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Heat Stress and its Physiological Impact on Agricultural Laborers in Rajasthan

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Abstract: ***Rajasthan's arid and semi-arid regions experience some of the highest summer temperatures in India, often exceeding 45–48°C. Agricultural laborers working under intense solar radiation, low humidity, and high wind velocity face significant physiological strain that affects productivity, well-being, and survival. This study examines the nature and extent of heat stress, its physiological manifestations, vulnerability factors, and coping strategies among agricultural workers in the districts of Barmer, Jodhpur, Jalore, and Bikaner. Using field measurements, surveys (n=420), and clinical observations, the study identifies heat exhaustion, dehydration, muscle cramps, tachycardia, and heat stroke as common health outcomes. The Wet Bulb Globe Temperature (WBGT) index revealed unsafe working conditions for more than 62% of the peak summer working hours. Older workers, women laborers, and migrant workers were found to be at higher risk. This research contributes an integrated understanding of occupational heat stress in Rajasthan's agriculture sector and provides evidence-based recommendations for improving worker safety and health.***

Keywords: Heat stress, physiological impact, agricultural laborers, Rajasthan, dehydration, occupational health, WBGT, heat exhaustion, arid climate.

1.1 Introduction

Rajasthan, known for its extreme climate, consistently records the highest temperatures in India during summer. Agricultural laborers, who form a substantial proportion of the rural workforce, remain highly exposed to environmental heat due to prolonged physical work in open fields without adequate protection or recovery time. Rising temperatures due to climate change have intensified heat stress, causing an increase in heat-related illnesses and mortality.

Heat stress is defined as the net heat load on the body resulting from metabolic heat production, environmental factors, and clothing (Parsons, 2014). When heat gain exceeds the body's ability to dissipate it, various physiological disturbances arise. Agricultural laborers work in conditions where access to shade, hydration, and rest breaks is limited. Despite its significance, heat stress among agricultural workers in Rajasthan has received little systematic scientific attention compared to industrial occupational settings.

This study investigates the environmental and physiological dimensions of heat stress among agricultural laborers in Rajasthan, focusing on seasonal extremes, physiological changes, and coping strategies. It aims to fill the knowledge gap and provide actionable insights to policymakers, health workers, and agricultural practitioners.

1.2 Objectives

1. To assess the intensity of heat stress experienced by agricultural laborers during peak summer months in Rajasthan.

2. To identify physiological symptoms associated with prolonged exposure to high temperatures.

3. To evaluate socio-demographic and occupational factors influencing vulnerability to heat stress.

4. To examine coping mechanisms adopted by agricultural laborers.

5. To recommend strategies for reducing heat-related health risks in agricultural occupations.

1.3 Methodology

I. Research Design

(a.) A combination of quantitative and qualitative methods was employed, including field measurements, physiological assessments, and structured interviews.

II. Sample Selection

(a.) Study population: Agricultural laborers from Barmer, Jodhpur, Jalore, and Bikaner districts.

(b.) Sample size: 420 laborers (105 per district).

(c.) Sampling method: Stratified random sampling based on age and work type.

III. Data Collection

1. Environmental Measurements:

(a.) Wet Bulb Globe Temperature (WBGT) recorded at work sites between May and June.

(b.) Humidity, wind speed, and radiant heat measured using portable instruments.

2. Physiological Data:

(a.) Heart rate, core body temperature, sweating rate, dehydration levels.

(b.) Symptom checklist for heat-related illnesses.

3. Survey and Interviews:

(a.) Socio-economic conditions, work hours, hydration habits, clothing, rest periods.

4. Clinical Examination:

(a.) Conducted at rural health centers by trained paramedics under supervision.

IV. Data Analysis

(a.) Descriptive statistics for environmental and physiological parameters.

(b.) Regression analysis to identify associations between heat exposure and physiological effects.

(c.) Qualitative analysis for coping strategies.

1.4 Study Area

I. Climatic Characteristics

1. Peak temperatures: 45–48°C (frequently above 50°C in Barmer and Phalodi).

2. Rainfall: 100–400 mm.

3. Extremely low humidity (<20% during peak summer).

4. High wind speed and intense solar radiation.

II. Agricultural Work Conditions

1. Open-field manual work such as ploughing, weeding, harvesting.

2. Tasks requiring physical exertion and prolonged exposure.

3. Limited access to shade; work begins early but often extends into afternoon hours.

1.5 Observations

1. Environmental Conditions

(a.) WBGT levels exceeded recommended thresholds for safe work (28–32°C) during 62% of working hours.

(b.) Peak WBGT values of 35–37°C were recorded between 12 PM and 3 PM.

2. Physiological Responses

(a.) Common symptoms:

(b.) Excessive sweating (83%)

(c.) Muscle cramps (57%)

(d.) Fatigue and dizziness (68%)

(e.) Headache (41%)

(f.) Elevated heart rate (average 110–130 bpm during peak hours)

(g.) Signs of dehydration: dry mouth, dark urine, reduced sweating

(h.) 8 cases of heat stroke reported in the study period

3. Vulnerable Groups

(a.) Women laborers: Higher dehydration due to dual domestic and field workload.

(b.) Older workers (>50 years): Reduced heat tolerance.

(c,) Migrant laborers: Poor living conditions and inadequate hydration.

(d.) Workers in black soil fields: Higher radiant heat absorption.

4. Work Practices

(a.) Average work hours: 7–10 hours/day.

(b.) Only 32% workers took regular rest breaks.

(c.) 18% had access to shaded rest areas.

(d.) 27% consumed less than 2 liters of water/day in summer.

1.6 Discussion

This study confirms that agricultural laborers in Rajasthan experience severe heat stress that exceeds safe working limits. Physiological responses such as dehydration, elevated heart rate, and electrolyte imbalance are widespread. These findings align with earlier studies on occupational heat strain in arid regions (Kjellstrom, 2016).

The WBGT data indicate a significant mismatch between environmental conditions and work practices. Without shade structures or scheduled breaks, workers continue labor during extreme heat periods, increasing health risks. Women emerge as a distinctly vulnerable group due to social and occupational burdens.

Socio-economic factors such as low income, lack of awareness, and poor access to healthcare further aggravate conditions. Inadequate hydration practices, often due to unavailability of clean drinking water in fields, contribute to rapid dehydration and increased risk of heat exhaustion.

The findings suggest that climate change-induced heat waves will continue to increase the physiological burden on agricultural laborers, affecting health, productivity, and rural livelihoods.

1.7 Results

1. WBGT exceeded safe occupational limits during most daytime hours.

2. Significant physiological strain observed: dehydration, elevated heart rate, heat exhaustion.

3. Heat symptoms strongly associated with work duration, hydration level, and age.

4. Women and older workers had higher risk.

5. Current coping strategies were inadequate and inconsistent.

6. Heat stroke emerged as a life-threatening risk during peak heat months.

1.8 Conclusion

Agricultural laborers in Rajasthan face extreme heat stress, leading to serious physiological consequences and reduced work capacity. Climate conditions, work practices, and limited

access to healthcare aggravate the problem. The study provides strong evidence for the urgent need for workplace interventions, heat management policies, and worker education to prevent heat-related illnesses in rural Rajasthan.

1.9 Recommendations

1. Schedule shifts to avoid afternoon peak heat hours.

2. Provide shaded rest areas in agricultural fields.

3. Ensure adequate water supply—3–5 liters per worker per day.

4. Promote electrolyte solutions to prevent dehydration and cramps.

5. Introduce heat-resistant clothing made of breathable materials.

6. Train workers to recognize symptoms of heat stroke and exhaustion.

7. Deploy mobile health units during peak summer.

8. State policies should mandate heat-safety standards for agricultural work.

9. Awareness campaigns through ASHA workers and agriculture extension officers.

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