

Original Research Article

Prevalence of heat-related illnesses among adult brick kiln workers in rural south India: a cross-sectional study

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Received: 06 June 2025

Revised: 06 July 2025

Accepted: 08 July 2025

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ABSTRACT

Background: Heat-related illnesses (HRIs) pose a major occupational health challenge, particularly among workers engaged in strenuous labor in hot environments. Rural India's fire clay brick industry exposes workers to extreme temperatures, increasing their risk of heat stress and related complications. This study aimed to estimate the prevalence of HRIs and identify associated risk factors among brick kiln workers in rural India.

Methods: A cross-sectional study was conducted among 123 adult workers from three fire clay brick kilns in Andhra Pradesh, India. Data were collected using a structured questionnaire adapted from the high occupational temperature health and productivity suppression (HOTHAPS) tool and additional items assessing workplace exposures. Information on socio-demographics, occupational conditions, and HRI symptoms was collected. Data were analyzed using SPSS version 22.0, with associations tested using chi-square and other appropriate tests ($p < 0.05$).

Results: The overall prevalence of HRIs (excluding heavy sweating) was 80.49%. Significant risk factors included job type, prolonged direct heat exposure, high workload, inadequate hydration, and absence of shaded rest areas.

Conclusions: HRIs are highly prevalent among fire clay brick workers in rural India. Improved work conditions, hydration access, shaded areas, and heat safety education are urgently needed to reduce risk and enhance worker well-being.

Keywords: Brick kiln workers, Heat-related illness, Heat stress, Occupational health, Rural workers, South India

INTRODUCTION

Heat-related illness encompasses a range of conditions that occur when the body is unable to effectively regulate its internal temperature under thermal stress. These conditions include heat rash, heat cramps, heat exhaustion, fainting, and in severe cases, heat stroke¹. Extended exposure to high temperatures, combined with strenuous physical activity- even in moderately warm environments- can cause the body to overheat. Early signs of heat illness may be subtle or go unnoticed, yet

symptoms can escalate rapidly.¹ Collectively, these conditions fall under the term hyperthermia, which refers to the spectrum of illnesses caused by excessive heat exposure.²

India's growing heat levels, exacerbated by climate change, pose serious threats to outdoor labourers, especially those in physically demanding fields like construction, agriculture, mining, and brick manufacturing.³ Many regions experience temperatures exceeding 40°C, and this is intensified by heat from

machinery and job-site vehicles.⁴ Maintaining a core body temperature of 37°C is vital; failure to cool down through sweat or rest can lead to heat-related illnesses such as exhaustion or even heat stroke.⁵ The risks aren't just that medical workers under heat stress are more prone to accidents and reduced productivity, often due to dizziness, muscle cramps, foggy safety glasses, or loss of grip.⁶ One critical example is India's fire clay brick industry, which exposes workers to dangerous conditions, especially during peak summer months despite its economic importance and employment for millions. Brick-making tasks, from clay extraction to kiln firing and transportation, are carried out outdoors and demand strenuous physical effort, often under direct sun and without sufficient rest or protection. The industry remains largely traditional in practice, using coal-heavy kilns with minimal mechanization, leading to both environmental and health concerns.^{7,8}

This sector's workforce is mainly informal and includes men, women, and sometimes children, with a significant number of migrant labourers hired seasonally. Their work terms are typically unstable, lacking benefits or safety coverage.^{9,10} With India relying heavily on sectors involving heat-exposed labour, and limited research specifically focusing on the brick-making industry, this study aimed to examine heat-related health risks among brick kiln workers in Andhra Pradesh. It also sought to evaluate environmental and job-related stressors and offer strategies to improve safety and mitigate heat-related illnesses.^{11,12}

METHODS

The present community-based cross-sectional study was conducted among adult workers employed in fire clay brick kilns in Andhra Pradesh, south India, from 01 March 2025 to 31 March 2025. The study population included all workers aged over 18 years, including drivers and security personnel, who had been employed in the kilns for more than six months. Individuals who were unable to comprehend or respond to the questionnaire were excluded. The study location was randomly selected from among six administrative blocks in the NTR district, Andhra Pradesh, which is known for brick kiln operations. Within this region, three fire clay brick kilns, each employing approximately 40 to 70 adult workers, were included in the study through complete enumeration, resulting in a final sample size of 123 participants. As no prior research had been conducted on heat-related illnesses among brick kiln workers in this area, no formal sample size calculation was undertaken.

Data were collected using a structured questionnaire adapted from the high occupational temperature health and productivity suppression (HOTHAPS) tool, developed by Venugopal et al, and supplemented with additional items designed to capture work environment

characteristics.⁴ Given the low literacy levels among participants, all interviews were conducted in Telugu, the local language. Information collected included socio-demographic details, job roles, workplace heat exposure, symptoms of heat-related illness, and any previous history of such illnesses.

Responses were recorded using Google forms, exported to Microsoft Excel, and analyzed using IBM SPSS Statistics version 26.0. Continuous variables were summarized using mean and standard deviation (SD) or median and interquartile range (IQR), based on data distribution. Categorical variables were expressed as frequencies and percentages. Associations between variables were examined using the Chi-square test and other appropriate statistical methods. A p value of less than 0.05 was considered statistically significant.

RESULTS

A total of 123 adult workers from three fire clay brick kilns in Mylavaram, Andhra Pradesh, participated in the study. The overall prevalence of heat-related illnesses (HRIs), excluding heavy sweating, was 80.49%. The majority of participants were male and predominantly in the younger to middle-age brackets, reflecting the physically demanding nature of the work. A significant proportion (over half) of the workers were illiterate, potentially limiting their understanding of occupational hazards and preventive strategies.

Most workers were engaged in high-exertion tasks such as brick loading/unloading (43.9%) and brick molding (26.0%), with 51.2% reporting either heavy or very heavy workloads. Despite 79.7% of workers reporting regular hydration, HRIs remained prevalent, particularly among those without access to shade or rest areas (41.5%) and among the 96.7% who had never received training on heat prevention. Table 1 summarizes the baseline characteristics of the 123 participants, including demographic, occupational, and workplace factors.

Heat-related illnesses by type of work

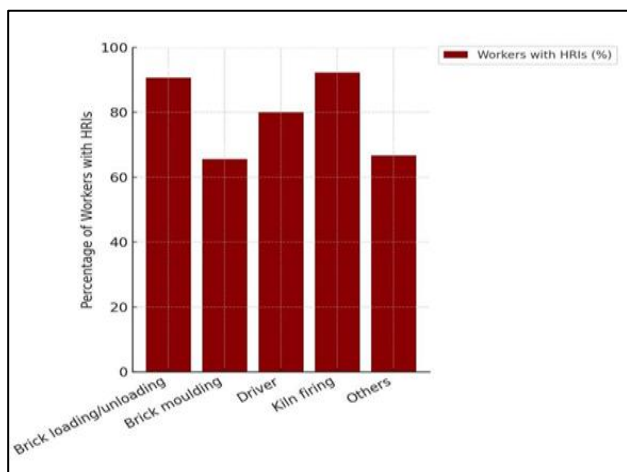
The prevalence of HRIs significantly varied by job role ($\chi^2=13.72$, $p=0.0083$). Workers involved in kiln firing (92.31%) and brick loading/unloading (90.74%) had the highest prevalence, followed by drivers (80.00%). Brick moulders (65.63%) and those in miscellaneous roles (66.67%) had comparatively lower rates (Figure 1).

Heat-related illnesses and hydration practices

Although the highest prevalence of HRIs was observed in workers who drank water only occasionally (100%), the difference across hydration frequencies was not statistically significant ($\chi^2=1.44$, $p=0.4867$), as shown in Table 1.

Table 1: Demographic and baseline characteristics of study participants (n=123).

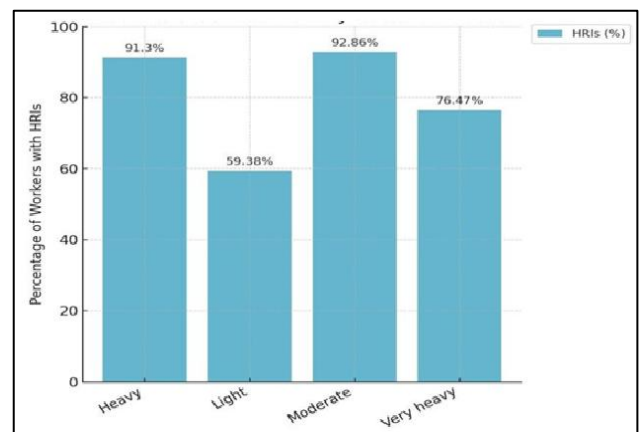
Characteristic	Category	Frequency	Percentage
Sex	Male	104	84.6
	Female	19	15.4
Age Group (years)	18-30	52	42.3
	31-45	49	39.8
	>45	22	17.9
Education	Illiterate	63	51.2
	Literate	60	48.8
Job role	Brick loading/unloading	54	43.9
	Brick moulding	32	26.0
	Kiln firing	13	10.6
	Drivers	10	8.1
	Miscellaneous	14	11.4
Workload intensity	Heavy/very heavy	63	51.2
	Moderate/light	60	48.8
Hydration practice	Always	98	79.7
	Often	22	17.9
	Occasionally	3	2.4
Access to shade/rest	Yes	72	58.5
	No	51	41.5
Heat training received	Yes	4	3.3
	No	119	96.7

**Figure 1: Heat-related illnesses prevalence by type of work.****Heat-related illnesses and direct heat exposure**

Among those exposed to direct heat, 94.12% reported HRIs, compared to 79.25% among those not exposed. This difference was not statistically significant ($\chi^2=1.27$, $p=0.2606$) as shown in Table 1.

Heat-related illnesses by workload intensity

A statistically significant association was observed between workload level and HRIs ($\chi^2=15.87$, $p=0.0012$). Moderate (92.86%) and heavy (91.30%) workloads were most associated with HRIs (Figure 2).

**Figure 2: Heat-related illnesses prevalence by workload level among study subjects.****Heat-related illnesses and availability of shade/rest areas**

Among workers without access to shaded rest areas, 90.0% experienced HRIs, significantly higher than the 73.61% observed among those with shade access ($\chi^2=4.03$, $p=0.0446$) as shown in Table 1.

Training on heat illness prevention

Among workers, only 3.3% of workers reported receiving formal training, and 96.7% had not received any training related to heat illness prevention or workplace safety, as shown in Table 1.

DISCUSSION

The present study provides a comprehensive assessment of heat-related illnesses (HRIs) among 123 fire clay brick kiln workers in rural Andhra Pradesh, revealing a high prevalence of HRIs (80.49%) and significant associations with occupational and environmental risk factors. The majority of participants were young adult males performing physically intensive tasks under extreme heat conditions. These demographic characteristics are consistent with findings from similar occupational settings in West Bengal, where younger labor forces predominate due to the physically demanding nature of the work.^{13,14}

The high frequency of symptoms such as dehydration, fatigue, and muscle cramps parallels observations from kiln workers in south India.¹⁵ Educational disparities also emerged as a critical barrier to heat illness prevention, with over half the workforce being illiterate. This limited health literacy may hinder symptom recognition and effective self-care, corroborating findings by Shaikh et al. and Sanjel et al., who emphasized the role of education in occupational health resilience.¹⁶⁻¹⁷

Interestingly, even though a considerable number of workers reported higher income levels, the lack of fundamental protective measures such as functional personal protective equipment (PPE), shaded rest areas, and access to formal heat illness training contributed to elevated HRI rates. This supports the argument by Kjellstrom et al. and Kuklane et al. that income alone does not mitigate the risks posed by occupational heat stress in the absence of structural safeguards.^{18,19}

Contrary to expectations, work experience did not correlate with a reduced prevalence of HRIs. This finding challenges the hypothesis that long-term exposure leads to acclimatization and improved tolerance to heat. Instead, it aligns with studies by Crowe et al. and Varghese et al., who reported that cumulative heat exposure without protective interventions can lead to chronic conditions such as kidney damage.²⁰⁻²²

Hydration alone, though practiced by most workers, was insufficient in preventing HRIs. Workers who reported consistent water intake still experienced high symptom prevalence, emphasizing that hydration, while necessary, is not adequate in isolation. This finding is reinforced by Jay et al., who advocate for comprehensive interventions including cooling strategies and rest breaks.²³

The lack of shaded rest areas and heat safety training were among the most significant modifiable risk factors identified. Workers without access to shade or rest zones reported significantly higher HRI rates, confirming the importance of passive cooling interventions. This aligns with evidence from Parsons et al. and Ioannou et al., who have stressed the need for environmental and educational strategies in occupational heat illness prevention.^{24,25}

In conclusion, while hydration and PPE use are critical, our findings strongly support the need for integrated, multi-level interventions. These should include structured work-rest cycles, climate-appropriate clothing, access to shaded rest areas, and mandatory training programs. These measures are consistent with the recommendations of Venugopal et al., Xiang et al., and Miller et al., who emphasize that protecting vulnerable labourers requires systemic change at policy and workplace levels.²⁶⁻²⁸

Despite providing important insights, this study has several limitations. First, the reliance on self-reported data for symptoms and workplace behaviours introduces the potential for recall bias, especially among participants with limited health literacy. Second, due to logistical constraints, the study did not include objective environmental or physiological data such as ambient temperature, wet bulb globe temperature (WBGT), or core body temperature, which could have enhanced the accuracy of exposure assessment. Lastly, the findings are geographically limited to the Mylavaram block in the NTR district, restricting their generalizability to other regions with different climate conditions, brick kiln structures, or work practices.

CONCLUSION

This study highlights a substantial burden of heat-related illnesses (HRIs) among fire clay brick kiln workers in rural Andhra Pradesh, with 80.49% of participants reporting at least one HRI symptom (excluding heavy sweating). Key factors contributing to this high prevalence include the type and intensity of work performed, prolonged exposure to direct heat, insufficient hydration, lack of shaded rest areas, and the absence of formal training on heat stress prevention. While hydration practices were common, they proved inadequate in isolation. Moreover, the majority of workers lacked access to basic occupational protections, such as PPE and shade, underscoring significant gaps in workplace safety infrastructure. These findings reinforce the urgent need for multi-faceted, low-cost interventions- including structured work-rest cycles, climate-appropriate protective gear, shaded rest zones, and mandatory heat safety education to safeguard the health and productivity of this vulnerable workforce. Future research should incorporate longitudinal assessments and objective heat exposure measures to better understand long-term health outcomes and adaptation strategies. Policymakers and industry stakeholders must act promptly to implement sustainable and scalable heat mitigation strategies to protect workers in heat-intensive industries, particularly in the context of rising global temperatures.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee of ESIC Medical College, & Hospital, Chennai (Approval Ref No: IEC/2025/AFIH 10)

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Cite this article as: Siriyala UNK, Daniel RA, Chenchula S, Saggurthi P. Prevalence of heat-related illnesses among adult brick kiln workers in rural south India: a cross-sectional study. *Int J Community Med Public Health* 2025;12:3690-5.