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Article

Occupational Health Risks and Safety Gaps: A Cross-Sectional Study Among Brick Kiln Workers in Bahawalpur, Pakistan

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Abstract

Background: Brick kiln workers in Pakistan face hazardous occupational conditions, yet limited evidence exists from Southern Punjab. This study aimed to assess occupational health risks and workplace safety gaps among kiln workers in Bahawalpur, Pakistan. **Methods:** A cross-sectional survey was conducted from April-June 2023 among 70 workers selected at seven brick kilns in Bahawalpur. Both the kilns and the participating workers were selected through random sampling. Data were collected using structured questionnaires and direct observation covering demographics, workplace facilities, and health outcomes. Descriptive statistics summarized the prevalence of hazards, and Pearson correlation tested associations between work patterns (daily hours, years of experience) and self-reported health problems. **Results:** High rates of respiratory complaints (72.8% cough, 61.4% throat irritation), musculoskeletal pain (82.8%), and heat-related symptoms (97.1% weakness, 65.7% dizziness) were reported. None of the kilns provided personal protective equipment or first aid, and sanitation facilities were absent in most sites. Longer working hours were significantly associated with more heat-stroke symptoms ($r = 0.25$, $p = 0.037$), and greater years of employment were linked with poorer respiratory status ($r = 0.14$, $p = 0.026$). **Conclusions:** Brick kiln workers in Bahawalpur experience severe occupational health risks compounded by critical safety gaps. The findings highlight urgent needs for policy interventions, including mandatory provision of PPE, sanitation, shaded rest breaks, and regular health assessments. Strengthening labor law enforcement and adapting international occupational safety standards to Pakistan's informal sector could mitigate health vulnerabilities and promote safer, more dignified working conditions.

Keywords: occupational health; brick kilns; heat stress; safety gaps; Pakistan

1. Introduction

Occupational health and safety (OHS) is a pressing global concern, with the International Labour Organization (ILO) estimating over 2.7 million annual work-related deaths and hundreds of millions of non-fatal injuries. While significant progress has been made in formal sectors of high-income countries, workers in informal industries across low- and middle-income countries remain highly vulnerable. Poor regulatory oversight, lack of employer accountability, and minimal worker protections exacerbate occupational risks in these contexts.

The brick kiln industry in South Asia is one of the largest informal labor sectors, employing millions under hazardous conditions. Previous studies from India, Bangladesh, and parts of Pakistan have reported high rates of respiratory illness, musculoskeletal disorders, and heat stress among kiln workers. However, most of this research is fragmented, with limited systematic data from Southern Punjab, a region characterized by extreme climatic conditions that may intensify occupational hazards. Moreover, few studies in Pakistan have systematically examined both **health outcomes** and **workplace safety gaps** within the same framework. This represents a critical gap in the literature.

From a theoretical standpoint, OHS frameworks such as the European Union’s “prevention at source” principle and the hierarchy of controls emphasize risk identification, protective measures, and worker participation. Applying such frameworks to informal sectors like brick kilns can provide valuable insights into how systemic vulnerabilities (e.g., lack of PPE, sanitation, or rest breaks) translate into health outcomes. Yet these theoretical models have rarely been tested or adapted in the Pakistani context, leaving unanswered questions about their relevance and applicability.

This study aims to address these gaps by investigating occupational health risks and workplace safety deficiencies among brick kiln workers in Bahawalpur, Pakistan. Specifically, we ask:

1. What is the prevalence of key self-reported health problems (respiratory, musculoskeletal, heat-related) among brick kiln workers?
2. What safety provisions (e.g., PPE, sanitation, first aid, shaded rest areas) are available at kilns?
3. Are longer daily working hours associated with more heat-related symptoms, and is cumulative employment duration linked to poorer respiratory status?

By combining structured surveys with direct observation, this study contributes empirical evidence from an under-researched region. The findings not only enrich the literature on informal labor and occupational health but also provide a foundation for policy dialogue on improving worker protections in Pakistan’s brick kiln sector.

2. Materials and Methods

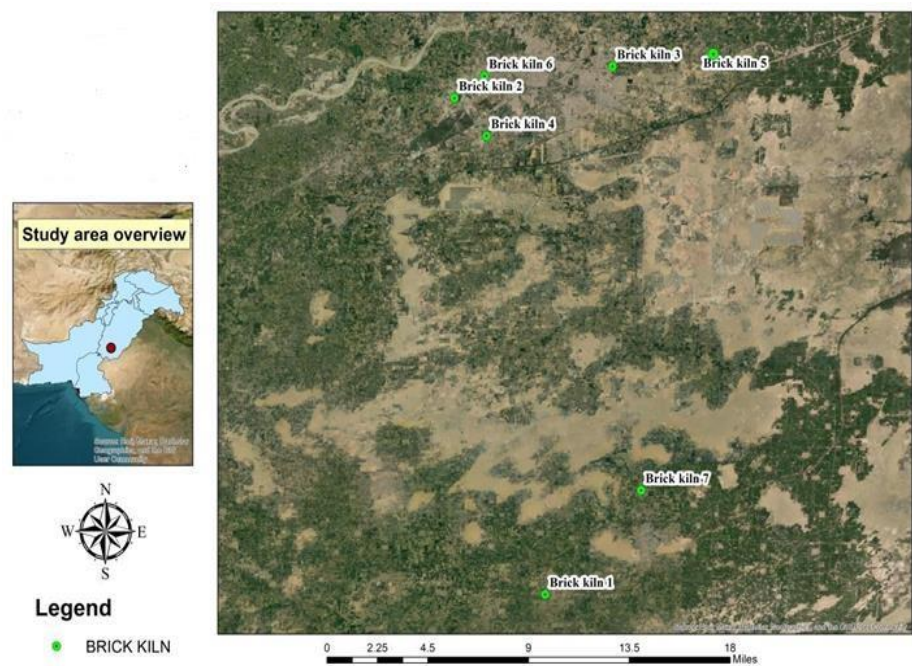


Figure 1. Location of the study area (Bahawalpur District, Punjab, Pakistan), showing the sites of the seven surveyed brick kilns.

Sample and data

This cross-sectional study was conducted between April-June 2023 among brick kiln workers in Bahawalpur district, Southern Punjab, Pakistan. Seven kilns as well as the ten workers recruited from each kiln were selected through random sampling, yielding a total sample of 70 participants. The sample included both adult and child workers, reflecting the actual composition of the brick kiln labor force.

Participation was entirely voluntary. Written informed consent was obtained from all participants, including children, using consent forms. For child workers, assent was obtained from the children themselves, and guardian/parental permission was sought where available. Ethical

approval for the study was granted by the Ethical Review Committee of Kinnaird College for Women, Lahore (Approval no. KC/ORIC/ERC/2023/006)

Data were collected through structured questionnaires and an observational checklist documenting workplace safety facilities.

(A detailed description of each kiln, including type, fuel source, and structural design, is provided in Appendix Table A1.)

Measures of Variables

- **Demographics:** age, sex, education, monthly income.
- **Work characteristics:** job role (mud preparation, transport, loading, chimney work), daily working hours (categorized as 6–8 hours or 9–12 hours), and years of work experience.
- **Workplace facilities:** presence/absence of personal protective equipment (PPE), first aid, medical care provided by the kiln owner, access to safe drinking water, sanitation (toilets, washing areas), shaded rest areas, and duration of meal breaks.
- **Health outcomes:** self-reported health complaints including respiratory symptoms (cough, throat irritation, congestion), musculoskeletal pain/backache, headaches/fatigue, skin and eye irritation, and heat-related symptoms (muscle cramps, nausea, dizziness, weakness, heavy sweating).

Data Analysis Procedure

Data were entered and analyzed using (SPSS IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies, percentages, means ± SD) were used to summarize participant characteristics, workplace conditions, and health outcomes.

To examine associations between work patterns and health outcomes, Pearson correlation (two-tailed) was applied. Specifically, we tested whether daily working hours were associated with the number of heat-related symptoms, and whether years of experience were associated with respiratory symptoms. Pearson correlation was selected because these variables were measured on continuous scales. Statistical significance was set at $p < 0.05$, and results are reported with correlation coefficients (r), p-values, and sample size (N).

A correlation table is presented in the Results section to illustrate these associations.

3. Results

A total of 70 workers from seven randomly selected brick kilns in Bahawalpur participated in the study (April-June 2023).

Demographic characteristics

- Mean age of participants was 34.4 ± 9.2 years.
- 75.7% were male, 24.2% were female, and 5.7% were children under 18 years.
- Educational attainment was low, with 78.5% reporting no formal education.
- The mean monthly income was 15,450 PKR ($\approx 15.5k$).

(Table 1 summarizes demographic characteristics.)

Table 1. Demographic characteristics of brick kiln workers (Bahawalpur, April-June 2023).

Characteristics	Frequency (N=70)	Percentage%
Respondent’s details		
Gender		
Male respondents	51	75.7
Female respondents	15	24.2
Children	4	5.71
Age		
Below 20	4	5.7
20-35	32	45.7
36-40	9	12.8

More than 40	25	35.7
Education Status		
Formal education	15	21.4
No formal education	55	78.5
Work experience		
0-5 years	10	14.2
Between 6-10 years	27	38.6
More than 10 years	33	47.1
Income		
0-15k	17	24.2
16-20k	53	75.7
Nature of work		
Making mud and placing bricks	38	54.2
Transporting raw bricks to kiln	13	18.5
Transporting cooked bricks	12	17.1
Working in chimney	7	10
No of working hours		
6-8	62	88.5
9-12	8	11.4

Workplace facilities

- None of the kilns provided personal protective equipment (PPE) or first aid.
 - None of the kilns provided shaded area.
 - Toilet facilities were available in only 2 kilns (28.5%)
 - Washing facilities were present in only 1 kiln (14.3%).
- (Table 2 shows availability of basic facilities across kilns. A full checklist of facilities by kiln is provided in Appendix Table A2.)

Table 2. Availability of workplace facilities across surveyed kilns (Bahawalpur, April-June 2023).

Characteristics	Frequency (N=7)	Percentage%
Workplace facilities		
Shade during summer/rain		
Yes	0	0
No	7	100
First aid		
Yes	0	0
No	7	100
Medical facility provided by the owner		
Yes	0	0
No	7	100
Water for drinking		
Yes	7	100
No	0	0
Toilet		
Yes	2	28.5
No	5	71.4
Washing area		
Yes	1	14.2
No	6	85.7
Time for meal break		
1 hour	4	57.1

30mins	3	42.8
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Health outcomes

- Respiratory complaints were common: cough (72.8%), throat irritation (61.4%), and chest congestion (25.7%).
- Musculoskeletal pain was reported by 82.8% of participants.
- Heat-related problems were highly prevalent: weakness (97.1%), dizziness (65.7%), and heavy sweating (37.1%).

(Table 3 presents the prevalence of major health problems.)

Table 3. Prevalence of health problems among brick kiln workers (Bahawalpur, April-June 2023).

Characteristics	Frequency (N=70)	Percentage %
Health Condition		
Respiratory disease		
Cough	51	72.8
Irritation in throat	43	61.4
Congestion	18	25.7
Asthma	0	0
Bronchitis	0	0
Skin disease		
Yes	16	22.8
No	54	77.1
Reported the following symptoms		
Headache	60	85.7
Fatigue	60	85.7
Eye irritation	34	48.5
Hearing problem	7	10
Health problems experienced year-round		
Body pains and aches	58	82.8
Back ache	60	85.7
Fever and cough	45	64.2
Generalized pain and aches	70	100
Season in which workers mostly get sick		
Summer	21	30
Winter	49	70
Symptoms of heat stroke		
Muscle or abdominal cramp	42	60
Nausea	41	58.5
Vomiting	11	15.7
Headache	39	55.7
Dizziness	46	65.7
Weakness	68	97.1
Heavy sweating	26	37.1

Correlations between work patterns and health outcomes

- Daily working hours were significantly associated with the number of heat-stroke symptoms ($r = 0.250$, $p = 0.037$).
- Years of work experience were positively associated with self-reported respiratory symptoms ($r = 0.137$, $p = 0.026$).

(Table 4 presents the correlation results.)

Table 4. Correlations between work patterns and health outcomes (Bahawalpur, April-June 2023).

Variables	r	p-value
Working hours ↔ Heat symptoms	0.250	0.037
Years of experience ↔ Respiratory symptoms	0.137	0.026

4. Discussion

This study provides evidence on occupational health risks and workplace safety deficiencies among brick kiln workers in Bahawalpur, Pakistan. A summary of the main findings is presented in Table 5 to enhance clarity for readers.

Table 5. Summary of key findings (Bahawalpur, April-June 2023).

Key finding	Value	Significance
Cough	72.8%	High respiratory burden linked to dust and smoke exposure
Musculoskeletal pain	82.8%	Result of repetitive manual handling of bricks
Heat-related weakness	97.1%	Indicates severe heat stress risk in extreme climate
No PPE / First aid	0 of 7 kilns	Critical safety gap
Toilet facilities	28.6% of kilns	Poor sanitation standards
Correlation: Hours ↔ Heat symptoms	r = 0.250, p = 0.037	Longer shifts increase heat illness risk
Correlation: Experience ↔ Respiratory symptoms	r = 0.137, p = 0.026	Cumulative exposure linked with respiratory decline

The high prevalence of respiratory symptoms and musculoskeletal disorders observed here is consistent with studies in Nepal and India, where brick kiln workers face significant exposures to dust, smoke, and heavy manual labor (Joshi & Dudani, 2008; Ghosh et al., 2014). A systematic review by Parvez et al. (2019) further confirms that kiln workers across South Asia experience elevated risks of respiratory illness and musculoskeletal pain. Similar findings have been reported in Pakistan, where Khan and Javed (2020) documented widespread occupational health hazards among kiln workers.

Heat-related complaints were more prominent in our study compared to some earlier reports, likely reflecting Bahawalpur’s extreme climatic conditions. This is consistent with evidence linking prolonged work hours in hot environments to increased risk of heat stress and reduced labor productivity (Kjellstrom et al., 2016). The observed association between long working hours and heat-related symptoms in our sample supports these global findings.

Unexpectedly, the correlation between years of experience and respiratory symptoms was weaker than anticipated (r = 0.137). This may reflect limitations of self-reported data, small sample size, or adaptation among longer-term workers. Nonetheless, the positive association suggests that cumulative exposure to kiln dust and fumes remains a health risk.

Findings highlight urgent needs for basic workplace protections. Simple measures such as shaded rest areas, provision of PPE (masks, gloves), safe drinking water, and first aid could substantially reduce risks. Employers should also regulate working hours and ensure rest breaks during peak heat.

Integrating lessons from international frameworks offers valuable guidance. The **European Union’s OHS directives**, particularly the Strategic Framework on Health and Safety at Work (2021–2027), emphasize risk prevention, employer accountability, and worker consultation (EU-OSHA, 2021). Similarly, **China’s Work Safety Law** mandates risk assessment, provision of PPE, and protections against heat stress, with enforcement mechanisms that have reduced occupational disease risks in comparable industries (State Council of China, 2021). Adapting such approaches to

Pakistan's informal kiln sector would require stronger labor law enforcement, subsidized PPE programs, periodic health surveillance, and elimination of child labor.

This study addressed three key research questions. First, it quantified the prevalence of major health problems, showing a high burden of respiratory, musculoskeletal, and heat-related symptoms. Second, it identified severe gaps in workplace facilities, with almost no provision of PPE, sanitation, or first aid. Third, it found associations between longer working hours and heat stress, and between years of experience and respiratory symptoms, highlighting how labor patterns translate into health risks. These findings extend existing knowledge by linking health outcomes with safety gaps in the same framework.

5. Limitations

The study has limitations. The sample size was relatively small (N=70) and drawn from a single district, limiting generalizability. Health outcomes were based on self-report rather than clinical or physiological measures, which may under- or over-estimate prevalence. Cross-sectional design prevents causal inference. Nevertheless, the findings provide an important baseline for Southern Punjab and point to clear areas for intervention and future research.

6. Conclusion

Theoretical implications

This study contributes to the occupational health literature by documenting both health risks and safety gaps in Pakistan's brick kiln sector, an under-researched informal labor setting. By statistically linking work patterns with health outcomes, it highlights how environmental exposures, labor practices, and inadequate workplace protections intersect. These findings extend existing theories of occupational health by emphasizing the combined role of climate stressors and informal labor structures in shaping workers' vulnerabilities (Parvez et al., 2019; Kjellstrom et al., 2016).

Managerial and policy implications

Findings point to urgent needs for practical interventions at the kiln level: provision of PPE, shaded rest areas, clean drinking water, first aid, and regulated work breaks. At a broader level, enforcement of labor laws, elimination of child labor, and integration of international OHS frameworks are critical. The **EU Strategic Framework on Health and Safety at Work (2021–2027)** emphasizes employer responsibility and worker consultation, while China's **Work Safety Law** enforces PPE provision and heat protections (EU-OSHA, 2021; State Council of China, 2021). Adapting such approaches to Pakistan's informal kiln sector could significantly improve worker health, productivity, and dignity.

Ideas for future research

Future studies should use larger, multi-district samples to capture regional variation and include objective health assessments such as spirometry and environmental exposure monitoring (Joshi & Dudani, 2008; Ghosh et al., 2014). Longitudinal research is needed to assess cumulative effects of kiln employment and to establish causal links between exposures and health outcomes. Intervention studies evaluating the effectiveness of PPE distribution, shaded rest areas, or heat mitigation strategies would provide practical evidence to guide policy implementation (Khan & Javed, 2020).

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Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest: The author declares no conflict of interest.

Ethical Statement: This study was approved by the Ethical Review Committee of Kinnaird College for Women, Lahore. Informed consent was obtained from all participants prior to data collection.

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Appendix A

Table A1. Detailed description of surveyed kilns (Bahawalpur, April-June 2023).

Brick Kiln 1	
No of male workers	65
No of female worker	25
No of children	10
Type of brick kiln	Zigzag
Type of fuel used	Coal and wood
Brick Kiln 2	
No of male workers	60
No of female worker	0
No of children	00
Type of brick kiln	Zigzag
Type of fuel used	Coal and wood
Brick Kiln 3	
No of male workers	78
No of female worker	19
No of children	03
Type of brick kiln	Zigzag
Type of fuel used	Coal and wood
Brick Kiln 4	
No of male workers	55
No of female worker	23
No of children	08
Type of brick kiln	Zigzag
Type of fuel used	Coal, wood and animal dung
Brick Kiln 5	
No of male workers	33
No of female worker	20
No of children	09
Type of brick kiln	Zigzag
Type of fuel used	Coal, animal dung and rubber
Brick Kiln 6	
No of male workers	83
No of female worker	15
No of children	02
Type of brick kiln	Zigzag
Type of fuel used	Coal and wood
Brick Kiln 7	
No of male workers	45
No of female worker	31
No of children	04
Type of brick kiln	Circular
Type of fuel used	Coal and wood

Table A2. Detailed checklist of workplace facilities at surveyed kilns (Bahawalpur, April-June 2023).

Physical Hazards	Yes	No
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Are the workers exposed to fall injuries?	✓	
Are the workers exposed to noise pollution?	✓	
Are there any fumes and vapors to be aware of?		✗
Are the workers protected from the fumes and vapors in anyway?		✗
Are the workers protected from heat and cold?		✗
Is there any awareness about the physical hazards among the workers?		✗
Ergonomic hazards		
Do the workers experience discomfort while working in brick kiln?	✓	
Do the workers have to work continuously for long hours	✓	
Is there any assistance provided to the workers while lifting heavyweights?		✗
Do workers experience work stress?	✓	
Repetitive and awkward postures?	✓	
Biological and chemical hazards		✗
Are the workers exposed to chemicals like silica and chemical fumes like CO, SO _x , and NO _x etc?	✓	
Is there exposure to volatile organic compounds and particulate matter?	✓	
Are the workers in direct contact with the soil?	✓	
Are the workers exposed to insects and animals?	✓	
Health conditions and facilities		
Do the workers face health issues like muscle cramps, heat stroke, headaches, fatigue, cough etc?	✓	
Do the workers have hearing problem, eye irritation, and skin diseases?	✓	
Do they have access to proper medical facility?		✗
Is first aid available?		✗
Are any sort of medical costs for brick kiln covered by the owner of the brick kiln?		✗
Are there any preventive health care measures provide to brick kilnworker?		✗
Is there any awareness provided to the workers regarding their healthcare?		✗

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