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# Heat-stress thresholds and physiological strain in agricultural workers in Bangladesh

**Submission date**
22/07/2026

**Recruitment status**
Recruiting

**Registration date**
02/09/2026

**Overall study status**
Ongoing

**Last Edited**
02/09/2026

**Condition category**
Other

[ ] Prospectively registered
[X] Protocol
[ ] Statistical analysis plan
[ ] Results
[ ] Individual participant data
[X] Record updated in last year

## Plain English summary of protocol

Background and study aims
Agricultural workers in Bangladesh regularly engage in physically demanding labor outdoors under hot and humid conditions. Following long hours of fieldwork in the heat, farmers typically return to homes that remain hot through the evening and into the night, reducing their ability to recover from heat exposure. The impact of the same weather conditions in workers varies due to differences in workload, hydration status, age, body size (mass and surface area), housing characteristics, rest and access to drinking water.
The aim of this study is to identify environmental heat thresholds at which agriculture workers experience elevations in body temperature, dehydration, indicators of kidney stress, and symptoms of heat-related illness. The results will guide the development of more individualized and accessible heat-safety thresholds for agricultural workers in Bangladesh.

Who can participate?
Males and females aged 18-60 years who perform agriculture outdoors for 3 or more days per week from preselected areas of Rajshahi and Jashore districts. Participants must be able to carry out their routine farming tasks and they must consent to physiological monitoring, an ingestible temperature capsule, a wearable, activity monitoring device and semen, blood and urine samples.

What does the study involve?
Each participant will take part in a 3-day study cycle.
The research team will visit the participant’s home on Day 1 during the evening. The study team will then describe the study, obtain written consent, administer a brief questionnaire, characterize housing conditions, install a small temperature and humidity sensor in the home and provide an indoor urine collection container.
On Day 2, farmers will continue their regular agricultural activities for around 6 hours. The research team will assess outdoor heat, body temperature, physical activity, fluid intake and work tasks as well as rest breaks, perceived exertion and symptoms related to heat. Both blood and urine samples will be taken before and after the work shift.
Day 3 will consist of next-morning blood and urine samples, sleepandrecovery questionnaires,

followed by the removal of the indoor temperature sensor.
The research team will not request more effort from participants, such as drinking less water, staying in the sunlight or changing their typical routine at work.

What are the possible benefits and risks of participating?
Participants might not receive any health advantages directly. The study may help improve understanding of agricultural workers' responses to outdoor heat exposure and develop future guidance on potential heat protection.
The potential risks include temporary discomfort, bruising or infection at the blood collection site; discomfort associated with wearing monitoring equipment; and in rare cases, difficulty swallowing or passing the temperature capsule. Field staff will assess participants for heat-related illnesses and that work observation will stop when safety thresholds are reached.

Where is the study run from?
This study led by icddr,b aims to be implemented in selected agricultural communities of Rajshahi and Jashore districts, Bangladesh.

When is the study starting and how long is it expected to run for?
Recruitment of participants is anticipated to commence from 01 August 2026, once ethical amendment and ISRCTN registration process have been completed. Participants will be recruited until 31 October 2026, and the study is expected to conclude by 30 November 2026.

Who is funding the study?
The study is funded by The Rockefeller Foundation

Who is the main contact?
Mrs Farjana Jahan, farjana.jahan@icddrb.org

# Contact information

### Type(s)
Principal investigator, Scientific, Public

### Contact name
Mrs Farjana Jahan

### ORCID ID
https://orcid.org/0000-0003-1662-4734

### Contact details
Environmental Health and WASH, icddr,b, 68 Shaheed Tajuddin Ahmed Sarani
Dhaka
Bangladesh
1212
+880 (0)1843894364
farjana.jahan@icddrb.org

# Additional identifiers

# Study information

## Scientific Title
Establishing personalized heat-strain thresholds for agricultural workers through integrated environmental and physiological monitoring

## Acronym
THRESH-BD

## Study objectives
Main objective:
To develop individualized heat-stress thresholds for Bangladeshi agricultural workers by integrating outdoor occupational heat exposure, indoor residential heat exposure, physical activity, housing characteristics, thermoregulatory responses, and physiological markers of dehydration during routine agricultural work.

Specific objectives:
1. To examine how thermoregulatory and physiological responses change based on varying levels of outdoor occupational heat exposure, indoor residential heat exposure, physical activity intensity and housing characteristics among Bangladeshi agricultural workers.
2. To assess individualized thresholds for heat-stress signals of dehydration risk and thermoregulatory strain in Bangladeshi agricultural workers performing routine field work.

## Ethics approval required
Ethics approval required

## Ethics approval(s)
Submitted 20/07/2026, Ethical Review Committee, icddr,b (68 Shaheed Tajuddin Ahmed Sarani, Mohakhali 1212, Dhaka, 1212, Bangladesh; +880 (0)2 9827084; shiblee_s@icddrb.org), ref: PR-25026

## Primary study design
Observational

## Secondary study design
Cohort study

## Study type(s)

## Health condition(s) or problem(s) studied
Occupational heat strain, dehydration, and renal stress among agricultural workers exposed to environmental heat

## Interventions
The study will be a prospective observational study; no intervention or exposure will be assigned by the research team. Participants will perform their usual agricultural work, rest, drink water, eat food, and engage in household activities without any interference from the investigators.

Each of the 200 agricultural workers will complete a single structured 3-day monitoring cycle.

Day 1: Household eligibility screening, informed consent, baseline survey, heat-related knowledge attitudes and practices assessment, housing-characteristics assessment, indoor

temperature and relative-humidity sensor installation and successful provision of first-morning urine container.

Day 2: About 6 hours of routine agricultural task observation, continuous outdoor environmental monitoring, continuous gastrointestinal core-temperature monitoring via an ingestible telemetry capsule, physical-activity monitoring with an ActiGraph accelerometer, hourly observation of work task, posture, sun and shade exposure, rest breaks taken and time spent resting (in shade or indoors), fluids intake (e.g. water, beverage type/volume), thermal sensation, perceived exertion and heat-related symptoms, and blood samples pre-shift and post-shift.

Day 3: Blood and urine samples collected after the next-morning, assessment of adequate sleep and recovery, monitoring of food volume and fluid intake throughout the night, thermal-comfort assessments, retrieval of the indoor temperature humidity sensor.
The Universal Thermal Climate Index will be used to assess outdoor heat exposure. Around 140 worker-day observations are expected at UTCI≥36°C and around 60 observations at UTCI <32°C. Participants will not be intentionally exposed to heat over and above their normal occupational exposure.

Exposure being studied:

Main exposure:
Naturally occurring outdoor occupational heat exposure during agricultural work, measured using the Universal Thermal Climate Index.

Additional exposures and modifiers:
1. Indoor post-work and nighttime temperature and relative humidity
2. Physical activity intensity and estimated metabolic heat production
3. Work task and posture
4. Direct sunlight and shade availability
5. Rest breaks
6. Fluid intake
7. Housing materials and ventilation
8. Age, sex, body mass index, and baseline health
9. HbA1c as a baseline metabolic-health indicator

Comparison:
The UTCI distribution will be continuously measured and physiological responses compared between approximately 140 hot worker-days with UTCI ≥36°C and approximately 60 cooler worker-days with UTCI <32°C; both are passive determinants of these naturally occurring exposure categories not assigned by investigators.

Recruitment and sampling:
Recruitment method:
Eligible participants will be selected from lists of farmers identified through the Upazila Agriculture Offices under the Department of Agricultural Expansion. Household screening of potentially eligible farmers against study eligibility criteria. Potentially eligible farmers will be approached at their households and screened against the study eligibility criteria.

Sampling method:
The purposive site selection followed by the recruitment of eligible agricultural workers of the selected communities.

Sample allocation:
Rajshahi district: 100 farmers
Jashore district: 100 farmers
One upazila per district: two upazilas in total
Two unions per selected upazila: four unions in total
Approximately 50 farmers per union
Target female participation: approximately 20%, equivalent to about 40 women and 160 men overall

## Intervention Type
Other

## Primary outcome(s)
1. Core body temperature measured using the e-Celsius Performance ingestible telemetry capsule continuously and non-invasively at 1-minute intervals during the approximately 6-hour agricultural work shift on Day 2

## Key secondary outcome(s)
1. Plasma osmolarity measured using biochemical laboratory analysis of blood samples at pre-shift and post-shift on Day 2
2. Urine specific gravity measured using urine sample testing at pre-shift and post-shift on Day 2 and next morning on Day 3
3. Post-shift body weight change measured using a digital weighing scale at pre-shift and post-shift on Day 2
4. Serum creatinine measured using biochemical laboratory analysis of blood samples at pre-shift and post-shift on Day 2 and next morning on Day 3
5. Urine albumin measured using laboratory analysis of urine samples at pre-shift and post-shift on Day 2 and next morning on Day 3
6. Urine creatinine measured using laboratory analysis of urine samples at pre-shift and post-shift on Day 2 and next morning on Day 3
7. Urine NGAL measured using laboratory analysis of urine samples at pre-shift and post-shift on Day 2 and next morning on Day 3
8. Urine IGFBP7 measured using laboratory analysis of urine samples at pre-shift and post-shift on Day 2 and next morning on Day 3
9. Urine TIMP-2 measured using laboratory analysis of urine samples at pre-shift and post-shift on Day 2 and next morning on Day 3
10. Estimated metabolic heat production measured using ActiGraph accelerometer data and observed work activity during the approximately 6-hour agricultural work shift on Day 2
11. Perceived exertion measured using the Borg CR-10 scale at each hourly observation round during the approximately 6-hour agricultural work shift on Day 2
12. Fatigue score measured using the structured study questionnaire at each hourly observation round during the approximately 6-hour agricultural work shift on Day 2
13. Thirst score measured using the structured study questionnaire at each hourly observation round during the approximately 6-hour agricultural work shift on Day 2
14. Thermal sensation measured using the structured study questionnaire at each hourly observation round during the approximately 6-hour agricultural work shift on Day 2
15. Thermal comfort measured using the structured study questionnaire at each hourly observation round during the approximately 6-hour agricultural work shift on Day 2 and next morning on Day 3
16. Heat-related illness symptoms measured using a structured symptom checklist at each hourly observation round during the approximately 6-hour agricultural work shift on Day 2

17. Overnight sleep quality measured using the sleep-and-recovery questionnaire next morning on Day 3

### Completion date
30/11/2026

## Eligibility

### Key inclusion criteria
1. Adult male or female aged 18 to 60 years (confirmed by asking the farmer their age or by review of a national identity document where available)
2. Currently engaged in outdoor agricultural field work for at least three days per week during the study period
3. Physically capable of performing routine field tasks such as planting, harvesting, weeding, or carrying loads
4. Willing to undergo all study procedures: physiological monitoring with wearable devices, swallowing an ingestible temperature capsule (T-pill), providing blood and urine samples, and being observed during a full work shift
5. Able and willing to provide written informed consent

### Healthy volunteers allowed
Yes

### Age group
Adult

### Lower age limit
18 Years

### Upper age limit
60 Years

### Sex
All

### Total final enrolment
0

### Key exclusion criteria
1. Known or suspected current gastrointestinal obstruction or a history of gastrointestinal surgery (e.g., bowel resection, intestinal bypass, colostomy) that would make ingestion of the capsule unsafe
2. Physician-diagnosed severe cardiovascular disease, including unstable angina, recent myocardial infarction (within 6 months), or severe heart failure
3. Current pregnancy or breastfeeding
4. Presence of implanted electronic devices, such as a cardiac pacemaker or insulin pump, that may be subject to electromagnetic interference from the capsule receiver
5. Current use of diuretics, anticholinergic medications, or other medications known to substantially impair thermoregulation or sweat response
6. Acute febrile illness on the day of the visit axillary temperature will not be measured on Day 1,

but the farmer will be asked whether they are currently experiencing fever, diarrhoea, or vomiting. A formal temperature check takes place on Day 2

**Date of first enrolment**
01/08/2026

**Date of final enrolment**
31/10/2026

# Locations

**Countries of recruitment**
Bangladesh

**Study participating centre**
**icddr,b**
Environmental Health and WASH
Dhaka
Bangladesh
1212

# Sponsor information

**Organisation**
International Centre for Diarrhoeal Disease Research

**ROR**
https://ror.org/04vsvr128

# Funder(s)

**Funder type**

**Funder Name**
Rockefeller Foundation

**Alternative Name(s)**
The Rockefeller Foundation, Rockefeller Fdn, RF

**Funding Body Type**
Private sector organisation

### Funding Body Subtype
Trusts, charities, foundations (both public and private)

### Location
United States of America

# Results and Publications

### Individual participant data (IPD) sharing plan
De-identified individual participant data underlying the published findings may be made available upon reasonable written request after publication of the main study results. Requests will be reviewed by the principal investigator and icddr,b in accordance with participant consent, institutional data-access policies, ethical approvals, and applicable data-protection requirements. Data that could identify individual participants or households will not be shared. A data dictionary and relevant supporting documentation may be provided with approved datasets.

Type of data that may be shared:
De-identified participant demographic, occupational, environmental exposure, physiological monitoring data questionnaire and laboratory outcome data used in the final analysis may be shared.

When will data become available?
After the publication of the main results from study A, and for a time period in accordance with icddr,b institutional data-retention and sharing policy.

Who may request the data?
Provision of a scientifically justified project proposal from qualified researchers with suitable ethical approval where applicable

How will data be shared?
The sharing of data will be routed through icddr,b's institutional data-use process and usually requires approval from the principal investigator as well as signing a data-use agreement.

Type of analysis permitted:
Potential analyses in accordance with participant consent, approved study purposes, ethical approvals and institutional data-use agreement.

Consent, anonymisation, and restrictions:
The use of data and confidentiality will also be included in the consent for participation. All shared data will be released in a de-identified format. No data which may identify a participant, household or study community will be shared.

### IPD sharing plan summary
Available on request

### Study outputs

| Output type | Details | Date created | Date added | Peer reviewed? | Patient-facing? |
|---|---|---|---|---|---|
| Other files | Standard operating procedures version 1.0 | 16/07/2026 | 22/07/2026 | No | No |

| | | | | | |
|---|---|---|---|---|---|
| Protocol file | version 1.0 | 16/07/2026 | 22/07/2026 | No | No |