflects varying degrees of either restriction or obstruction of air movement through the parenchyma in the lungs. The elasticity of the lungs gets destroyed with exposure to various things such as smoking, silica, asbestos and many other occupational or environmental factors. Asthma, allergic bronchitis, etc., also have an adverse impact on PFT values. The predicted values of an individual for his age, height, weight and ethnicity are plotted to the actual performed values, and the results calculated. These spirometry results are interpreted as varying degrees of severity of obstruction or restriction of airways of the individual.

The abbreviations used in the above table are:

MO = Mild Obstruction
MR = Mild Restriction
MoO = Moderate Obstruction
MSR = Moderate Severe Restriction
SR = Severe Restriction
OPR = Obstruction with possible Restriction
SO = Severe Obstruction

Of the 91 PFTs done, 71 per cent are normal. Eleven women workers and 15 men have performed less than the normal predicted values for them. Nine of 11 women and 9 out of 15 men had either mild obstruction or restriction. There are not

**Table 24: Occupation, Gender and Pulmonary Function Test (PFT) evaluation**

| Occupation | Women | | | | | Men | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MO | MR | MSR | SR | Normal | MO | MR | MoO | MSR | OPR | SO | Normal | |
| ***Pathai*** | 1 (1.10%) | 1 (1.10%) | - | 1 (1.10%) | 3 (3.30%) | 2 (2.20%) | 2 (2.20%) | - | - | 1 (1.10%) | 1 (1.10%) | 12 (13.19%) | **24 (26.37%)** |
| ***Bharai*** | 2 (2.20%) | 5 (5.49%) | 1 (1.10%) | - | 10 (10.99%) | 2 (2.20%) | 1 (1.10%) | 1 (1.10%) | 2 (2.20%) | - | - | 28 (30.77%) | **52 (57.14%)** |
| ***Jalai*** | - | - | - | - | - | 1 (1.10%) | - | - | - | - | 1 (1.10%) | 5 (5.49%) | **7 (7.69%)** |
| **All Work** | - | - | - | - | 1 (1.10%) | 1 (1.10%) | - | - | - | - | - | 6 (6.60%) | **8 (8.79%)** |
| **Total** | **3 (3.30%)** | **6 (6.59%)** | **1 (1.10%)** | **1 (1.10%)** | **14 (15.38%)** | **6 (6.59%)** | **3 (3.30%)** | **1 (1.10%)** | **2 (2.20%)** | **1 (1.10%)** | **2 (2.20%)** | **51 (56.04%)** | **91 (100%)** |

many complaints of respiratory illness among the workers, therefore, these findings of PFT are confirmatory.

Corrected p value for women *pathai* as well as *bharai* workers is 1.0 each, showing no correlation of poor PFT with the work exposure.

Corrected p value for men *pathai* workers is 0.352, *bharai* workers is 0.470 and *jalai* workers is 1.0, again discarding any correlation with the work exposure.

A worker with abnormal PFT value needs to do further investigations such as chest x-ray and repeat PFT after treatment of any respiratory illness.

**Spirometry Test being Conducted**

### 3.2.3. Symptoms for various illnesses

The participants were asked about different symptoms related to various illnesses, which are deemed to be present because of occupational and/or environmental exposure occurring at the workplace/living places. The response to specific questions for various organs systems were noted during the questionnaire schedules.

Only three participants claimed to have eye irritation, two (one man and one woman) of them in the 21–30 years age group. One man in 51–60 age group complained of eye irritation. Eye irritation can be due to allergic conditions. The workers were given the medication and were advised to visit the eye specialist if symptoms persisted.

Nine workers—4 women and 5 men—complained of dizziness. Four (2 men and 2 women) were in the 21–30 age group. Although there is no specific correlation with any disease, these self-limiting episodes of dizziness or light-headedness, the diagnosis of orthostatic hypotension (postural hypotension—a form of low blood pressure that happens when one stands up from the sitting or lying down position) should be considered. Working in a hot environment of the kilns causes sweating and, possibly, dehydration; this can lower the blood pressure and trigger orthostatic hypotension. These workers were advised to move slowly, especially when standing up from a sitting position. Persistent symptoms need further evaluation.

**Table 25 & 26** are compilation of the chief complaints/ symptoms of illnesses experienced in last six months by each worker. They were asked about the symptoms related to various organ systems and their responses were recorded in the affirmation of the corresponding symptoms.

These tables analyze the age group, occupation and various symptoms. Table 25 is compilation of major symptoms wherein

more than 10 respondents (both men and women) have given a response in the affirmative. The most experienced symptom is back pain, which affected 47 men and 15 women. The next most frequently experienced symptom is arm pain, felt by 23 men and 8 women workers. Shoulder pain (27 workers), leg pain (25 workers), neck pain (24 workers), tingling sensation in fingers (23 workers), headache (21 workers) and blurred vision (17 workers) are the other symptoms. However, because of the small number of data, it was not possible to establish the cause-and-effect relationship between the work and the symptoms experienced. Table 25 gives an overall glimpse of the frequency of symptoms vis-a-vis work, gender and age group.

Three workers, 2 women (one each in 16–20 years and 21–30 years age group) and a man (51–60 years age group) complained of restricted or decreased neck movements. Long-standing musculoskeletal strain and workload could be the possible contributing factors for such symptoms.

Back discomfort was reported by 4 workers—3 men and 1 woman. The sole woman is from the 21–30 years age group and the men are 1 each from 31–40, 41–50 and 51–60 years age groups.

Early morning back stiffness was also experienced by 5 workers, 4 men and 1 woman. The only woman (*pathai* worker) and one man (*bharai* worker) is from the age group of 31–40 years. Two men (one each from *pathai* and *bharai*) from the 41–50 years age group and one male *pathai* worker from the 51–60 years age group also had complaints of early morning back stiffness.

Limited back movement was also the complaint of 8 workers—5 men and 3 women. One woman worker, each from the age groups of 16–20 (*bharai* worker), 21–30 (*bharai* worker) and 31–40 (*pathai* worker) years had difficulty in free movement of their lower backs. One man each from the age groups of 21–30 (*bharai* worker), 41–50 (*bharai* worker)and 51–60 (*pathai* worker) years and 2 men (one *bharai* worker and one *pathai* worker) in age group of 31–40 years experienced difficulty in free movement of their lower backs.

Wrist pain was mentioned by 10 workers—8 men and 2 women. In the age group of 16–20 years, 1 woman and 2 men, all engaged in *bharai* work have wrist pain. One *pathai* woman worker and two *bharai* men in the age group of 21–30 years and two men each (one *bharai* worker and one *jalai* worker) in the 31–40 years age group, and one *bharai* and one *pathai* worker in the 41–50 years age group had wrist pain.

Fifteen men and 7 women complained of cough whereas 15 men and 4 women reported upper abdominal pain (gastritis). Pain in the abdomen (16 workers), decreased appetite (11 workers) and shortness of breath/breathlessness (8 workers) were other complaints.

Three women *bharai* workers, one in the 16–20 years age group and two (one *pathai* and one *bharai* worker) in the 21–30 years age group complained of fatigue.

Eight workers—5 men and 3 women—reported constipation. Four workers (2 men *pathai* workers and 2 women—one *pathai* and one *bharai* worker) in the 21–30 years age group suffer from constipation. Overall, 4 men *pathai* and 2 women *pathai* workers, and 1 man and 1 woman *bharai* worker complained of constipation. Seventy-five per cent (6 out of 8) complaints of *pathai* workers could be due to the early start of work, the sitting posture and the eating timings.

**Demonstration of an Exercise to Relieve Back, Shoulder, Arm, Wrist and Leg Pain**

**Table 25: Musculoskeletal Symptoms**

| Age Group in Years | Occupation | Blurred Vision | | Headache | | Neck Pain | | Shoulder Pain | | Arm Pain | | Back Pain | | Finger Tingling | | Leg Pain | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ |
| 16–20 | *Pathai* | | | | | | | | | | | 1 | | | | | |
| | *Bharai* | 1 | | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 4 | 2 | 1 | 3 | 2 |
| | *Jalai* | | | | | | | | | | | | | | | | |
| | All Work | | | | | | | | | | | | | | | | |
| 21–30 | *Pathai* | 3 | 1 | 2 | | 1 | | 2 | 3 | 2 | 1 | 2 | 5 | 2 | 1 | 1 | |
| | *Bharai* | | 1 | 4 | 2 | 3 | 4 | 1 | 5 | 1 | 7 | 5 | 12 | 2 | 3 | 3 | 4 |
| | *Jalai* | | 1 | | | | 2 | | | | | | 3 | | 2 | | |
| | All Work | | | | | | | | | 1 | | 1 | | | | 1 | |
| 31–40 | *Pathai* | | 2 | 1 | 1 | | | | | | 1 | | 3 | | 1 | | 2 |
| | *Bharai* | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 3 | 1 | 2 | 1 |
| | *Jalai* | | | | | | 1 | | 2 | | 2 | | 2 | | 2 | | 1 |
| | All Work | | 1 | | 1 | | | | | | | | | | | | |
| 41–50 | *Pathai* | | 1 | | 1 | | | | | | | | 1 | | | | 2 |
| | *Bharai* | | 2 | 1 | 1 | | 1 | | 1 | | 1 | 1 | 3 | | 1 | | |
| | *Jalai* | | | | | | | | | | | | | | | | |
| | All Work | | | | | | | | | | | | 1 | | | | |
| 51–60 | *Pathai* | | 1 | | 1 | | 1 | | 3 | | 3 | | 4 | | | | 1 |
| | *Bharai* | | | | | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 |
| | *Jalai* | | | | | | | | | | | | | | | | |
| | All Work | | 1 | | | | 1 | | | | 1 | | 2 | | 1 | | 1 |
| 60+ | *Pathai* | | | | | | | | | | 1 | | 1 | | | | |
| | *Bharai* | | | | | | | | | | | | | | | | |
| | *Jalai* | | | | | | | | | | | | | | | | |
| | All Work | | | | | | | | | | | | | | | | |
| Total | | 5 | 12 | 11 | 10 | 9 | 15 | 8 | 19 | 8 | 23 | 15 | 47 | 9 | 14 | 10 | 15 |

**Table 26: Gastro-intestinal and Respiratory Symptoms**

| Age Group in Years | Occupation | Decrease Appetite | | Pain Abdomen | | Gastritis | | Cough | | Shortness of Breath | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ |
| 16–20 | *Pathai* | 1 | | | | | | 1 | | 1 | |
| | *Bharai* | 1 | | 2 | 1 | 1 | 2 | 1 | 1 | | |
| | *Jalai* | | | | | | | | | | |
| | All Work | | | | | | | | | | |
| 21–30 | *Pathai* | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| | *Bharai* | 1 | 1 | 1 | 3 | 1 | 2 | 2 | 4 | 1 | |
| | *Jalai* | | 1 | | 1 | | 3 | | 1 | | |
| | All Work | | | | | | | 1 | | | |
| 31–40 | *Pathai* | 1 | 1 | | 3 | | 2 | | 1 | | 1 |
| | *Bharai* | | | 1 | | 1 | 1 | | | | 1 |
| | *Jalai* | | | | | | 1 | | 1 | | |
| | All Work | | | | | | | | | | |
| 41–50 | *Pathai* | | | | | | | | 1 | | 1 |
| | *Bharai* | | 1 | | | | | 1 | 1 | | |
| | *Jalai* | | | | | | | | | | |
| | All Work | | 1 | | | | 1 | | 1 | | |
| 51–60 | *Pathai* | | 1 | | 2 | | 1 | | 2 | | 2 |
| | *Bharai* | | | | | | 1 | | 1 | | |
| | *Jalai* | | | | | | | | | | |
| | All Work | | | | | | | | | | |
| 60+ | *Pathai* | | | | | | | | | | |
| | *Bharai* | | | | | | | | | | |
| | *Jalai* | | | | | | | | | | |
| | All Work | | | | | | | | | | |
| **Total** | | 4 | 7 | 5 | 11 | 4 | 15 | 7 | 15 | 3 | 5 |

| **Highlights 2** | |
|---|---|
| *Bharai* workers: | 55% |
| *Pathai* workers: | 29% |
| *Jalai* workers: | 7% |
| Underweight workers: | 49% (64% women, 44% men) |
| Anaemic workers: | 51% (80% women, 40% men) |
| Eosinophilia: | 78% (80% women, 78% Men) |
| Spirometry test: | 71% normal |
| Back pain: | 66% (60% women, 68% men) |
| Arm pain: | 33% (32% women, 33% men) |

We can add Total No. of Workers (N-94 (100%), Women (N 1- 25 (100%), Men (N 2 - 69 (100%), So 64% (16) women and 30 men are underweight

To the question whether they consult a doctor for their ailments, 31 of 60 respondents replied in the affirmative whereas 29 denied having visited a doctor for treatment. Interestingly, almost an equal number of participants across each age group either consult a doctor or do not, with the exception of men in the 51–60 years age, wherein 6 out of 7 workers do consult a doctor for their ailments.

Only one woman in the age group of 21–30 years is on continuous treatment, and 20 workers have to visit the doctor at least once a month. The rest of the 10 workers recall a visit to the doctor about once in three months.

To the question of preference for a doctor in a private or a government hospital, 15 of 42 workers expressed their choice of consulting a private doctor, nursing home or hospital. The remaining 27 workers were happy with the services provided in government institutions be it the CHC Manu, the district hospital, the ESI dispensary or hospital, or the Agartala Medical College and Hospital. Some of the workers even expressed their preference for a doctor or hospital of their respective states from which they have migrated.

As many of the symptoms of workers are of repetitive musculoskeletal injury, they were advised some exercises to strengthen their muscular mass so as to prevent fatigue and pain. A back exercise was demonstrated in all the kilns, with instructions that it be done daily.

# 4. Environmental Data

Some of the prescribed standards by Central Pollution Control Board (CPCB) for FCBTK kilns are provided in Table 27

**Table 27: Standards Prescribed by Central Pollution Control Board**

| Bull's Trench Kiln (BTK) Category* | |
|---|---|
| Particular matter | (Limiting concentration in mg/ Nm3) |
| Small | 1000 |
| Medium | 750 |
| Large | 750 |
| Stack height | minimum (metre) |
| Small | 22 or induced draft fan operating with minimum draft of 50 mm WG with 12 metre stack height. |
| Medium | 27 or induced draft fan operating with minimum draft of 50 mm WG with 15 metre stack height. |
| Large | 30 or induced draft fan operating with minimum draft 50 mm WG with 17 metre stack height. |
| *Category Trench width (m) | Production (bricks/day) |
| Small BTK <4.50 | Less than 15,000 |
| Medium BTK 4.50-6.75 | 15000–30000 |
| Large BTK above 6.75 | Above 30000 |

Although all the above parameters were not verified, the ambient air quality and drinking water samples were tested by Tripura State Pollution Control Board (TSPCB).

## 4.1. Ambient Air Quality Data

The assessment of the ambient air quality was continuously monitored at two locations (L-1) and (L-2) for 24 hours by a team from TSPCB (Tripura State Pollution Control Board).

**Analytical Result of Air Quality at Jirania Brick Field Area**

| Pollutants | Frequency of Monitoring | Measured Value (L-1) | Measured Value (L-2) | Standard |
|---|---|---|---|---|
| Particulate Matter (PM10), Hg/ m3 | 24 hours | 79.05 | 83.17 | 100 |
| Particulate Matter (PM2.5), Hg/m3 | 24 hours | 58.25 | 37.45 | 60 |
| Sulphur Dioxide ($SO_2$), Hg/ m3 | 24 hours | 21.39 | 16.53 | 80 |
| Nitrogen Dioxide ($NO_2$), Hg/ m3 | 24 hours | 23.57 | 14.98 | 80 |

L-1 = Tripura Brick Industry, Jirania, West Tripura
L-2 = AVI Brick Industry, Jirania, West Tripura

Emissions from the brick kilns were evaluated for particulate matter PM10 and PM2.5, $SO_2$ and Nitrogen Dioxide ($NO_2$) because these are the main air pollutants in a brick kiln.

The ambient air quality monitoring was conducted using a respirable dust sampler (Envirotech APM 460 XNL), with attachments for absorbing gaseous pollutants and PM 2.5 analyser. The air samples collected were analysed in the laboratory, using the standards prescribed by CPCB. The analysis of both the samples for PM10, PM2.5, $SO_2$ and $NO_2$

were within the prescribed limits. Because the exposure was well within the prescribed limits, the symptoms of workers were not correlated with these environmental exposures.

## 4.2. Water Quality Data

Two samples of drinking water were collected and tested in the Tripura State Pollution Control Board (TSPCB lab on the prescribed parameters for drinking water.

Drinking water samples from the above two locations were collected. The physical and chemical parameters as per the above table were analysed, using the standard method prescribed by American Public Health Association.

The Ph in both the samples was lower than the standard limit; the iron content in both the samples was high, and the turbidity of S-1 was high. Remedial measures were recommended to make the water suitable for drinking. It will be premature to correlate the abdominal symptoms of workers to the drinking water quality.

For the limited purpose of this study, the ecological impact of brick kilns on human beings was considered. Changes in the ambient environment can impact human health, animal health and flora and fauna of the area adversely. However, the parameters were in the prescribed range, and a visible inspection of vegetation around the area also did not reveal any adverse impact.

**Analytical Report of Drinking Water Samples Collected from Bricks Industries, Jirania, West Tripura**

| No. | Parameters | S-1 | S-2 | Standard (BISI) |
|---|---|---|---|---|
| 1 | Temperature© | 25 | 25 | |
| 2 | Ph | **6.37** | **6.43** | 6.5-8.5 |
| 3 | Conductivity (Hs/cm) | 126.9 | 162.5 | |
| 4 | Turbidity (NTU) | **6.44** | 0.5 | 5 |
| 5 | Total Suspended solids (mg/I) | 18 | 24 | |
| 6 | Total Dissolved solids (mg/I) | 64 | 82 | 500 |
| 7 | Total Hardness (mg/I) | 29.72 | 49.54 | 300 |
| 8 | Calcium (mg/I) | 11.23 | 17.39 | 75 |
| 9 | Magnesium (mg/I) | 5.31 | 9.86 | 24.28 |
| 10 | Chlorides (mg/I) | 28.29 | 23.57 | 250 |
| 11 | Alkalinity (mg/I) | 50.4 | 95.76 | 200 |
| 12 | Fe (mg/I) | **4.18** | **0.47** | 0.3 |
| 13 | Arsenic (mg/I) | BDL | BDL | 0.05 |
| 14 | Total Coliform (cfu/100ml) | <1 | <1 | Nil |

S-1 = Tripura Brick Industry, Jirania, West Tripura
S-2 = AVI Brick Industry, Jirania, West Tripura

# 5. Gaps between the Legal Provisions of OSH under the Factories Act and the Implementation of these in the Brick Kilns in India

**The Factories Act 1948** serves to assist in formulating national policies in India, with respect to OSH in factories in India. It deals with various problems concerning safety, health, efficiency and well-being of the persons at work places.

The Act is administered by the Ministry of Labour and Employment in India through its Directorate General Factory Advice Service &Labour Institutes (DGFASLI) and by the state governments through their factory inspectorates. DGFASLI advises the central and state governments on the implementation of the Factories Act and coordinates the factory inspection services in the states.

The Act is applicable to any factory where ten or more workers are working, or were working on any day of the preceding 12 months, and in any part of which a manufacturing process is being carried on with the aid of power, or is ordinarily so carried on, or whereon twenty or more workers are working, or were working on any day of the preceding 12 months, and in any part of which a manufacturing process is being carried on without the aid of power, or is ordinarily so carried on; but this does not include a mine, or a mobile unit belonging to the armed forces of the union, a railway running shed or a hotel, restaurant or eating place.

The Factories Act 1948 has various chapters related to the provisions of health and safety of the workers. Chapter III (Sec. 11 to Sec. 20) is on health; Chapter IV is related to Safety Provisions (Sec. 21 to Sec. 41 H); Chapter V is on Welfare (Sec. 42 to Sec. 50); Chapter VI is on Working Hours of Adults (Sec. 51 to Sec. 66);Chapter VII is on Employment of Young Persons (Sec. 67 to Sec. 77);Chapter VIII is on Annual Leave with Wages (Sec. 78 to Sec. 84);Chapter IX is on Special Provisions (Sec. 85 to Sec. 91A). All these chapters are prescriptive in nature and contain directions for the occupier to comply with the provisions of these chapters. However, Chapter X through its Sec. 92 to Sec. 106 A, is on Penalties and Procedures for non-compliance of all the other chapters. The three schedules contained in the Factories Act are:

The First Schedule: List of Industries Involving Hazardous Processes

The Second Schedule: Permissible Levels of Certain Chemicals Substances in Work Environment

The Third Schedule: List of Notifiable Diseases

As per the applicability of provisions of the Factory Act 1948, brick kilns being manufacturing units with employment of more than 20 workers without power are considered as Factory. However, there is no direct reference to brick kilns in any of the schedules or even State Factory Rules (various State Factory Rules were scanned to find Brick Kilns). The manufacturing process, which may be considered closest to brick manufacturing, is at No. 22 (glass and ceramics) of The First Schedule: List of Industries Involving Hazardous Processes of The Factory Act 1948.

Another close reference is Schedule XXXI on Manufacture of Pottery in The Tripura Factories Rules 2007 of the State of Tripura. The Factories and Boiler Inspectorate website of Tripura has listed the district-wise number of brick fields and a total of 358 brick fields being covered under the provisions of The Tripura Factories Rules.

Many sections of the Factories Act are applicable to the brick industry, for example, Sec. 34 deals with excessive weights, Sec. 35 with protection of eyes, Sec. 41 G with Workers' Participation in Safety Management, Sec. 41 H with the right of workers to warn about imminent danger, Sec. 42 with washing facilities, Sec. 45 with first-aid appliances, Sec. 48 with creches, Sec. 55 with intervals for rest, Sec 69 with certificates of fitness, Sec 75 with power to require medical examination, and Sec 91 with occupational safety and health surveys. This is just an indicative list of sections.

Section 69 is elaborated here, to understand the finer details about the Certificate of Fitness.

**Sec. 69. CERTIFICATES OF FITNESS**

(1) A certifying surgeon shall, on the application of any young person or his parent or guardian, accompanied by a document signed by the manager of a factory, that such person will be employed therein if certified to be fit for work in a factory, or on the application of the manager of the factory in which any young person wishes to work, examine such person and ascertain his fitness for work in a factory.

(2) The certifying surgeon, after examination, may grant to such young person, in the prescribed form, or may renew

(a) a certificate of fitness to work in a factory as a child, if he is satisfied that the young person has completed his fourteenth year, that he has attained the prescribed physical standards and that he is fit for such work;

(b) a certificate of fitness to work in a factory as an adult, if he is satisfied that the young person has completed his fifteenth year, and is fit for a full day's work in a factory:

Provided that unless the certifying surgeon has personal knowledge of the place where the young person proposes to work and of the manufacturing process in which he will be employed, he shall not grant or renew a certificate under this sub-section until he has examined such place.

(3) A certificate of fitness granted or renewed under sub-section (2) -

(a) shall be valid only for a period of twelve months from the date thereof;

(b) may be made subject to conditions in regard to the nature of the work in which the young person may be employed, or requiring re-examination of the young person before the expiry of the period of twelve months.

(4) A certifying surgeon shall revoke any certificate granted or renewed under sub-section (2) if in his opinion the holder of it is no longer fit to work in the capacity stated therein in a factory.

(5) Where a certifying surgeon refuses to grant or renew a certificate or a certificate of the kind requested or revokes a certificate, he shall, if so requested by any person who could have applied for the certificate or the renewal thereof, state his reasons in writing for so doing.

(6) Where a certificate under this section with reference to any young person is granted or renewed subject to such conditions as are referred to in clause (b) of sub-section (3), the young person shall not be required or allowed to work in any factory except in accordance with those conditions.

(7) Any fee payable for a certificate under this section shall be paid by the occupier and shall not be recoverable from the young person, his parents or guardian.

Thus, each section of the Factories Act is elaborative on the dos and dont's regarding the health and safety of workers.

Field Notes: The owners of the kilns were asked about their compliance to The Tripura Factories Rules. They were aware of very few provisions such as taking a licence or complying with the pollution norms. But none has provided documentary evidence of a fitness certificate or any other form/register required to be maintained for such provisions.

It can be safely said that the Factories Act/Rules are only partially complied with by brick-manufacturing units, barring a large number of constraints. There is no certifying surgeon appointed by state government of Tripura for the purpose of issuing the Certificate of Fitness. Also, first-aid provisions, safety equipment, etc., if present, were not as per the provisions of the Factories Act.

Overall, there is a huge gap in the implementation of Factories Act, with respect to the OSH provisions in the brick Industry. Strengthening the factory Inspectorate, namely, the number of inspectors, the digitalization of records, and the awareness among employers about the provisions of the Factories Act may augment compliance with the Act.

# 6. Conclusion and Recommendations

## 6.1. Limitations of the Study

This study is the first of its kind for comprehensive evaluation of occupational health outcomes for brick-kiln workers. With the limited resources, it was not possible to take a comparative non-exposed control group of workers, to establish some of the findings with statistical certainty. Also, the sub-group of the study had a limited number of participants, for example, only 7 *jalai* workers were available at the time of the study in all the four kilns. The availability of fewer *jalai* workers could be attributed to the low requirement for *jalai* workers because mainly pre-*jalai* work was being done at that time.

## 6.2. Conclusion

India's brick sector is characterized by manual work and traditional firing technologies of FCBTK; high dependency on human and animal labour and low mechanization; dominance of small-scale brick kilns with limited financial, technical and managerial capacity, and limited alternatives to raw material such as good quality clay and coal, resulting in increased burden, affecting the health of the workers. The same holds good for the Tripura brick kiln cluster, as is evident in this study.

Although the quality of ambient air was within the prescribed limits, the drinking water quality had slightly acidic pH and high iron content. Morbidity in kiln workers, both men and women, is high in terms of being underweight (49 per cent), anaemic (51 per cent), high eosinophil counts in 78 per cent workers, and complaints of back pain by 66 per cent workers.

## 6.3. Recommendations

Brick kilns need a well-designed, comprehensive plan and the necessary resources, to prevent work-related illnesses, health risks and improve the working conditions and productivity of the workers. Some of the improvements may be in the following directions.

### 6.3.1. Occupational Health and Safety:

**i. Policy Level Interventions**

a) Issue detailed and comprehensive guidelines on OSH as a policy document for brick-kiln work, with suggestions for practical implementation with respect to a specific state.
b) Hold ITI-level apprenticeship/training programs to develop the skills of workers in the kiln.
c) Conduct induction training of workers at the time of joining, to orient the workers to the work culture of the particular kiln.
d) Hold pre-employment, periodic and specific medical surveillance programmes for all workers.
e) Conduct safety and health audits as well as accident investigation procedures.
f) Have workplace exposure assessment programmes for noise, heat and environmental exposure to respiratory air pollutants.
g) Modify government policies for current employment characteristics such as bonded labour, contract labour or other forms of labour exploitation, insurance facilities, better housing facilities for workers, education facilities for the children of migrant brick kiln workers.
h) Secure resources in the form of finances and expertise for carrying out all the above steps.

**ii. Technology Interventions**

a) Use mechanical supports/means for all the works and workers in the kiln, for example, in *pathai* work, use mechanical mixtures, mechanical moulder, conveyer belt etc.; and in *bharai* work use mechanical means for transportation, conveyer belts, etc. This will help reduce repetitive trauma to the musculoskeletal system of the workers.
b) Change of FCBTK technology to other modern technologies, to reduce environmental impact of higher emissions.

**Example of Mechanical *Pathai***

**iii. Training and Education Programmes**

a) Hold training, education and awareness programmes for owners, managers and supervisors for identifying hazardous situations, safety measures, health issues, emergency and first-aid methods.
b) Proactive baseline data collection and availability of data for management decisions.

**iv. Welfare Programmes**

a) Provide drinking, bathing and washing facilities for workers residing/working at a kiln.
b) Ensure availability of toilets for workers.

**v. Safety Provisions**

a) Supply adequate and appropriate protective gear for all workers.
b) Maintain surfaces/heaps/movement paths, to prevent injury to workers.

**vi. Health Interventions**

a) Encourage workers to go for treatment of unattended symptoms/illnesses to recognized medical centres.
b) Provide workers basic, hands-on training in first-aid and cardio-pulmonary resuscitation procedures.
c) Ensure that a kiln is provided with first-aid boxes.
d) Ensure that workers have accident/dismemberment/ permanent disability or loss insurance coverage and the sum assured is according to the risk.
e) Extend medical benefits to the dependents of the workers.
f) Immunize workers and their children against tetanus, hepatitis (A & B) and typhoid.
g) Ensure medical surveillance with biological monitoring, as necessary.

**Example of Low-cost Hand Protection for Nikasi Workers**

## 6.3.2. Environmental Issues

**i. Long-term Measures**

a) Have effective policies and regulations for implementing energy efficient technologies such as tunnel

kilns, Hoffman kilns, etc.

b) Establish a demand/market for resource-efficient products such as hollow and perforated bricks, thereby limiting the production of solid bricks in phases.

c) being, require Ensure mechanisms of financial support before replication on a large scale, as the technologies are very capital intensive.

**ii. Short-term Measures**

a) Reduce smoke emission from the kiln stack, especially during charging time, by adopting improved feeding, firing and operating practices in existing FCBTKs

b) Retrofit kilns and convert into High Draft Kiln/ Fixed Chimney Bull's Trench Kiln with zig-zag firing.

c) Conduct extensive capacity building programmes

**iii. Reduction of Fugitive Emissions**

a) Minimize fugitive emissions caused by the ash layer becoming airborne through raising the wind breakers along the outer trench wall of the brick kiln by constructing a two-feet high brick wall.

b) Provide sheds over the kiln structure to reduce fugitive emissions.

c) Sprinkle water over the *keri*/ash layer before its removal and transfer.

d) Install the coal crusher in an enclosed area within a minimum of 6-foot high walls.

e) Construct brick paved/earthen stabilized roads along the outer periphery of the brick kiln and approach roads. Sprinkle water sprinkled frequently over these roads.

f) Plant two or three rows of trees with thin leaves along the outer periphery of kiln area.

g) Cover the ash layer in the preheating zone with plastic sheets/tarpaulins (*tirpal*).

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