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Testing a heat early warning system with messages to protect pregnant and postpartum women in Zimbabwe

Submission date
07/04/2026

Recruitment status
No longer recruiting

Registration date
23/04/2026

Overall study status
Ongoing

Last Edited
20/04/2026

Condition category
Pregnancy and Childbirth

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

Plain English summary of protocol

Background and study aims
Pregnant women, postpartum women, and infants face heightened health risks from extreme heat events exacerbated by climate change, including increased rates of preterm birth and stillbirth, yet existing early warning systems often fail to provide the specific, actionable health guidance required by these vulnerable subpopulations. This study, situated within the broader HIGH Horizons project, aims to evaluate the feasibility, acceptability, and usability of the MotherHeat Alert mobile application in Zimbabwe, a personalised intervention built on the ClimApp platform that translates real-time meteorological data and individual risk factors into tailored heat-health warnings. Specifically, the research seeks to assess the pilot effectiveness of the intervention in improving heat-health knowledge through the delivery of early warning system messaging for maternal adaptation, while also monitoring physiological indicators of hydration, estimating the economic burden of heat exposure, and identifying barriers and facilitators to uptake and sustained use.

Who can participate?
228 pregnant and postpartum women enrolled into the study from across the three study sites, namely Chitse Rural Health Centre, Dotito Rural Health Centre and Mt Darwin District Hospital. To be eligible, participants needed to be at least 16 years old and belong to one of the following groups: pregnant women in their second trimester (16–24 weeks), early postpartum women (infant aged 0–3 months), or late postpartum women (infant aged 6–9 months). Women experiencing serious pregnancy complications requiring hospitalisation were excluded from the study. 35 community health workers from across the three sites were also enrolled to deliver messages to the pregnant and postpartum women.

What does the study involve?
Participants receive personalised heat-health messages through the MotherHeat Alert Early Warning System (EWS). Given limited smartphone access in rural Zimbabwe, delivery is facilitated by trained community health workers (CHWs), referred to as heat champions. Each heat champion is assigned a cohort of 3–10 women and conducts regular home visits to deliver tailored early warning messages and behavioural guidance based on real-time weather data and

individual risk factors, including gestational stage. CHWs are equipped with smartphones, solar chargers, and basic cooling kits (an umbrella, a sun hat, a paper fan and a water bottle) to support outreach. Messaging focuses on hydration, thermal regulation, and recognition of danger signs related to dehydration and heat stress. Data are collected at baseline, 3 and 6 months. Quantitative measures include urinary biomarkers of hydration, structured questionnaires assessing heat-health knowledge and economic burden, and basic body measurements. Qualitative data are generated through in-depth interviews and participatory reflection meetings with women and CHWs to assess user experience, acceptability, and implementation fidelity.

What are the possible benefits of participating?
Participants may benefit from receiving timely, personalised heat-health warnings and practical guidance delivered through the MotherHeat Alert Early Warning System, supported by trained community health workers (heat champions). For pregnant and postpartum women, this includes tailored advice on hydration, thermoregulation, workload adjustment, infant care during heat, and early recognition of danger signs such as dehydration in infants and heat-related illness in mothers. While there is no direct therapeutic benefit, the intervention may improve heat-health knowledge and support adaptive practices during pregnancy and the postpartum period. The study is considered low risk and does not involve invasive clinical procedures. Data collection includes basic anthropometric measurements (height and weight), midstream urine sampling to assess hydration, and structured questionnaires. Some participants may experience minor discomfort when discussing personal health, household conditions, or economic circumstances. Participation is entirely voluntary, and participants may withdraw at any time without penalty. In line with the Medical Research Council of Zimbabwe (MRCZ) ethical guidelines, participants receive a reimbursement to cover reasonable costs incurred through participation, including transport and time. This reimbursement is not intended to constitute an inducement to participate. Findings from this study will be used to refine the MotherHeat Alert EWS and its community-based delivery. The results will contribute to evidence on the feasibility and acceptability of early warning system messaging for pregnant and postpartum women in low-resource settings and may inform future scale-up of targeted heat-health interventions.

Where is the study run from?
CeSHHAR Zimbabwe leads the study in collaboration with Mt Darwin District Hospital, Chitse Rural Clinic, and Dotito Rural Clinic (Zimbabwe)

When is the study starting, and how long is it expected to run for?
August 2025 to May 2026

Who is funding the study?
The study is funded by the European Union Horizon Europe Framework Programme as part of the HIGH Horizons project and UK Research and Innovation

Who is the main contact?
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Study information

Scientific Title
HIGH Horizons maternal heat early warning system messaging intervention in Zimbabwe: implementation and quasi-experimental evaluation among pregnant and postpartum women

Acronym
MotherHeat Alert EWS

Study objectives
Primary objectives:
1. To assess the pilot effectiveness of the MotherHeat Alert early warning system in improving heat-health knowledge among pregnant and postpartum women
2. To evaluate the feasibility, acceptability, and usability of the MotherHeat Alert intervention among pregnant and postpartum women

Secondary objectives:
1. To assess physiological responses to heat exposure by measuring changes in hydration status

using urinary biomarkers
2. To estimate the economic burden of heat exposure among pregnant and postpartum women and explore the potential for the intervention to mitigate this burden;
3. To explore user experiences and the barriers and facilitators influencing uptake, adherence, and sustained use of the MotherHeat Alert system

Ethics approval required
Ethics approval required

Ethics approval(s)
approved 16/12/2024, Medical Research Council of Zimbabwe (20 Cambridge Road, Avondale, Harare, 263, Zimbabwe; +263 (0)8644 073772; mrcz@mrcz.org.zw), ref: MRCZ A/3109

Primary study design
Interventional

Allocation
Non-randomized controlled trial

Masking
Open (masking not used)

Control
Uncontrolled

Assignment
Single

Purpose
Device feasibility, Health services research, Prevention

Study type(s)

Health condition(s) or problem(s) studied
Heat-related health risks during pregnancy and the postpartum period

Interventions
The MotherHeat Alert Early Warning System (EWS) is a personalised digital health intervention designed to mitigate heat-related risks for pregnant and postpartum women and their newborns in resource-poor settings. The intervention responds to the increasing frequency of extreme heat events associated with climate change, which have been linked to adverse pregnancy outcomes such as preterm birth and stillbirth.

The system is built on the ClimApp platform, compatible with Android and iOS devices, and automatically integrates GPS-based local weather forecasts. By year 2 of the HIGH Horizons project, the platform is expected to reach full Technology Readiness Level for the target populations.

The EWS integrates multiple environmental and physiological indicators, including air temperature, humidity, wind speed, and solar radiation. It applies advanced human thermal heat-balance models such as Wet-Bulb Globe Temperature (WBGT), the Universal Thermal Climate

Index (UTCI), and the ISO7933 Predicted Heat Strain (PHS) model to estimate individual heat stress levels. Risk assessments are further enhanced by incorporating outdoor air pollution data (via OpenWeatherMap API) and self-reported indoor pollution exposure (e.g., biomass fuel use).

Unlike conventional EWS approaches, the system translates meteorological data into tailored, actionable health guidance specific to vulnerable subpopulations.

Intervention co-design and message development:
The intervention adopts a participatory, bottom-up approach to message development. During the formative phase, an adapted Photovoice methodology was used as a citizen science tool. In each study site, groups of pregnant women, postpartum women, and health workers documented lived experiences of heat exposure, coping strategies, and available community resources using cameras or smartphones.

Postpartum participants highlighted challenges such as maintaining breastfeeding during extreme heat. Through iterative analysis involving participants, community health workers (CHWs), and other stakeholders and with oversight from a WHO expert group, key themes were identified and translated into culturally relevant messages delivered as text and infographics.

Eight core behavioural themes informed the intervention:
1. Directly cool the body
2. Plan ahead
3. Stay in cool environments
4. Avoid or limit sun exposure
5. Take care of yourself
6. Utilise support services
7. Adjust clothing
8. Stay hydrated
9. Personalisation and risk stratification

A defining feature of the MotherHeat Alert system is its high level of personalisation. Messages are tailored based on individual physiological status and weighted risk factors, such as multiple pregnancies or infant prematurity.
Distinct message sets are developed for:
1. Pregnant women (16–24 weeks of gestation)
2. Early postpartum women (infants 0–3 months)
3. Late postpartum women (infants 6–9 months)
This ensures that guidance on hydration, infant care, sun exposure, and heat avoidance is relevant to each participant’s circumstances.

Delivery Mechanism and Community Engagement
Due to limited smartphone ownership, internet connectivity, and electricity access in rural Zimbabwe, the intervention uses CHWs (heat champions) as the primary delivery mechanism.

A total of 35 heat champions were recruited and equipped with smartphones, solar-powered chargers, and personal cooling kits (umbrella, hat, paper fan, water bottle). Each Heat Champion supports 3-10 women and delivers personalised alerts and advice through weekly home visits.

Heat champions:
1. Receive alerts via the mobile application
2. Deliver warnings at least three days before extreme heat events
3. Provide weekly in-person guidance and support

4. The system also supports proactive, non-alert messaging focused on preparedness, hydration practices, and recognition of maternal and infant danger signs.

Procedural activities:
The participants are given a tailored intervention package that is implemented for a period of 6 months. During this period, the participants are visited once a week at home by community health workers who give them tailored messages for hydration and adaptation to heat. Data is collected using surveys at baseline, midline (after 3 months), and endline (after 6 months). Participants also receive additional alerts before extreme heat waves to boost their protective responses. Urine samples are also collected during the study period to measure participants' urine specific gravity and osmolality. Some participants also take part in in-depth interviews and reflection sessions.

Setting and Implementation:
The intervention is implemented in the Mt Darwin District of Zimbabwe across three health facility catchment areas:
1. Mt Darwin District Hospital (peri-urban)
2. Dotito Rural Health Centre (rural)
3. Chitse Rural Health Centre (rural)

The intervention design is adapted from a direct-to-user mobile model to a CHW-supported model to address contextual barriers, including low smartphone penetration, limited electricity access, and high data costs.

Implementation monitoring:

Fidelity of intervention delivery:
Implementation fidelity was monitored to assess whether the MotherHeat Alert Early Warning System (EWS) was delivered as intended. Key fidelity indicators included: (i) the proportion of scheduled home visits completed by heat champions; (ii) timely delivery of early warning messages (≥3 days before forecasted heat events); and (iii) consistency of message delivery with the co-designed messaging package. Fidelity monitoring combined multiple data sources, including real-time WhatsApp reporting by heat champions, app-based interaction data, and participant-reported experiences. Additional assessment was conducted through surveys, in-depth interviews, and participatory reflection meetings with pregnant and postpartum women, heat champions, and household members. Urinary biomarkers (specific gravity and osmolality) were used as objective indicators of behavioural response to heat-health messaging.

Dose delivered:
Dose delivered refers to the amount of intervention provided. Over the six-month implementation period, heat champions conducted weekly home visits to deliver tailored heat-health messages and behavioural guidance. In addition, early warning alerts were issued ahead of extreme heat events to support anticipatory action. Evaluation activities, including baseline, midline (3 months), and endline (6 months) assessments, as well as periodic urine sampling, were integrated into the intervention schedule.

Dose received:
Dose received reflects participant engagement with, and response to, the intervention. Messages were tailored to the pregnancy or postpartum stage and aligned with core behavioural domains addressing hydration, cooling, reduced heat exposure, and maternal and infant care. Engagement was assessed through self-reported knowledge, behavioural adaptation, and perceived usefulness of messages, captured via structured questionnaires and

qualitative methods. In-depth interviews and participatory reflection meetings further explored comprehension, acceptability, and contextual barriers to applying recommended practices.

Reach and coverage:
The intervention was implemented across three health facility catchment areas in Mt Darwin District (Mt Darwin District Hospital, Dotito, and Chitse), enrolling 228 pregnant and postpartum women followed over six months. Reach was achieved through a community-based delivery model, with 35 trained Heat Champions each supporting 3–10 women. This approach enabled the delivery of early warning messages and behavioural guidance in settings with limited access to smartphones, internet connectivity, and electricity, thereby extending access to interventions for and peri-urban populations.

Intervention Type
Behavioural

Primary outcome(s)
1. Proportion of pregnant and postpartum women demonstrating adequate heat-health knowledge, measured using a structured heat-health knowledge questionnaire at baseline (pre-intervention), 3 months, and 6 months post-enrolment

Key secondary outcome(s))
1. Mean heat-health knowledge score measured using a structured heat-health knowledge questionnaire at baseline (pre-intervention), 3 months, and 6 months post-enrolment

2. Feasibility of the intervention, measured using the proportion of planned intervention activities (e.g. message delivery and scheduled visits) successfully delivered over the 6-month study period based on programme monitoring data (e.g. heat champions reports and system logs), continuously monitored over the intervention period with summary assessment at 8 months

3. Acceptability of the intervention, defined as the proportion of participants reporting a positive perception of the MotherHeat Alert system, measured using using structured acceptability questionnaires (e.g. Likert-scale responses) at 3 and 6 months post-enrolment

4. Usability of the MotherHeat Alert system assessed using user-reported measures (e.g. structured usability questionnaires) at 3 and 6 months measured using Mean usability score derived from structured user-reported questionnaires (e.g. Likert-scale-based usability assessment tools) at 3 months and 6 months post-enrolment.

5. Uptake of heat-health messages and recommended behaviours: percentage (%) of participants reporting adherence to recommended heat-health behaviours (e.g. hydration, cooling, reduced heat exposure), measured using structured questionnaires at 3 and 6 months post-enrolment

6. Hydration status measured using urinary biomarkers (urine specific gravity) at baseline, 3 months, and 6 months post-enrolment

7. Economic burden of heat exposure: self-reported household and individual costs measured using structured economic questionnaires at baseline and 6 months post-enrolment

8. Barriers and facilitators to intervention uptake and sustained use measured using thematic analysis of in-depth interviews and participatory reflection meetings at during implementation and at 8 months post-enrolment

Completion date
18/05/2026

Eligibility

Key inclusion criteria
1. Pregnant/postpartum women
2. Aged 16 years or older
3. Confirmed pregnancy in the 2nd trimester (16-24 weeks) or having an infant aged 0–3 months and 6-9 months
4. Resident in the Mt Darwin District for at least 6 months
5. Able and willing to provide informed consent

Healthy volunteers allowed
Yes

Age group
Mixed

Lower age limit
16 years

Upper age limit
49 years

Sex
Female

Total final enrolment
228

Key exclusion criteria
1. Experiencing severe or unstable medical or obstetric conditions requiring hospitalisation or intensive clinical management at the time of recruitment
2. Unable to participate in study procedures due to serious illness or clinical instability
3. Not intending to remain in the study area for the duration of follow-up
4. Unable or unwilling to provide informed consent

Date of first enrolment
13/08/2025

Date of final enrolment
13/04/2026

Locations

Countries of recruitment
Zimbabwe

Sponsor information

Organisation
Centre for Sexual Health and HIV AIDS Research

ROR
https://ror.org/041y4nv46

Funder(s)

Funder type

Funder Name
European Union (EU) – Horizon Europe Programme (Environmental and Health Call)

Funder Name
UK Research and Innovation

Alternative Name(s)
UKRI

Funding Body Type
Government organisation

Funding Body Subtype
National government

Location
United Kingdom

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Not expected to be made available