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Assessment of respiratory symptoms and peak expiratory flow rate among brick kiln workers in Bhaktapur

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Abstract

Introduction: Brick kiln workers are exposed to high concentrations of dust and smoke, predisposing them to respiratory problems and impaired lung function. The objective of this study was to assess the prevalence of respiratory symptoms and evaluate peak expiratory flow rate among these workers in Bhaktapur.

Method: A cross-sectional study was conducted among brick kiln workers from three brick kilns in Bhaktapur district between 02 Apr to 30 Jun 2025 after obtaining ethical approval. Sample size was calculated to be 267. Using a 2:1 ratio of workers:unexposed controls, 178:89, aged ≥18 years, were matched for age and compared for respiratory symptoms and peak expiratory flow rate. Student t-test was used to assess the difference in the mean of peak expiratory flow rate, with $p<0.05$ considered statistically significant.

Result: The prevalence of respiratory symptoms among 178 brick kiln workers was 32(17.97%) for chronic cough, 23(12.9%) for phlegm, 19(10.7%) for shortness of breath, 20(11.2%) for chest pain, and 10(5.6%) for wheezing. The mean peak expiratory flow rate of brick kiln workers, 415.17±53.09 L/min was significantly lower than that of the control group, 499.25±19.89 L/min ($p<0.001$). Within the brick kiln workers, smokers had a significantly reduced mean peak expiratory flow rate of 376.86±22.59 L/min compared to non-smokers 475.70±21.37 L/min ($p< 0.001$).

Conclusion: Brick kiln workers in Bhaktapur have a high prevalence of respiratory symptoms and significantly reduced peak expiratory flow rate, particularly among smokers.

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Introduction

Brick manufacturing is an important industry in Nepal's Kathmandu Valley. More than 120 of the country's total 1,700 brick kilns are located here, providing work to over 30,000 people every year.[1] As a consequence, the kiln furnaces emit large amounts of harmful gases, including sulfur oxides, nitrogen oxides, fluoride compounds, hydrogen sulfide, carbon monoxide, carbon dioxide, suspended particulate matter, and varying levels of carcinogenic dioxins.[2]Apart from smoking, occupational exposures play a significant role in decreased pulmonary function, chronic respiratory diseases, contributing to around 13% of COPD, 11% of asthma cases, and nearly all instances of silicosis, asbestosis, and pneumoconiosis globally.[3]

Brick manufacturing has expanded rapidly across Southeast Asia, with Nepal showing especially notable growth.[4] In recent years, the rise in urbanization and the growing need for building materials for development projects have led to an increase in both the number and production capacity of brick kilns. Most brick kilns in the Kathmandu Valley operate from the month of December until May [5] Previous study has documented a higher prevalence of respiratory symptoms like chronic cough, phlegm, and bronchitis among brick kiln workers compared to control groups.[6]

Studies conducted in other countries have consistently reported a decline in peak expiratory flow rate (PEFR) among workers in dusty environments, but there is a lack of similar research focused on brick kiln workers locally.[2,7] This study was conducted to assess the prevalence of respiratory symptoms and measure PEFR among brick kiln workers in Bhaktapur, Nepal, and to compare findings with a control group.

Method

This cross-sectional study was conducted in three different nearby worksites of brick kiln workers at Duwakot, Bhaktapur, 02 Apr to 30 Jun 2025. The study protocol was approved by the Institutional Review Committee of Kathmandu Medical College with reference number 02042025/01. Approval was also obtained from the owner of the brick kilns to collect worker data. The study included adult brick kiln workers aged 18 years or older who had been working at the brick kilns for more than 1 year. Workers with a prior history of chronic respiratory diseases diagnosed before joining the brick kiln work, those currently on treatment for acute respiratory infections, history of systemic illness (diabetes, hypertension, thyroid dysfunction), use of medications such as anti-asthmatics, anti-depressants, and those unwilling to participate were excluded. The sample was selected from the study population using the purposive sampling technique.

Sample size was calculated using the following formula: $n=z^2pq/e^2$, (where z=1.96 at 95% confidence interval, p=22.4% (prevalence taken from the previous study)[3], e=5 %), n=267.

Taking 2:1 ratio between the brick kiln workers and the control group, 178 brick kiln workers and 89 controls were included in the study.

The brick kiln workers were assessed for respiratory symptoms and peak expiratory flow rate. For the control group, 89 staff from the Kathmandu Medical College hospital at Duwakot who came from different places were chosen. Informed consent was taken from all participants after thoroughly explaining the purpose of the study to them.

A semi-structured interview was conducted with the brick factory workers and the control group after preparing a questionnaire that comprised of socio-demographic profile (age, gender, height, weight, type of work, years of exposure to brick factory, number of years of smoking, and any associated co-morbidities). This study employed the Nepali-adapted version of the "American Thoracic Society Division of Lung Disease (ATS-DLD)" standard questionnaire for data collection. This widely used tool helps in identifying respiratory symptoms and diseases. It includes questions

on common chronic respiratory issues such as cough, phlegm production, wheezing, asthma, and shortness of breath.[6]

Respiratory symptoms were assessed only in the brick kiln workers. We used the following working definition for the study purpose.

Chronic cough: Defined as coughing at least 4-6 times daily on most days of the week (≥5 days) for a minimum of 3 months per year, sustained over at least 2 consecutive years.

Chronic phlegm: Defined as sputum production occurring at least twice daily on most days of the week (≥5 days), for a minimum of 3 months each year, over at least 2 consecutive years.

Wheezing: Presence of wheezing or whistling sounds in the chest on most days or nights during the preceding 2 months.

Dyspnea: Presence of self-reported shortness of breath during usual physical activities.[4]

The PEFR (L/min) was measured with Mini Wright's peak flow meter (Ferraris Pocket peak flow meter) for both brick kiln workers and the control group. Brick kiln workers were assessed at the worksite itself. While the control group was assessed for PEFR in the hospital. Prior to recording the subjects' PEFR, the use of the instrument was repeatedly demonstrated and explained to them. The peak flow meters with a disposable mouthpiece were given to the subject. They were instructed to stand erect and hold the instrument in a horizontal position in such a way that the hand did not obstruct the movement of the pointer. The pointer was kept at the lowest level. The nostrils were clipped with a nose clipper. They were trained to take a deep breath, put the mouthpiece of the peak flow meter inside the mouth, and exhale forcefully. Three readings were taken, with intervals of approximately 10 seconds between each.

The best of three readings was recorded. After each use, the mouthpiece of the peak flow meter was disinfected using 70% ethanol and allowed to air-dry before reuse.[8]

The data was entered and analysed using the IBM SPSS (Statistical Product and Service Solutions) v22.0. All the values were expressed in mean and SD. Demographic characteristics and the prevalence of respiratory symptoms were summarized using descriptive statistics. The difference in mean Peak Expiratory Flow Rate (PEFR) between brick kiln workers and controls was assessed using an unpaired Student's t-test. A p-value <0.05 was considered statistically significant.

Result

The present study was conducted on 267 participants. Among them, 178 were brick kiln workers and 89 were control group. The mean age of brick kiln workers was 46.44±11.82 years, comparable to 45.36±14.80 years in the control group. Brick kiln workers had a slightly lower mean height but higher mean BMI than controls, Table 1.

Among brick kiln workers, 98(55.05%) were males, and 55(30.89%) were in the 41-50 years age group. Out of the total workers, 109(61.23%) were smokers, and 114(64.04%) were illiterate. The predominant type of work was moulding, which was done by 76(42.69%) workers, and 77(43.25%) workers had more than 10 years of work experience, Table 2.

The mean PEFR was significantly lower among brick kiln workers compared to controls (415.17±53.09 L/min vs. 499.25±19.89 L/min, p< 0.001). Smokers within the brick kiln group had markedly reduced PEFR compared to non-smokers (376.86±22.59 L/min vs. 475.70±21.37 L/min, p<0.001), Tables 3 and 4.

The prevalence of respiratory symptoms among brick kiln workers was 32(17.97%) for chronic cough, 23(12.9%) for phlegm, 19(10.7%) for shortness of breath, 20(11.2%) for chest pain, and 10(5.6%) for wheezing, Table 5.

Table 1. Anthropometric data of brick kiln workers and control group, n=267

Parameter	Brick kiln worker (n=178)	Control group(n=89)
Age (years)	46.44±11.82	45.36±14.80
Height (cm)	160.35±6.72	162.39±5.96
Weight (kg)	59.17±6.87	57.49±6.25
BMI (kg/m^2)	22.98±2.02	21.79±1.96

Table 2. Sociodemographic profile of brick kiln workers, n=178

Parameter	n	%
Gender		
Male	98	55.05
Female	80	44.94
Age category (years)		
≤ 30	22	12.35
31-40	41	23.03
41-50	55	30.89
51-60	42	23.59
>60	18	10.11
Smoking status		
Smoker	109	61.23
Non-smoker	69	38.76
Education status		
Illiterate	114	64.04
Up to primary level	47	26.40
Up to secondary level	15	8.42
Above	2	1.12
Type of work at brick kiln		
Carriage and placement	52	29.21
Molding	76	42.69
Baking	50	28.08
Duration of work in years		
< 5	64	35.95
5-10	37	20.78
>10	77	43.25

Table 3. Comparison of PEFR among smoker and non-smoker brick kiln workers, 178

Parameter	Smoker (n=109)	Nonsmoker (n=69)	p-value
PEFR (L/min)	376.86±22.59	475.70±21.37	<0.001

Table 4. Comparison of PEFR among brick kiln workers and control group, n=267

Parameter	Brick kiln worker (n=178)	Control group (n=89)	p-value
PEFR (L/min)	415.17±53.09	499.25±19.89	<0.001

Table 5. Prevalence of respiratory symptoms among brick kiln workers, n=178

Respiratory symptom	n	%
Frequent cough		
Present	82	46.06
Absent	96	53.93
Chronic cough		
Present	32	17.97
Absent	146	82.02
Frequent phlegm		
Present	52	29.21
Absent	126	70.78
Chronic phlegm		
Present	23	12.9
Absent	155	87.1
Shortness of breath		
Present	19	10.7
Absent	159	89.3
Chest pain		
Present	20	11.2
Absent	158	88.8
Wheezing		
Present	10	5.6
Absent	168	94.4

Discussion

The brick manufacturing process generates considerable dust, with silica being the main contaminant, along with emissions resulting from fuel combustion.[9] Evidence indicates that long-term inhalation of such pollutants can trigger inflammation and the production of harmful oxygen radicals, resulting in localized lung tissue damage and respiratory discomfort.[10]

The brick kiln workers in the present study were comparable to controls in age, 46.44±11.82 vs 45.36±14.80, and slightly higher in BMI. A large proportion were smokers, 61.23 % and illiterate, 64.04%, with most involved in moulding and having >10 years of experience. In a study conducted in Bangladesh among brick field workers, reported that 42.29% of the respondents were current smokers.[11] The present sociodemographic setup aligns with findings from rural Nepal and Pakistan: for example, a Nepalese study emphasized illiteracy, long working hours, and job-specific high exposures among kiln workers in Kathmandu Valley.[6] In a study done in Pakistan, similar education and smoking patterns were reported among kiln workers, though the mean age was lower (~31 years), illustrating demographic variability across regions.[3] These similarities underline the persistent vulnerability of kiln workers, typically low-educated, male-dominated, recurrent smokers across South Asia.

The PEFR was lower in brick kiln workers than in controls 415.17±53.09 vs 499.25±19.89, and the finding was statistically significant ($p< 0.001$). This mirrors findings from Maharashtra, India, where brick kiln workers exhibited significantly lower PEFR.[2] Another study found that brick kiln workers in West Bengal, India, had a markedly lower PEFR compared to healthy individuals of similar age and sex. Likewise, research conducted in Punjab observed reductions in several spirometry measures among workers exposed for more than eight years, compared to those with less than eight years of exposure, indicating possible cumulative effects over time.[12] The study showed that brick kiln workers are more prone to reduced respiratory function than the control unexposed group working in the hospital due to higher exposure to dust particles in the brick kiln factory.

In the present study, smoking brick kiln workers had markedly reduced PEFR 376.86±22.59 in comparison to nonsmoking brick kiln workers 475.70±21.37. Similarly, the results of other studies showed significant decreases in PEFR in workers who were also smokers.[13-15] Smoking adds an independent risk for reduced lung function and respiratory illnesses among brick kiln workers already exposed to dust. Evidence indicates that while dust exposure in kilns causes breathing problems, smoking intensifies these impacts. As a result, kiln workers who smoke face a sharper decline in lung capacity and more pronounced respiratory symptoms compared to those exposed only to dust.[16]

Smoking damages air sacs in the lungs and triggers inflammation, reducing the lung's ability to exchange gases and maintain proper airflow. When this effect is combined with irritation from workplace dust exposure, it can accelerate lung function deterioration, which can be observed through reduced peak expiratory flow rates.[17]

The common rrespiratory symptoms among our brick kiln workers were chronic cough 18%, chronic phlegm 13%, dyspnoea 11%, chest pain 11% and wheeze 6%. In a study done in Sarlahi, Nepal, the most commonly experienced symptom was chronic cough at a rate of 12.3% and only 10.8% had chronic phlegm.[4] In another study, chronic cough accounted for 14.3% and 16.6% for chronic phlegm, reporting that silica exposure in brick industries contributes to silicosis, which impairs lung function and reduces breathing efficiencycy.[6] In other countries the prevalence of these symptoms are higher.[3,6] For instance, in a study done in Pakistan, chronic cough was 22.4%, phlegm 21.2%, dyspnoea with wheeze 13.8%.[3] In another study done in West Bengal, the prevalence of respiratory symptoms was dyspnoea 46.8%, phlegm 39.2%, and chest tightness 27.6%.[13]The cross-sectional study done in 350 brick industry workers in Egypt showed shortness of breath 28.6% as the most prevalent respiratory symptoms, followed by expectoration 19.4%.[9] A study conducted in Croatia found that brick kiln workers experienced chronic cough in 31.8% of cases and phlegm production in 26.2% of cases.[18]

The gases from brick kiln form mists in the workplace that are well known to cause airway inflammation, leading to increased mucus secretion, narrowing of the bronchi, and a decline in lung function when inhaled over extended periods.[19] The absence of regular health screenings, adequate protective gear, and health insurance may be a key factor contributing to the occurrence of respiratory diseases among brick kiln workers in Nepal.[4]

The variation observed in the prevalence of respiratory symptoms in our study may be attributed to several factors. Differences in kiln design and fuel types, such as reduced coal usage, might influence exposure levels. Additionally, informal rest practices and potential underreporting by workers could affect symptom reporting. Another consideration is the "healthy worker effect," where only healthier individuals may continue working in such environments, leading to an underestimation of health risks.[20]

These findings highlight that brick kiln work poses a significant occupational hazard, with consistent evidence of reduced lung function and respiratory symptoms caused by exposure to particulate matter and silica. The marked decline in PEFR among smokers indicates that tobacco use amplifies the harmful effects of occupational dust, underscoring the need for integrated smoking cessation and workplace safety measures.

The present study has certain limitations. Its cross-sectional design prevents establishing causality, and the use of PEFR alone without full spirometry limits the ability to distinguish obstructive from restrictive patterns. Workplace exposures such as particulate matter and silica were not directly measured, and respiratory symptoms were self-reported, introducing potential recall bias. Furthermore, the study was conducted in a single geographic area, which may limit generalizability.

Longitudinal designs with comprehensive spirometry and personal exposure monitoring should be done to better assess exposure-response relationships. Implementation of engineering controls, provision of effective respiratory protective equipment, and integration of smoking cessation into workplace programs are essential. Regular occupational health surveillance and stronger policy measures to regulate emissions and improve kiln technology are recommended to protect this vulnerable workforce.

Conclusion

The brick kiln workers in this study demonstrated significantly reduced PEFR compared to controls and a notable prevalence of respiratory symptoms, with smokers being particularly affected. These findings indicate that occupational dust exposure, compounded by tobacco use, poses a substantial risk to respiratory health in this population. Urgent preventive measures, including improved workplace safety, smoking cessation programs, and regular health surveillance, are essential to protect and promote the well-being of this vulnerable workforce.

Author contribution

Conception, design: GK; Data acquisition: GK, KG, PKK; Data analysis, interpretation: GK; Drafting: GK, KG, PKK; Revision: GK, KG; Final approval of the version to be published: All; Agreement to be accountable for all aspects of the work: All.

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Conflict of interest

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Supplementary material

Data and supplementary material that support the findings of this study are available from the corresponding author upon reasonable request.

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