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Heat Waves and Public Health Risks in Western Rajasthan: A Medical Geographical Analysis

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Abstract: ***Western Rajasthan—covering Jodhpur, Barmer, Jaisalmer, and Bikaner—is one of the world's hottest semi-arid zones, where extreme summer temperatures regularly exceed 48–50°C. Heat waves have intensified over recent decades, increasing the burden of heat-related illnesses including dehydration, heat exhaustion, heat cramps, and heat stroke. This study analyzes the spatial distribution, frequency, and health impacts of heat waves across Western Rajasthan using a medical-geographical approach. Using meteorological data (2000–2017), GIS-based spatial modeling, field surveys across 16 villages and 4 urban wards, and health records from district hospitals, the study assesses population vulnerability. Results indicate that Barmer and Jaisalmer experience the longest heat wave durations, whereas Bikaner records the highest urban heat island intensity. Heat-related morbidity increases significantly among outdoor workers (farmers, laborers), elderly individuals, and low-income groups with inadequate housing. The study concludes that rising temperatures and spatial variations in exposure demand a geographically targeted heat action strategy focusing on early warning systems, improved housing, community cooling shelters, and awareness campaigns.***

Keywords: Heat Waves; Medical Geography; Western Rajasthan; Public Health; Climate; Thermal Stress; Heat Stroke; Spatial Analysis; Arid Region; Vulnerability.

1.1 Introduction

Heat waves—extended periods of abnormally high temperatures—pose severe public health challenges in arid and semi-arid regions. Western Rajasthan, located on the fringes of the Thar Desert, experiences some of the highest temperatures in India. Recurrent heat waves affect vulnerable populations and intensify health risks. According to the Indian Meteorological Department, the frequency of heat waves has increased significantly in Rajasthan between 2000 and 2017.

Extreme heat affects the human body by disrupting thermoregulation mechanisms, resulting in heat exhaustion, heat cramps, dehydration, and in severe cases, fatal heat stroke. Medical geography offers a spatial and environmental lens to analyze these patterns, correlating climatic variables with health outcomes.

Western Rajasthan's distinctive environment—low humidity, intense solar radiation, sandy soils, sparse vegetation, and long dry spells—creates a unique thermal profile. Human exposure patterns, socio-economic vulnerabilities, and settlement structures further shape risk levels. This study seeks to provide an integrated medical-geographical assessment of heat wave impacts.

1.2 Objectives

1. To analyze the temporal and spatial patterns of heat waves in Western Rajasthan.

2. To identify vulnerable populations most affected by heat-related illnesses.

3. To examine environmental and socio-economic factors contributing to heat stress.

4. To map heat-prone zones using GIS techniques.

5. To propose medical-geographical strategies for heat wave mitigation.

1.3 Methodology

Data Collection

I. Meteorological Data:

1. Indian Meteorological Department heat wave data (2000–2017)

2. Daily maximum temperature, humidity, wind speed

II. Health Data:

1. District hospital records (2005–2017) for heat exhaustion and heat stroke

III. Field Survey:

1. 16 villages and 4 urban wards across Jodhpur, Barmer, Jaisalmer, and Bikaner

2. 650 respondents (farmers, laborers, elderly, women)

IV. Household Questionnaire:

1. Type of housing

2. Water availability

3. Occupation and exposure time

4. Awareness of heat wave warning systems

V. Statistical Techniques

1. Correlation between maximum temperature and morbidity

2. Trend analysis using Mann–Kendall test

1.4 Study Area

1. Jodhpur

Semi-arid region with urban heat island development, dense built-up areas, and high population exposure.

2. Barmer

Highly arid district with extreme temperature fluctuations; long summer dry spells.

3. Jaisalmer

Desert environment with sparse settlements, low vegetation cover, and high radiant heating.

4. Bikaner

Known for sandy terrain, dust storms, and rising urban temperatures.

These districts represent the core of Western Rajasthan's heat wave ecology.

1.5 Observations

I. Temperature Trends (2000–2017)

District	Average Max Temp (May–June)	Highest Recorded
Barmer	44.8°C	50.2°C
Jaisalmer	45.1°C	49.8°C
Jodhpur	43.9°C	48.7°C
Bikaner	44.2°C	48.9°C

II. Heat Wave Days (per year)

1. Barmer: 18–26 days
2. Jaisalmer: 20–28 days
3. Bikaner: 15–22 days
4. Jodhpur: 12–20 days

III. Health Impacts

1. Heat exhaustion: 712 reported cases (2005–2017)
2. Heat stroke: 157 cases
3. Highest heat stroke mortality in Barmer

IV. Vulnerable Groups

1. Outdoor workers: 47%
2. Elderly: 21%
3. Women in poorly ventilated houses: 18%
4. Children: 14%

V. Contributing Factors

1. Low vegetation cover
2. Poor housing insulation
3. Water scarcity
4. High exposure hours
5. Lack of heat wave awareness (only 12% respondents aware)

1.6 Discussion

I. Environmental Drivers

Western Rajasthan's desert ecosystem with sandy soils, low moisture, and high radiation enhances heat stress. Land surface temperature mapping shows hotspots in:

1. Barmer–Sheo belt
2. Jaisalmer's Sam and Khuri region
3. Bikaner outskirts
4. Jodhpur industrial areas

II. Urban Heat Islands (UHI)

Bikaner and Jodhpur show strong UHI effects due to dense construction, concrete materials, and reduced green spaces.

III. Occupational Exposure

Agricultural and construction workers experience prolonged exposure (6–10 hours daily), raising risk of dehydration and heat stroke.

IV. Water Scarcity

In remote Barmer and Jaisalmer villages, water sources are 2–5 km away. Lack of hydration increases vulnerability.

V. Socio-economic Dimensions

Low-income families lack cooling devices. Traditional mud houses provide better insulation than modern tin roofs, yet many poor households live in tin-roofed shelters.

VI. Gendered Vulnerabilities

Women face indoor heat exposure due to cooking in poorly ventilated kitchens; elderly women show high heat exhaustion incidence.

1.7 Results

I. Heat Wave Intensity Regions

1. Most severe: Barmer, Jaisalmer
2. Moderate: Bikaner
3. Least severe: Jodhpur (but stronger UHI)

II. Health Risk Zones

Heat Vulnerability Index identifies:

1. High risk: Indo-Pak border villages, Barmer interior, Jaisalmer dunes
2. Medium: Bikaner periphery
3. Low: Jodhpur city (but high UHI)

III. Statistical Relationships

1. Temperature vs. morbidity: $r = 0.71$ (strong positive correlation)
2. Heat wave duration vs. heat stroke cases: $r = 0.63$

1.8 Conclusion

Western Rajasthan is emerging as a heat wave hotspot where environmental, social, and climatic factors combine to increase public health risks. Barmer and Jaisalmer show the highest temperature extremes, while Bikaner and Jodhpur present

strong UHI effects. Vulnerable groups—including laborers, elderly, and low-income households—face significant risks due to inadequate housing and low awareness. A medical-geographical approach reveals distinct spatial clusters that must guide district-level heat mitigation strategies.

1.9 Recommendations

1. Early Heat Wave Warning System through mobile messages and radio.

2. Community Cooling Centers in rural and urban hotspots.

3. Heat-Safe Housing Schemes using insulated roofs, reflective paints, mud plastering.

4. Occupational Safety Guidelines:

(a.) Shift outdoor work to mornings/evenings

(b.) Mandate water breaks

5. Hydration Points in markets, bus stands, labor sites.

6. Urban Heat Island Mitigation:

(a.) Increase green cover

(b.) Cool roofs

(c.) Pavement shading

7. monitoring for district heat action plans.

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