Bio-meteorological assessment of outdoor micro-entrepreneurial informal communities in extreme heat- A case of two tropical Indian megacities

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Extreme heat and associated health risks are increasingly becoming threats to urban populations, especially in developing countries of the tropics. Although human thermal exposure in cities has been studied across the globe, biometeorological conditions in mixed-used spaces, informal economic activity settings, and informal settlements have received little attention. We present a comparative analysis of outdoor thermal comfort for informal micro-entrepreneurial communities in Kolkata and Mumbai. Both cities belong to the Aw Köppen Climate Classification, which signifies tropical hot and dry or Savannah climate. Due to excessive humidity, uncomfortable thermal conditions persist year-round in both cities.

An extensive thermal comfort perception survey was conducted between November 2018 and August 2019 in three similar neighborhoods in each city with over 650 valid samples. The microentrepreneurial locations included two pottery markets (Kumbhadwada in Mumbai, Kumartuli in Kolkata); two flower markets that are linear stretches of informal activity areas along very important transportation networks (Dadar in Mumbai, Mallickghat in Kolkata); a book selling and book binding market (Boipara in Kolkata); and an informal commercial area with apparel shops (Fashion Street in Mumbai).

Results show that outdoor thermal comfort varied by city, micro-enterprise, and season. Overall, Kolkata respondents reported warmer sensations compared to Mumbai respondents. During the winter, neutral Physiologically Equivalent Temperature (PET) was 27.50°C in Kolkata and 23.75°C in Mumbai. Annual neutral PET was 22.7°C and 26.5°C in Mallickghat and Boipara, respectively. Respondents in Boipara were more sensitive towards warmer sensation than in Mallickghat. Even during the winter, people reported warmer sensation votes. PET was a better predictor of the mean Thermal Sensation Vote (mTSV) compared to air temperature. In Mumbai, we report higher neutral PET for activities at the clothing market compared to other microentrepreneurial activities. Acclimatization significantly improved comfort in the summer, while evaporative cooling was beneficial in the winter. We further employed an ANCOVA to analyze the impact of various non-climatic variables on thermal comfort. Results reveal that behavioral and physiological attributes (presence in the location, expectation, beverage intake) impact the overall sensation in both cities.
Availability of shading was a significant parameter in Kolkata, while shading had a negligible effect on outdoor thermal sensation in Mumbai neighborhoods.

This is the first study to assess outdoor thermal comfort conditions and perceptions of populations involved in various outdoor informal economic activities in India. Findings of this study help understand the heat health risks of informal communities and inform the design and revitalization of such spaces to improve thermal comfort.