

Respiratory Morbidities Related To the Concentration of Airborne Particulate Matter among Brick Kiln Workers- A Cross Sectional Study in Charhi Block, Jharkhand

Leena Singh¹, Shuvankar Mukherjee², Nabanita Bhattacharyya³, Mahul Mukherjee⁴, Sukanta Majumdar⁵

¹Junior Resident, ³Professor and Head, ⁴Demonstrator, ⁵Assistant Professor, Department of Community Medicine, Calcutta National Medical College and Hospital, Kolkata, West Bengal, India.

²Associate Professor, Department of Community Medicine, Raiganj Medical College and Hospital, Raiganj, Uttar Dinajpur, West Bengal, India.

Corresponding Author: Shuvankar Mukherjee

ABSTRACT

Background: Brick kiln workers are occupationally more vulnerable towards developing various respiratory disorders like asthma, bronchitis, emphysema, and decreased lung function. But very few research studies have been conducted to assess the respiratory health status of brick kiln workers in India and other developing countries.

Objective: This study tried to assess the prevalence of respiratory morbidities among brick kiln workers of Charhi Block, Jharkhand, estimate the magnitude of particulate exposures among brick kiln workers and to find out the relation, if any between different types of respiratory morbidities and different types of working groups in brick kilns.

Methods: A cross-sectional, community based study was conducted in 270 brick kiln workers of Charhi Block, Jharkhand from May, 2018-Feb, 2019. American Thoracic Society –Lung Disease Questionnaire was used for the interview of brick kiln workers.(in Hindi version). Spirometry was performed using PFT Architech 5-Version-S.0.22.32360. Ambient Air Quality Monitoring Equipment was used for Ambient Air Quality Analysis.

Results: Study revealed that 33% workers had chronic cough while 23.3% reported chronic phlegm. 5.6% suffered from dyspnoea, 18.9% were suffering from chronic bronchitis while 3.3% reported physician diagnosed Asthma. Brick kiln workers involved in Baking and Firing were strongly associated with abnormal

spirometry results (OR=3.61, 95% CI 1.822-7.137, $p \leq 0.05$) than workers involved in Moulding and Carrying.

Conclusion: High Frequency of respiratory symptoms and illnesses were observed in the brick kiln workers. Workers involved in baking and firing were strongly associated with abnormal spirometry results.

Keywords: Respiratory Morbidities, Brick Kiln Workers, Cross Sectional, Airborne Particulate Matter.

INTRODUCTION

Recent few years have seen escalating awareness throughout the world regarding various occupational health problems.

The brick manufacturing industry is one of the oldest and the most rapidly growing industries in India so much so that India has been ranked just behind China as the second largest producer of bricks in the world. ⁽¹⁾

Recent report issued by World Bank reveals that more than 100,000 brick kilns are currently functional in Bangladesh, India, and Nepal; these brick kilns have been stamped as the topmost sources of air pollution in these countries. ⁽²⁾

The Indian brick industry is a labor intensive industry that employs about 15 million workers and consuming about 35

million tons of coal annually. ⁽¹⁾ Different steps involved in brick making are briefed below.

(1) Clay/soil excavation and preparation: Excavation of top soil from nearby agricultural fields is carried out and is mixed with other soil types depending on requirements. It is followed by wet mixing of soil manually. (2) Green brick moulding: This process is carried out manually with the help of wooden/plastic moulds. (3) Drying of bricks: Moulded green bricks are filled with moisture which is removed by sun drying. For drying process green bricks are kept under open field, and upon drying they are loaded in the kiln. (4) Brick firing. Manual loading and stacking of hard dried bricks is done inside the kilns. After the process of firing and cooling, bricks are categorized by visual inspection and stacked for dispatch.

Unfortunately, this labour intensive sector is not regulated aptly by any specific administrative guidelines as per designing of kilns, type of fuels to be used, protective and safety measures, etc. As a result of which majority of the brick kilns are inappropriately designed and use all sorts of available combustible materials as fuels, eg, coal, petrol, diesel, wood, cow dung cakes, plastics, old tyres, etc. ⁽³⁾

This leads to the emission of a gamut of toxic gases in large amounts from the furnaces of the kilns, eg, oxides of sulfur (SO_x) and nitrogen (NO_x), fluoride compounds, Oxides of Carbon as Carbon Monoxide (CO), Carbon Dioxide (CO₂), hydrogen sulfide (H₂S), suspended particulate matters (SPM) and various amounts of carcinogenic dioxins.

There are strong documentations which prove that chronic inhalation of these pollutants lead to local lung tissue injury and pulmonary distress. ⁽⁴⁾ Therefore, brick kiln workers are occupationally at a high risk of developing various respiratory disorders like bronchitis, emphysema, asthma, and decreased lung function. ⁽⁵⁾ Studies clearly show that brickfield workers and people in the surrounding community

are more likely to suffer from illnesses caused by the kilns' pollution. ⁽⁶⁾

In addition, workers engaged in different work tasks inside brick kilns suffered variety of respiratory illnesses. ⁽⁷⁾

A study which compared brickfield workers to non-brickfield workers found that respiratory illness was present in 42% of brickfield workers whereas only 9.3% in the other group of workers. ⁽⁸⁾ As, per sincerest of literature search, it is found that very few research studies have been conducted to assess the respiratory health status of brick kiln workers in India and other developing countries. Therefore this study is an attempt to find out the respiratory health status of workers of endlessly enlarging and mushrooming brick kilns flourishing along the Central Coalfields Area of which Charhi Block is an important contributor to this endless chain.

MATERIALS AND METHODS

This cross-sectional, community based study was conducted in 5 brick kilns of Charhi Block, Jharkhand from May, 2018-Feb, 2019. Taking the prevalence of chronic cough among brick kiln workers from previous studies, i.e.-brick kiln workers in Pakistan. ⁽⁹⁾ (Sheikh, et al-2012)= p=22.4%. Applying the formula for sample size calculation for cross-sectional studies, taking standard normal deviate (z=1.96) at 95% confidence level and allowable error (d) as 5%, sample size taken was (n) =270. As per the information received from district administration (Hazaribagh) – operating brick kilns were mainly present in five blocks namely-Barkagaon, Charhi, Padma, Bishnugarh and Keredari. Out of these blocks –Charhi block was selected randomly for this study.

There are around 30 functional brick kilns in this area with approximately 55 to 60 brick kiln workers, each, so 5 out of total number of brick kilns were selected randomly which altogether had 288 workers. Inclusion Criteria for the study was all Brick kiln workers willing to participate in the study. Exclusion Criteria were - Child

labourers working in the brick kilns, Pregnant workers and Brick kiln workers diagnosed with Tuberculosis. Following the inclusion and exclusion criteria 270 workers were finally included in the study.

American Thoracic Society –Lung Disease Questionnaire was used for the interview of brick kiln workers.(in Hindi version). Variables considered for the study were age, gender, religion, caste, residence, place of origin, socio-economic status, educational status, marital status, smoking, alcoholism, duration of exposure, type of work, any concurrent health problem, past history of any respiratory disease, family history of any respiratory morbidity. Socio-economic status was assessed with the help of Modified B.G.Prasad Scale,2018.

Spirometry was performed using PFT Architech 5-Version-S.0.22.32360. Spirometer was provided by Central Coalfields Hospital, Charhi. Spirometry Parameters studied was FEV1/FVC Ratio. Based on this parameter, spirometry results were classified as Restrictive and Obstructive lung disease.

Ambient Air Quality Monitoring Equipment was used for Ambient Air Quality Analysis. Ambient Air Quality Monitoring Equipment was arranged by Regional Pollution Control Board (Hazaribagh, Jharkhand). Measurement was done for 3 stations at each of the 5 brick – kilns.(Station 1=closest to firing zone, Station 2=moulding zone, Station 3=carrying zone) Measurement was done by: (1)Respirable Dust Sampler Make Envirotech APM 406(NL) and (2)Thermo Electrically cooled Gaseous Sampling Attachment Envirotech Model APM 411 TE.24 hours Ambient Air Quality monitoring was done at each brick kiln .Ambient Air Quality(AAA) Parameters which were measured are as follows:1.PM-10(Particulate matter less than 10 μ)

2.No_x(Oxides of Nitrogen) 3.Sox(Oxides of Sulphur).

Health Records of the brick kiln workers were also checked.

This study was conducted after obtaining permission from the Institutional Ethics Committee of Calcutta National Medical College & Hospital, Kolkata. Informed Consent was taken from each Brick Kiln Owner.. Informed Consent was taken from each study participant, clearly explaining the purpose of study. Brick kiln workers found to be suffering from respiratory morbidities were counselled and referred to the nearest public health facility.

Statistical Analysis: Data were entered in Microsoft Excel 2010.SPSS 23.0(IBM, Armonk, New York, USA) was used to perform statistical analysis. Chi-square Test, One-way ANOVA Test (with Bonferroni post-hoc test) and Binary Logistic Regression analysis were done at 5% significance level.

RESULTS

Average age of the brick kiln workers was 39.5 \pm 10.9 years. Majority (33.3%) of them were in the age group of 40-49 years. Majority were male workers (64.1%). Most of them belonged to Other Backward Caste (47.8%).All the workers were Hindu. All of them were married except 1. Most of the workers were migrant workers (65.9%). Most of the workers had Primary level of education (45.9%). Majority of them were from nuclear families (64.8%). Most of the brick kiln workers belonged to Lower Middle Class (49.3%). Majority of the workers were both alcoholic as well as smokers (43.3%). Majority of them had work exposure in the brick kilns for 5 years or less (53%). No past history of respiratory problems were reported in 93.3% of the workers and none reported of any family history of any respiratory problems.(Table 1)

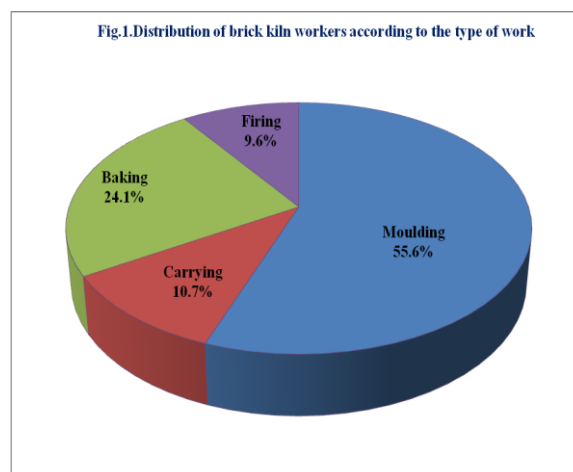
Table 1: Socio-demographic profile of the study subjects (n=270)

Variables	Groups	Number	Percentage
Age group(years)	20 & below	9	3.3
	20-29	43	15.9
	30-39	69	25.6
	40-49	90	33.3
	50-59	47	17.4
	60 & above	12	4.4
Gender	Female	97	35.9
	Male	173	64.1
Caste	Other Backward Caste	129	47.8
	Scheduled Caste	43	15.9
	Scheduled Tribe	98	36.3
Religion	Hindu	270	100
	Muslim	-	-
Marital Status	Married	269	99.6
	Unmarried	1	0.4
Place of origin	Within District	92	34.1
	Out of District	178	65.9
Levels of education	Illiterate	106	39.3
	Primary	124	45.9
	Upper Primary	40	14.8
Type of family	Nuclear	175	64.8
	Joint	95	35.2
Socio-economic status(modified B.G.Prasad scale,2018)	Middle Class	16	5.9
	Lower Middle Class	133	49.3
	Lower Class	121	44.8
Addiction	Only Smokers	3	1.1
	Only Alcoholics	57	21.1
	Both	117	43.3
	None	93	34.4
Duration Of Work(in years)	5 Or Less	143	53
	6-10	56	20.7
	11-15	62	23
	16-20	8	3
	20 Or More	1	0.4
Past h/o-any respiratory problems	Present	18	6.7
	Absent	252	93.3
Family h/o-any respiratory problems	Present	-	-
	Absent	270	100

Majority (33.3%) of the brick kiln workers were in the age group of 40-49 years. Majority were male workers (64.1%). All(100%) were Hindus. Majority (99.6%) of them were married. Most of them belonged to Other Backward Caste (47.8%). Most of the workers were migrant workers (65.9%). Most of the workers had Primary level of education (45.9%). Majority of them were from nuclear families (64.8%). Most of the brick kiln workers belonged to Lower Middle Class (49.3%). Majority of the workers were both alcoholic as well as smokers (43.3%). Majority of them had work exposure in the brick kilns for 5 years or less (53%). No past history of respiratory problems were reported in 93.3% of the workers and none reported of any family history of any respiratory problems.

Fig.1 shows the distribution of brick kiln workers according to the type of work.

Majority of the brick kiln workers were engaged in Moulding process (55.6%) followed by Baking process(24.1%) followed by Carrying process(10.7%). Only 9.6% of the brick kiln workers were employed for Firing process.



Majority (55.6%) of the workers were involved in the Moulding process.

Fig.2: Study reveals that 33% workers had chronic cough while 23.3% reported chronic phlegm.5.6% suffered from dyspnoea, 18.9% were suffering from chronic bronchitis while 3.3% reported physician diagnosed Asthma.

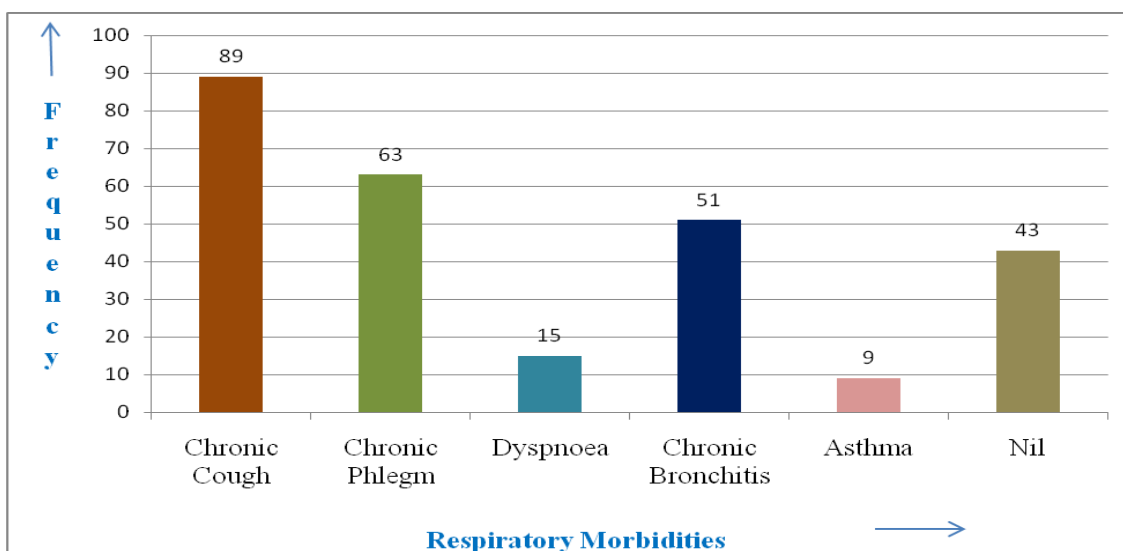


Fig.2.Prevalence of Respiratory Morbidities in the Brick Kiln Workers

Majority (89%) of the brick kiln workers suffered from Chronic cough followed by other respiratory morbidities.

Table 2 shows Spirometry results which reports that 33.3% of the workers suffered from restrictive lung disease whereas 18.1% suffered from obstructive lung disease.

Table 2: Prevalence of Respiratory Morbidities in the Brick Kiln Workers According to Spirometry Results (n=270)

Spirometry results	Number	Percentage
Restrictive Lung Disease	90	33.3
Obstructive Lung Disease	49	18.1
Normal	131	48.5

33.3% of the workers suffered from restrictive lung disease whereas 18.1% suffered from obstructive lung disease.

Ambient Air Quality Monitoring test result reports reveal that levels of Sox, Nox and PM-10 at all stations were well within the standard of CPCB(Central Pollution Control Board).(Table 3)

One-way ANOVA Test and Post hoc-Bonferroni correction test applied while comparing mean level of pollutants at different work stations of brick kilns revealed that levels of Nox showed significant difference between station 1 versus stations 2 and 3.(Station 1=closest to firing zone, Station 2=moulding zone, Station 3=carrying zone)(Table 3)

Table 3: Comparison of mean level of pollutants at different work stations of brick kilns

POLLUTANT	Level at Station 1(in µg/m3) (mean±SD)	Level at Station 2(in µg/m3) (mean±SD)	Level at Station 3(in µg/m3) (mean±SD)	P Value
SOX(80=standard of CPCB)	24.3±5.42	22.9±4.30	20.81±3.57	0.113
NOX(80= standard of CPCB)	33.08±1.71	28.54±4.00	28.61±3.411	0.000
PM10(100=standard of CPCB)	75.07±13.66	71.14±12.70	70.35±13.76	0.589

Station 1=Baking & Firing zone, Station 2=Moulding zone, Station 3=Carrying zone

3 readings were recorded for each pollutant at each station in each brick kiln.

Levels of Nox showed significant difference between station 1 versus stations 2 and 3.

Binary Logistic Regression analysis showed that workers involved in Baking and Firing were strongly associated with abnormal spirometry results (OR=3.61,95% CI 1.822-7.137,p≤0.05) than workers involved in Moulding and Carrying.(Table 4)

Table 4: Binary Logistic Regression showing role of independent variables on spirometry results n=270

Variables		Sig.	AOR	95% C.I. for OR	
				Lower	Upper
Type of work	Carrying & moulding		1		
	Baking & firing	.000	3.606	1.822	7.137
Duration of exposure	≤ 10 yrs		1		
	> 10 yrs	.000	8.248	3.423	19.878
Smoking habit	Non-smoker		1		
	Smoker	.230	.705	.398	1.248

Spirometry Results=Normal & Abnormal (Obstructive+Restrictive lung disease)

Brick kiln workers involved in Baking and Firing were strongly associated with abnormal spirometry results (OR=3.61,95% CI 1.822-7.137,p≤0.05) than workers involved in Moulding and Carrying.

DISCUSSION

Shiraz Shaikh et al, 2012-A cross sectional study from rural districts of Pakistan revealed similar results with 22.4% of brick kiln workers suffering from chronic cough, 21.2% (chronic phlegm), 17.1% (chronic bronchitis), 8.2% (physician reported Asthma). Seshananda Sanjel, et,al, 2017-Study among brick kiln workers in Kathmandu Valley, Nepal showed chronic cough (14.3%), phlegm(16.6%) and bronchitis (19.0%) were higher (p<0.05) among brickfield workers compared with grocery workers(6.8,5.8 and 10.8%)

CONCLUSION

High Frequency of respiratory symptoms and illnesses was observed in the brick kiln workers. Workers involved in baking and firing were strongly associated with abnormal spirometry results which needs further investigation and follow up. The fact that respiratory illnesses lead to compromised work output should also be assessed.

Limitations

This study focusses entirely on respiratory symptoms and morbidities whereas brick kiln workers reported of many other problems as well, which could not be explored. PM 2.5- could not be recorded due to resource constraints.

Recommendations

Brick kiln workers should be informed about health services available at the nearest

government hospital and motivated to attend the same by the owners and subordinate staffs. Protective devices were not at all in use which should be used mandatorily for workers involved in Firing & Baking. Future studies should include PM2.5 parameters as well.

Conflict of Interest: There was no conflict of interest

Source of Funding: Nil

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