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Spatial Distribution of Water-Borne Diseases in Arid Districts of Rajasthan: A Medical Geography Perspective

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Abstract: ***Water-borne diseases remain one of the most persistent public health challenges in the arid districts of Rajasthan, where climatic constraints, low rainfall, acute groundwater dependence, and poor sanitation infrastructure combine to intensify disease vulnerability. This study examines the spatial distribution, determinants, and seasonal characteristics of major water-borne diseases—diarrhoea, cholera, typhoid, dysentery, and hepatitis E—in the districts of Barmer, Jaisalmer, Bikaner, and Jodhpur. Using secondary health records, field observations, household interviews, and GIS-based mapping, the study highlights the significant role of water scarcity, groundwater salinity and contamination, socio-economic factors, and limited medical accessibility in shaping disease patterns. The findings reveal clear spatial clusters of high disease incidence along low-water-quality belts, fluoride-salinity zones, and densely populated rural settlements lacking proper sanitation. Seasonal analysis indicates sharp peaks during monsoon and late summer months. The study concludes that integrated water resource management, community-level awareness, improved medical accessibility, and GIS-based disease surveillance are crucial for effective mitigation.***

Keywords: Water-borne diseases, Rajasthan, Arid region, Spatial distribution, Medical geography, Groundwater quality, Sanitation, Barmer, Jaisalmer, Bikaner, Jodhpur.

1.1 Introduction

Water-borne diseases pose a widespread health challenge worldwide, but their impact is particularly intense in arid and semi-arid regions where potable water availability is severely limited. Rajasthan, India's largest state by area, has more than 60% of its geographical expanse classified as arid or hyper-arid. The western districts—Barmer, Jaisalmer, Bikaner, and Jodhpur—depend heavily on groundwater, often contaminated by fluoride, salinity, nitrates, and microbial pollutants. Poor rainfall, traditional water storage systems, and rising population pressures make water scarcity an everyday reality, increasing the risk of contamination and disease transmission.

Medical geography provides a scientific framework to analyse how spatial, environmental, socio-economic, and climatic variables influence disease patterns. Understanding the geographical distribution of water-borne diseases is critical to planning targeted interventions, improving water governance, enhancing community resilience, and minimising disease outbreaks.

This study examines the spatial patterns, environmental determinants, and seasonal trends of major water-borne diseases in Rajasthan's arid districts. The research adopts a classical, field-based, and GIS-supported medical geographical approach to assess disease burdens and identify vulnerable hotspots.

1.2 Objectives

1. To analyze the spatial distribution of major water-borne diseases in the arid districts of western Rajasthan.

2. To assess environmental, climatic, and socio-economic determinants influencing disease occurrence.

3. To map disease incidence using GIS tools and identify high-risk zones.

4. To examine seasonal variations in water-borne disease cases.

5. To recommend region-specific mitigation strategies for disease reduction.

1.3 Methodology

I. Data Collection

Secondary data: District health department records (2005–2017), NRHM reports, and Rajasthan PHED water quality data.

II. Primary data:

1. Household surveys (600 households across 24 villages)

2. Interviews with health workers, ASHA workers, and PHED engineers

3. Field observations of water sources, sanitation, and drainage systems

III. Sampling

1. Stratified random sampling for household surveys

2. District-wise selection of villages based on water availability and quality indices

IV. Disease Categories Studied

1. Diarrhoea

2. Cholera

3. Typhoid

4. Dysentery

5. Hepatitis E

V. Tools and Techniques

1. Spatial autocorrelation

2. Water-quality mapping using PHED datasets

3. Statistical analysis

VI. Study Period

12-year dataset (2005–2017)

1.4 Study Area

The study covers four arid districts of western Rajasthan, forming the core of the Thar Desert. These districts exhibit:

1. Annual rainfall: 100–300 mm

2. Temperature extremes: 2°C to 49°C

3. High evapotranspiration levels

4. Groundwater salinity and fluoride hazards

5. Sparse vegetation and sandy terrain

District Profiles

1. Barmer

High salinity zones, poor sanitation, border settlements, and high rural density.

2. Jaisalmer

Hyper-arid, lowest rainfall in India, scattered settlements, deep groundwater extraction.

3. Bikaner

Groundwater depletion, industry-induced pollution, recurring diarrhoeal outbreaks.

4. Jodhpur

Comparatively better medical access but high contamination belts and peri-urban slum issues.

1.5 Observations

I. Disease Incidence Patterns

Disease	Highest Incidence District	Peak Season
Diarrhoea	Barmer	July–September
Cholera	Bikaner	July–August
Typhoid	Jodhpur	May–June
Dysentery	Jaisalmer	August–September
Hepatitis E	Barmer–Jodhpur belt	September–October

II. Environmental Determinants

1. High salinity + microbial contamination correlated with diarrhoea and dysentery.

2. Nitrate-rich groundwater linked with hepatitis E outbreaks.

3. Open defecation, livestock mixing, stagnant water in tanka/beri systems.

III. Socio-Economic Causes

1. Low literacy rates

2. Traditional water storage dependence

3. Inadequate PHC accessibility

4. Women's burden of water collection leading to stored-water contamination

IV. Spatial Clusters Identified

1. Barmer: Sheo–Baytu belt

2. Jaisalmer: Pokaran–Fatehgarh belt

3. Bikaner: Kolayat–Lunkaransar belt

4. Jodhpur: Bawadi–Mandor peri-urban slums

1.6 Discussion

1. The study highlights that the spatial distribution of water-borne diseases is deeply interlinked with Rajasthan's arid ecology. Water scarcity forces people to depend on marginal-quality groundwater, increasing exposure to contaminated sources. The presence of fluoride, salinity, and nitrates aggravates vulnerability.

2. Seasonal analysis shows that water-borne diseases spike during monsoon, when runoff contaminates open wells, beri systems, and handpumps. High summer temperatures (45°C+) also favour pathogen multiplication in stored water.

3. Socio-economic backwardness, poor sanitation, low awareness, and limited medical infrastructure collectively widen the health burden. GIS-based mapping clearly correlates water quality zones with disease incidence.

1.7 Results

1. Strong correlation ($r > 0.75$) between poor water quality and high disease incidence.

2. Barmer recorded the highest diarrhoeal burden among all districts.

3. Bikaner showed classical cholera clusters near old canal-distribution colonies.

4. Typhoid prevalence was higher in peri-urban Jodhpur.

5. Seasonal peaks corresponded to contaminated runoff and stagnant water.

6. GIS maps identified 17 high-risk clusters across four districts.

1.8 Conclusion

Water-borne diseases in Rajasthan's arid districts stem from a complex interplay of environmental, socio-economic, and infrastructural factors. Spatial analysis reveals clear clusters linked with poor water quality, groundwater contamination belts, traditional water practices, and low medical accessibility. The findings underline the need for integrated, geography-informed public health planning.

1.9 Recommendations

1. Integrated Water Quality Monitoring using mobile labs and community testing.

2. Village-level RO plants for high-salinity belts.

3. GIS-based public health surveillance for early outbreak detection.

4. Revival and hygienic maintenance of traditional tanka/beri systems.

5. Strengthening PHCs in remote settlements.

6. Behavioural change campaigns on water hygiene and sanitation.

7. Rainwater harvesting expansion to reduce groundwater dependence.

8. Inter-departmental coordination between PHED, Health, and Rural Development.

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