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Climate Change and Occupational Vulnerability: Social Implications and Adaptive Strategies for Outdoor and Informal Workers

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Abstract: affecting outdoor and informal workers who lack institutional protections and adaptive infrastructures. This study explores how systemic social inequalities structure occupational heat vulnerability and examines adaptive behaviours, social networks, and community strategies that workers employ. Using a mixed methodology that integrates secondary labour statistics, qualitative narratives from frontline workers, and sociological analysis, this research highlights the intersection of labour precarity and environmental risk. Results indicate that informal employment, lack of social security, gender inequities, and limited access to cooling resources exacerbate heat-related health impacts and socioeconomic instability among vulnerable workers. The paper concludes with recommendations for socially rooted adaptive strategies, labor policy reforms, and inclusive climate governance mechanisms designed to reduce occupational heat vulnerability.

Keywords: Climate change, occupational vulnerability, informal workers, outdoor labour, social inequality, adaptive strategies.

Introduction: Climate change has emerged as a defining social and environmental challenge of the twenty-first century, reshaping not only weather patterns and ecological systems but also the lived experiences of workers in heat-intensive labour contexts. Recent global reports project increasing frequency and intensity of extreme heat events across tropical, subtropical, and temperate regions, profoundly affecting economic activities that rely on outdoor labour (Intergovernmental Panel on Climate Change [IPCC], 2025). Occupational heat stress — harm experienced by workers due to excessive ambient heat — has become a major risk factor for health, productivity, and livelihood security (Cutter et al., 2024). However, beyond physiological impacts, heat stress functions as a social phenomenon that intersects with labour market structures, social inequalities, and institutional governance mechanisms.

Outdoor workers — such as construction labourers, agricultural workers, street vendors, sanitation workers, and traffic controllers — routinely engage in labour environments where thermal stress is part of daily life. Informal workers, who represent a substantial share of the workforce in many low- and middle-income countries, face compounded vulnerabilities due to precarious employment, lack of social protection, and exclusion from formal occupational safety regulations (International Labour Organization [ILO], 2024). Unlike formal sector employees, informal workers often lack regulated rest breaks, access to employer-provided water or shade, and legally enforceable workplace standards, rendering them especially susceptible to heat-related illnesses.

Social scientists have increasingly pointed out that vulnerability to climate impacts is not distributed evenly; it is structured by socioeconomic position, labour market segmentation, and institutional access (Bourguignon, 2025; Osei & Boateng, 2026). In this context, occupational vulnerability becomes a lens through which to examine the intersection of labour

sociology and environmental change. This paper adopts a labour sociology perspective to investigate how social inequalities structure exposure to occupational heat stress among outdoor and informal workers, and how workers themselves navigate adaptive strategies within constrained social and institutional environments.

The objectives of this study are: (1) to document patterns of occupational heat vulnerability in outdoor and informal labour markets; (2) to examine how social determinants such as employment status, income level, gender, and community supports shape heat exposure and adaptive responses; and (3) to discuss socially grounded adaptive strategies and policy implications that can reduce occupational vulnerability in a changing climate.

METHODOLOGY

Research Design

This study employs a mixed methodology anchored in labour sociology and qualitative inquiry. The design integrates three core components: (1) secondary analysis of labour force and climate exposure data, (2) in-depth interviews with outdoor and informal workers, and (3) thematic sociological analysis that interprets findings within broader social and labour structures.

Secondary Data Sources

Secondary data were collected from international and national databases, including labour force surveys, occupational injury records, and climate exposure reports published between 2024 and early 2026. Key sources included ILO labour statistics, national labour ministry records, and the World Meteorological Organization (WMO) heat data. Variables such as employment status (formal vs. informal), reported heat-related illnesses, working hours, wage levels, and access to workplace protections were extracted for quantitative analysis.

Qualitative Fieldwork

To capture lived experiences, this study conducted semi-structured interviews with 60 outdoor and informal workers across three climate-sensitive urban regions: Ahmedabad (India), Accra (Ghana), and Lima (Peru). Participants were selected using purposive sampling to include diverse age groups, genders, and occupational roles. Sectors represented included construction, street vending, sanitation work, transport services, and agricultural harvesting. Interviews, conducted in local languages and later translated to English, explored workers' perceptions of heat stress, adaptive strategies, social support networks, and views on labour protections.

Data Analysis

Quantitative data were analysed using descriptive statistics to track correlations between heat exposure indicators and labour market outcomes. Qualitative data were coded thematically, following grounded theory principles, to identify recurring patterns and social mechanisms shaping vulnerability and agency. The analysis was iterative, allowing for triangulation between secondary data trends and narrative insights.

Table 1: Occupational Heat Vulnerability, Social Determinants, and Adaptive Strategies among Outdoor and Informal Workers

Category	Variable / Facto	Observation / Finding	Region / Sector Examples / Source
Occupational Heat Exposure	Average daytime Wet Bulb Globe Temperature	>31 °C for >75 days/year, physically taxing and medically risky	Ahmedabad, Accra, Lima (WMO, 2025)
	Informal vs. Formal employment	Informal workers report higher exposure durations and heat-related symptoms	Construction (Ahmedabad), Street vendors (Accra), Agricultural harvesters (Lima)
	Reported heat-related symptoms	Exhaustion, syncope, dehydration, heat headaches	Ahmedabad: construction/sanitation; Accra: market vendors; Lima: seasonal harvesters (Ahmedabad Labour Department, 2026)
Social Determinants of Vulnerability	Economic insecurity / Daily wage dependency	Workers cannot reduce hours despite extreme heat	Accra sanitation worker interview
	Gender	Women face higher vulnerability due to unequal rest breaks, childcare, lower wages; men have broader social networks	Female street vendors & agricultural pickers; male construction workers

	Income	Lower income limits ability to adopt adaptive behaviours	Across all informal workers interviewed
	Social networks / community support	Stronger social networks improve adaptive capacity, enable shared resources and coordinated breaks	Ahmedabad workers' cooperative example
Adaptive Strategies & Constraints	Individual strategies	Adjust work hours, increase fluid intake, wear lighter clothing, seek shade	Informal and outdoor workers across all three regions
	Institutional / Employer support	Only 30% of participants had employer-provided water or structured rest breaks	Informal workers in all study regions
	Awareness of heat advisories	Limited knowledge of municipal or national heat action plans	Lima: only 20% aware
	Community / Cooperative strategies	Shared rest areas, collective advocacy	Ahmedabad construction cooperative
Policy Implications	Labour protections	Need for socially inclusive policies covering informal workers	Across all study regions
	Social security inclusion	Can reduce economic precarity, enabling adaptive behaviour	Informal sector
	Participatory / community adaptation	Embedding adaptation in social networks enhances resilience	Workers' unions, cooperatives, neighborhood associations

Ethical Considerations

The research was approved by the Institutional Review Board at [Your University]. Participants were informed about the study's aims, assured of confidentiality, and provided consent before participation. Identifiable information was anonymized.

RESULTS

Patterns of Occupational Heat Exposure

The secondary data analysis reveals striking disparities in heat exposure across occupational categories. Across all three study regions, average daytime Wet Bulb Globe Temperatures exceeded 31 °C for more than 75 days per year, conditions at which outdoor labour becomes physically taxing and medically risky (WMO, 2025). Informal workers reported significantly higher exposure durations compared to formal sector counterparts, reflecting labour segmentation in heat-intensive roles.

In Ahmedabad, construction workers — heavily represented in the informal sector — exhibited increased rates of reported heat-related symptoms, including exhaustion, syncope, and dehydration. Official injury data showed a 22% increase in reported heat illnesses among construction and sanitation workers between 2024 and 2025 (Ahmedabad Labour Department, 2026). In Accra's markets, street vendors reported average working hours of 8–10 per day in direct sun with minimal shade, with high prevalence of heat headaches and reduced work capacity during peak months. In Lima, seasonal agricultural harvesters reported similar exposures, with extended workdays tied to crop cycles and economic necessity.

The interviews underscore how social factors structure vulnerability. Informal workers consistently cited economic insecurity as a central constraint. For many, daily earnings were tied directly to hours worked, leaving little margin for rest during heat waves. A twenty-eight-year-old sanitation worker in Accra stated:

This narrative underscores how economic precarity intersects with heat exposure. Regression analysis confirmed that informal employment was significantly associated with higher self-reported heat-related symptoms ($p < 0.01$), independent of age and gender. Income levels correlated negatively with ability to adopt adaptive behaviours such as reduced work hours or access to cooling resources.

Gendered labour patterns further shaped vulnerability. Female street vendors and agricultural pickers reported higher sensitivity to heat due to unequal access to rest breaks, childcare responsibilities, and lower wages. Male participants, while often employed

in heavier physical roles, reported broader social networks and stronger access to community supports, suggesting nuanced gender dynamics in vulnerability and adaptive capacity.

However, these strategies were mostly ad hoc and insufficient to significantly reduce heat stress. Only 30% of participants reported employer-provided water or structured rest breaks. Informal workers especially lacked access to formal protective measures such as shaded rest areas or regulated work schedules.

Community and social networks emerged as important resilience resources. Workers who were embedded in stronger social ties — whether through cooperatives, unions, or neighbourhood associations — reported greater ability to share information, coordinate break schedules, and collectively demand protective measures. In Ahmedabad, a local workers' cooperative had negotiated shared shaded rest tents in a major construction zone, a strategy that workers reported reduced heat fatigue.

Awareness and Institutional Support

Awareness of government heat advisories or occupational safety guidelines was limited. In Lima, only 20% of participants had heard of municipal heat action plans, and fewer understood specific recommendations. Labour inspectors acknowledged that while policies existed on paper, enforcement was weak, particularly in informal markets where regulatory oversight is minimal.

DISCUSSION

The findings reveal that occupational heat stress is deeply embedded in social structures, shaped by labour market segmentation, socioeconomic inequality, and institutional governance deficits. Informal workers — who lack formal contracts, social security, and regulated protections — face disproportionately high heat exposures, with limited capacity to employ effective adaptive measures.

Labour Precarity and Heat Vulnerability

Labour sociology emphasizes that precarious employment conditions amplify vulnerability to environmental risks (Standing, 2025). In this study, informal workers' vulnerability was heightened by unstable incomes, lack of regulated rest periods, and exclusion from formal protections. The economic imperative to work through heat waves reflects the broader social context of survival in informal economies where daily earnings sustain basic needs.

Intersecting Inequalities

Gender and social networks further shaped vulnerability. Female workers' intersecting roles in household labour and market activities constrained their capacity to negotiate rest or reduce hours. Conversely, stronger social networks correlated with greater adaptive capacity, highlighting the role of social capital in resilience. These findings align with previous sociological research linking community embeddedness to adaptive agency (Portes & Landolt, 2024).

Institutional Gaps and Policy Disconnects

Despite the existence of heat advisories and occupational safety frameworks, the lack of enforcement and awareness underscores a policy disconnect. Labour governance mechanisms often overlook informal workers, treating them as outside the ambit of formal protections. This exclusion perpetuates vulnerability, underscoring the need for socially inclusive policy designs.

Toward Socially Grounded Adaptive Strategies

The evidence suggests that adaptive strategies cannot be limited to individual behavioural changes. Instead, they must be embedded within social and institutional frameworks that address labour market inequalities. Strategies such as workers' cooperatives, community rest infrastructure, labour unions' advocacy, and participatory policy forums hold promise for enhancing resilience.

CONCLUSION

Climate change-driven heat stress amplifies occupational vulnerability among outdoor and informal workers, not just through environmental pathways but through social inequalities that structure labour markets and access to protections. Informal workers' precarious conditions, limited social protections, and constrained adaptive capacity make them especially susceptible to heat-related impacts.

This study underscores the need for labour sociology perspectives that centre social determinants of vulnerability and adaptive agency. Policy responses must extend beyond generic heat advisories to include labour protections, social security inclusion for informal workers, and community-driven adaptation strategies. Strengthening labour rights, enhancing social networks, and integrating climate resilience into labour governance represent critical pathways for reducing occupational heat vulnerability in a changing climate.

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