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Behavioural Validation of Extreme Heat Stress Among Micro-Informal Fireworks Industry Workers

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Abstract- Occupational heat stress poses a critical, under-regulated health hazard to informal sector workers operating in extreme thermal environments. This study evaluates heat strain, risk perceptions, and self-protection behaviors among workers in micro-informal pyrotechnic units in Sivakasi, Tamil Nadu. Using a structured interview schedule, empirical data were collected on demographics, environmental microclimates, physiological symptoms, attitudinal predispositions, and preventive behaviors. Quantitative stratification using the Heat Strain Score Index (HSSI) revealed that 74.0% of the surveyed workforce operates under elevated physiological strain (38.0% Yellow Zone/Moderate Strain; 36.0% Red Zone/Severe Strain). Symptom evaluation confirmed universal thermoregulatory distress, with workers reporting high rates of excessive sweating (100%), fatigue (96%), persistent headaches (90%), heat rash (84%), and dizziness (76%). A significant operational disconnect was identified between worker safety attitudes and field compliance. Although respondents demonstrated high risk awareness and a favorable overall attitude toward heat prevention (Overall Attitude Index = 51.80), their actual preventive practices remained unfavorable (Overall Practice Index = 13.58). This attitude-practice gap is primarily driven by socio-demographic vulnerabilities (48% illiteracy, low income), piece-rate wage demands, and severe workplace structural barriers, including inadequate shade and continuous unventilated work shifts. The findings emphasize an urgent need for institutionalized engineering and administrative interventions, such as mandatory rest-hydration schedules, low-literacy visual safety training, and enhanced thermal controls tailored to micro-informal industrial settings.

Keywords- Attitudinal Heat Strain predispositions, Preventive Behaviour

I. Introduction

Across the Indian subcontinent, anthropogenic climate change acts as a powerful risk multiplier, turning typical pre-monsoon summer hot into dire, potentially fatal climate emergencies. India is at the forefront of climate vulnerability on a global scale. Heatwaves that occur significantly earlier in the year, last longer, and reach previously unheard-of peak temperatures are a problem for the country. Macroeconomic stability, regional food security, and public health are all directly threatened by this compounding environmental change.

Heat stress severely degrades both physical and cognitive performance, which lowers productivity and increases the risk of accidents at work. A variety of physiological heat disorders are brought on by extended exposure to high temperatures, ranging from minor pain, cramping in the muscles, and extreme exhaustion to serious consequences like syncope and heat stroke. In addition to physiological and environmental factors, a

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person's behavior, awareness, and use of personal protective equipment (PPE) are important elements that either reduce or increase heat stress.

In Sivakasi's fireworks hub, heatwaves caused by climate change pose a serious risk to the health of informal and micro-industrial workers. Due to the intersections of intense heat, high humidity, and volatile chemical conditions, these workers—who operate completely outside of traditional labor protections—face particular, exacerbating physiological and physical vulnerabilities. The danger of occupational heat stress is greatly increased when workers are exposed to extremely hot conditions while performing physically demanding tasks. Extended exposure to heat can cause serious health problems, such as heat exhaustion, heat syncope, heat rash, heat cramps, and heat stroke. It can even be fatal. Additionally, too much heat impairs motor and cognitive performance, leading to sweaty hands, fogged safety glasses, light-headedness, and poor spatial reasoning, all of which raise the risk of accidents at work.

There are still few empirical evaluations that incorporate behavioral validation, subjective strain measures, and attitudinal assessments, despite the increasing severity of thermal stress in micro-industrial and informal settings. In order to close this gap, this study assesses heat stress among informal workers using comprehensive instruments, such as the Heat Strain Score Index (HSSI), a structured assessment of predisposing attitudinal factors, and an evaluation of preventative workplace behaviors.

II. Section B: Objectives and Methodology

Objectives of the Study

1. Determine how common heat-related symptoms are
2. Assess environmental conditions and thermal strain at work.
3. Evaluate employee attitudes and predisposing views about the risks of heat stress, self-efficacy, and preventive strategies.
4. Examine coping strategies and preventive practices in the real world.

Methodology

Research Design and Sampling

In order to assess workplace heat stress, physiological heat strain, and behavioral mitigation strategies among informal sector workers, this study used a quantitative, cross-sectional descriptive methodology. Workers involved in a variety of informal occupational activities (such as thread sealing, dyeing, packing, sand packing, and pipe cleaning) were given a structured interview schedule to complete. Convenience sampling was used to choose the study sample from the targeted micro-industrial units.

Data Collection Instruments

The questionnaire is divided into four main operational modules: Socio-Demographic and Work Profile: Captures personal parameters (age, education, marital/family status, housing) and occupational variables (job type, daily working hours, monthly income, years of experience). Symptom Inventory: Evaluates the presence (Yes/No) of 10 physiological heat illness symptoms (e.g., dizziness, muscle cramps, nausea, syncope, fatigue). Heat Strain Score Index (HSSI): Assesses perceptual and environmental parameters related to thermal strain.

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Tools of Analysis
This research utilizes simple statistical tools to analyze the collected survey data. Percentage analysis is applied to summarize basic worker details, job types, working hours, and the occurrence of health symptoms like cramps, fatigue, and dizziness. The Heat Strain Score Index simplifies complex working conditions—such as temperature, humidity, airflow, clothing, and physical effort—into a single thermal strain risk rating that places workers into safe, caution, or danger zones. A five-point Likert scale ranks worker attitudes and safety beliefs on a simple spectrum ranging from strongly disagree to strongly agree. Finally, the Opinion Index converts these average attitude scores into clear percentage scores to easily compare overall heat risk awareness across different workplace groups.

III. Section C: Analysis and Interpretation

In this section, the researcher measures thermal strain on an individual basis, gauges worker perceptions of risk, and analyze daily self-protection practices. This chapter identifies operational safety deficiencies and categorizes the workforce into actionable risk zones by converting survey data into structured indices.

Table No.1 Demographic Characteristics of Respondents

Demographic Variable	Category	Frequency (n)	Percentage (%)
Age	20–25 years	2	4.0%
	25–30 years	7	14.0%
	30–35 years	7	14.0%
	35–40 years	14	28.0%
	Above 40 years	20	40.0%
Educational Status	Illiterate	24	48.0%
	Primary Level	15	30.0%
	Secondary Level	5	10.0%
	High School	1	2.0%
	Higher Secondary School	2	4.0%
	Graduation	3	6.0%
Marital Status	Married	37	74.0%
	Single	8	16.0%
	Unmarried	5	10.0%
Family Structure	Joint Family	41	82.0%
	Nuclear Family	9	18.0%
Housing Pattern	Rented House	34	68.0%
	Own House	16	32.0%
Family Size	1–3 members	19	38.0%
	4–6 members	30	60.0%
	Above 6 members	1	2.0%
Monthly Family Income	Rs. 10,000 – Rs. 15,000	23	46.0%
	Rs. 15,000 – Rs. 20,000	27	54.0%
Work Experience	< 5 years	23	46.0%

	5–10 years	16	32.0%
	10–15 years	9	18.0%
	Above 15 years	2	4.0%

Source: Computed Primary Data.

Based on the demographic profile of the studied firefighters, the workforce exhibits socio-economic vulnerability attributable to factors such as high household dependence, limited educational attainment, and an aging population. The majority of respondents are married (74%), reside in joint family systems (82%), are over the age of 35 (68%), and support households comprising four to six members (60%). Nearly half of the sample are illiterate (48%), and approximately a third have only completed basic schooling (30%), indicating notably low educational levels that may restrict their access to occupational health awareness. Economically, all workers report modest monthly family income ranging from Rs. 10,000 to Rs. 20,000, with over two-thirds (68%) residing in leased accommodations, a factor that often intensifies indoor heat stress. Furthermore, 46% of the workers possess less than five years of professional experience.

Heat-Related Illnesses and Physical Symptoms

This area examines the prevalence and distribution of clinical heat-related disorders, such as syncope, dizziness, muscle cramps, overall malaise, and cognitive distraction, that employees encounter during their operational shifts. This study establishes the empirical physiological toll of severe heat on worker health and safety by identifying prevalent symptoms.

Table No.2 Heat-Related Illnesses and Physical Symptoms Reported by Workers

Symptom / Illness Category	Specific Physical Symptom	Frequency (n)	Percentage (%)	Primary Heat-Related Cause / Context
Dermatological	Excessive Sweating (Diaphoresis)	50	100.0%	Continuous exposure to extreme ambient and radiant heat during work shifts.
	Heat Rash / Prickly Heat	42	84.0%	Blocked sweat ducts due to persistent heavy sweating and humid, hot environments.

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	Skin Burns / Redness	31	62.0%	Direct exposure to high radiation from heat sources and open flames.
Systemic & Neurological	Physical Fatigue / Exhaustion	48	96.0%	High physiological strain combined with inadequate rest and recovery cycles.
	Headache	45	90.0%	Mild-to-moderate dehydration, heat stress, and prolonged exposure to elevated temperatures.
	Dizziness / Giddiness	38	76.0%	Reduced blood pressure and cerebral blood flow resulting from heat-induced peripheral vasodilation.
Musculoskeletal	Muscle Cramps	36	72.0%	Severe loss of water and essential electrolytes (sodium/potassium) through profuse sweating.
	Joint Pain & Body Ache	33	66.0%	Heavy physical labor combined with thermal

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				stress and chronic fatigue.
Gastrointestinal & Ocular	Nausea / Loss of Appetite	29	58.0%	Core body temperature elevation affecting digestive function and appetite regulation.
	Eye Irritation / Redness	27	54.0%	Continuous glare, intense thermal radiation, and dust/smoke in the working environment.

Source: Computed Primary Data.

Extreme heat exposure during work shifts has an almost universal physical toll, according to survey data on heat-related ailments among workers. Every employee surveyed (100%) reported excessive sweating, which immediately leads to common symptoms of headaches (90%) and exhaustion (96%). Acute heat exhaustion symptoms, such as heat rash (84%), disorientation (76%), muscle cramps (72%), and joint pain (66%), are quite prevalent in the workforce and indicate considerable electrolyte depletion and physiological strain. Additionally, the majority of respondents experienced heat burns or redness (62%), nausea (58%), and eye irritation (54%), highlighting that daily exposure to smoke, intense radiant heat, and high ambient temperatures frequently pushes these people past safe thermal limits without sufficient recovery.

Heat Strain

The health, productivity, and physiological well-being of workers are seriously threatened by occupational heat stress, especially in informal sector settings with no environmental control. The Heat Strain Score Index (HSSI) combines self-reported physiological symptoms, physical activity levels, microclimatic exposures, and workplace behaviors to measure empirical thermal strain in order to systematically assess this risk.

The HSSI empirical results from a sample of 50 workers are described in this study, which divides their thermal stress levels into three different risk zones: Red (Severe Strain; > 18), Yellow (Moderate Strain; 13.6–18) and Green (Low Strain; < 13.5). The assessment assesses worker vulnerability, indicates imminent safety threats, and identifies crucial locations that need administrative and environmental control measures by stratifying physiological strain across these zones.

Table No.3 Heat Strain Score Index (HSSI) Distribution Among Respondents

Total score	No. of Respondents	Zone
>13.5	13	Green Zone
13.6 – 18	19	Yellow zone
<18	18	Red zone

Source: Computed Primary Data.

The HSSI assessment's empirical results show that the workers assessed were generally vulnerable to heat strain:

Yellow Zone (Moderate Strain): The majority of respondents (38.0%, n=19) were in the Yellow Zone (13.6–18.0). A significant risk of heat-related disorders is indicated by this moderate level of physiological strain, which calls for thorough microclimatic monitoring and focused interventions.

Red Zone (Severe Strain): Remarkably, 36.0% (n=18) of the employees received a score in the Red Zone (>18.0). This indicates a high risk of developing heat-related disorders due to an acute vulnerability to thermal overload. To reduce working dangers, this group urgently needs engineering controls, administrative changes, and personal protective procedures.

Green Zone (Low Strain): Under current operating conditions, only 26.0% (n=13) of the studied population reported scores inside the Green Zone (≤13.5), indicating minor heat strain or sufficient thermal tolerance.

In total, 74.0% of workers experienced moderate-to-severe thermal strain (combined Yellow and Red zones). These findings highlight the critical necessity for organized rest-hydration cycles, institutional heat safety management, and effective thermal mitigation techniques in the fireworks manufacturing industry.

Heat Stress Predisposing Attitude Factors

An essential part of evaluating occupational safety, risk perception, and behavioral preparedness in high-temperature workplaces is evaluating worker attitudes toward predisposing heat stress factors. This part assesses employees' self-awareness, perceived vulnerability, and beliefs about heat-related health concerns using a 5-point Likert scale from Strongly Disagree (SD) to Strongly Agree (SA).

Table No. 4: Respondent Attitudes Towards Predisposing Heat Stress Factors

No.	Statements	Mean Score	Attitudinal Level
1	I feel safe from heat stress at my job.	3.14	High
2	Feeling tired in the heat is a major warning sign.	4.04	High
3	My body type doesn't affect my risk of heat stress.	4.16	High

4	I must wear protective gear (PPE) in hot weather.	3.48	High
5	Heat stress is a severe threat to my health.	3.26	Moderate
6	Being healthy means, I don't need heat protection.	2.34	Low
7	Extreme heat lowers my work efficiency and output.	2.22	Low
8	Heat illnesses are predictable and preventable.	4.16	High
9	I can personally help prevent heat illnesses.	3.94	High
10	Working unprotected outdoors is the main cause of heat stroke.	4.44	High
11	Family heat safety knowledge prevents heat stroke.	4.54	High
12	Older workers are more vulnerable to heat.	3.86	High
13	Regular exercise helps the body handle heat better.	3.68	High
14	I am deeply concerned about heat risks at my workplace.	3.10	Moderate
—	Overall Opinion Index	51.80	Favorable

Source: Computed Primary Data

The survey's Overall Opinion Index of 51.80 indicates that employees generally have a good and safety-conscious attitude toward heat stress awareness. Statements that emphasized prevention, such as the importance of family heat safety education (4.54), the risks of working outside without protection (4.44), and the necessity of treating fatigue in hot situations as a severe concern (4.04), were most strongly agreed with by respondents. Additionally, the majority of workers felt that wearing protective gear is essential (3.48) and acknowledged that heat illnesses are preventable (4.16). Two important sections, however, scored poorly: most employees disagreed that being healthy eliminates the need for protection (2.34), and shockingly few admitted that heat stress lowers their overall productivity (2.22). Although safety attitudes are generally positive, specific training is still required. Overall, while safety attitudes are favourable, targeted training is still needed to help workers recognize how thermal strain directly impacts physical performance and productivity.

Preventive Behaviours Related to Heat Stress

Preventive behaviors reflect the practical safety measures workers adopt on-site to mitigate thermal strain and reduce the risk of heat-induced illnesses. Evaluating these practices is critical for determining whether positive safety attitudes translate into active self-protection during daily work shifts.

Table No. 5: Preventive Behaviours Related to Heat Stress

No.	Behavioural Statement / Question	Mean Score	Attitude / Practice Level
1	Active Self-Protection: Taking active measures to protect myself against heat stress during outdoor work.	3.14	Moderate
2	Barriers to Safety: Encountering obstacles or reasons that prevent me from taking heat protection measures.	2.22	Low
3	Recent Symptoms: Experiencing heat illness signs or symptoms at work in the last three months.	2.70	Moderate
4	Seasonal Discomfort: Suffering from health discomfort when working during warm months of the year.	2.82	Moderate
5	Corrective Action: Taking immediate action when experiencing heat-related health issues on the job.	2.58	Moderate
—	Overall Opinion Index	13.58	Unfavorable

Source: Computed Primary Data

There is a substantial operational gap between risk knowledge and real safety compliance on the job, according to an empirical evaluation of workers' preventive behaviours related to heat stress. Although respondents show a modest frequency of using self-protective measures when working outside (Mean = 3.14), they frequently encounter structural obstacles and resource limitations (Mean = 2.22) that keep them from following the right safety procedures. As a result, workers often report higher seasonal physical pain (Mean = 2.82) and heat illness symptoms in recent months (Mean = 2.70). Importantly, respondents show less-than-ideal corrective responses

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(Mean = 2.58) when thermal strain occurs, frequently opting to tolerate heat exposure instead of getting the rest or medical attention they need. These results, which are reflected in an Overall Opinion Index of 13.58, confirm an unfavourable level of preventive practice and highlight the urgent need for institutionalized, mandatory heat safety measures, such as scheduled rest-hydration cycles and personal protective equipment, to convert worker awareness into consistent, life-saving workplace habits.

IV. Conclusion

In an empirical analysis of pyrotechnic workers, 74% experience moderate-to-severe heat strain, with 38% in the Yellow Zone and 36% in the Red Zone. This is reflected in the Heat Strain Score Index (HSSI), causing various distress symptoms: excessive sweating (100%), fatigue (96%), headaches (90%), heat rash (84%), and dizziness (76%). Despite a favourable attitude towards safety (Attitude Index = 51.80), the practice level is low (Practice Index = 13.58) due to low literacy (48% illiterate), low income, high production demands, and structural barriers. To address the attitude-practice gap and prevent heat stroke, facilities should implement work-rest rotation schedules, shaded cooling stations with hydration, low-literacy visual safety training, and administrative thermal controls during peak heat shifts.

References

1. Belding, H. S., & Hatch, T. F. (1955). Index for evaluating heat stress in terms of resulting physiological strains. Heating, Piping, and Air Conditioning, 27(8), 129–136.
2. Dehghan, H., Habibi, P., Khodakarim, S., Hashemian, M., & Zeinodini, M. (2016). Assessment of the Heat Strain Score Index (HSSI) in predicting physiological strain under controlled thermal conditions. Journal of Occupational Health and Epidemiology, 5(2), 85–92.
3. Dehghan, H., Mortazavi, S. B., Jafari, M. J., & Maracy, M. R. (2013). Development and validation of a questionnaire for preliminary assessment of heat strain in jobs: Heat Strain Score Index (HS
4. Fatemi, F., Dehghan, H., & Zare, R. (2019). Knowledge, attitude, and practice (KAP) regarding occupational heat stress among outdoor workers in arid regions. Environmental Science and Pollution Research, 26(18), 18450–18458.
5. International Labour Organization. (2019). Working on a warmer planet: The impact of heat stress on labour productivity and decent work. ILO Flagship Report. International Labour Office.
6. International Organization for Standardization. (2017). Ergonomics of the thermal environment — Assessment of heat stress using the WBGT (wet bulb globe temperature) index (ISO Standard No. 7243:2017). https://www.iso.org/standard/69218.html
7. Kjellstrom, T., Briggs, D., Freyberg, C., Lemke, B., Otto, M., & Hyatt, O. (2016). Heat, human performance, and occupational health: A key issue for the assessment of global climate change impacts. Annual Review of Public Health, 37(1), 97–112. https://doi.org/10.1146/annurev-publhealth-032315-021740
8. National Institute for Occupational Safety and Health. (2016). Criteria for a recommended standard: Occupational exposure to heat and hot environments (DHHS/NIOSH Publication No. 2016-106). U.S. Department of Health and

Human Services, Centers for Disease Control and Prevention. https://www.cdc.gov/niosh/docs/2016-106/

9. Parsons, K. (2014). Human thermal environments: The effects of hot, moderate, and cold environments on human health, comfort, and performance (3rd ed.). CRC Press. https://doi.org/10.1201/b16750
10. Xiang, J., Bi, P., Pisaniello, D., & Hansen, A. (2014). Health impacts of workplace heat exposure: An epidemiological review. Industrial Health, 52(2), 91–101. https://doi.org/10.2486/indhealth.2012-0145