

DEVELOPMENT OF MESSAGES FOR PREGNANT AND POST- PARTUM WOMEN FOR THE EARLY WARNING SYSTEM

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Abbreviations

Abbreviation	Definition/Description
ANC	Antenatal care
CeSHHAR	Centre for Sexual Health and HIV/AIDS Research (Zimbabwe)
CHW	Community health worker
EU	European Union
EWS	Early Warning System
FGD	Focus group discussion
KI	Karolinska Institutet (Sweden)
LSHTM	London School of Hygiene and Tropical Medicine (United Kingdom)
SA	South Africa
SOP	Standard Operating Procedures
UK	United Kingdom
UN	United Nations
WHO	World Health Organization
WMO	World Meteorological Organization
Wits RHI	Wits Reproductive Health and HIV Institute (South Africa)

1 Introduction

This report describes the progress and status of the qualitative participatory study on message development for the Early Warning System (EWS) as part of the HIGH Horizons project (HIGH Horizons stands for: Heat Indicators for Global Health Monitoring, Early Warning Systems and health facility interventions for pregnant and postpartum women, infants and young children and health workers). This activity is currently underway. While some preliminary results are available and presented here, the bulk of fieldwork and analysis in South Africa, Sweden and Zimbabwe has yet to be undertaken.

This report presents a brief background explaining the scientific rationale for this study and the methodological approach employed for co-creation of messages. A status update from each of the three study countries is then presented. South Africa, being furthest along in the process, is presented first, which allows for further details of the study to unfold while also presenting its preliminary results. Status descriptions from Zimbabwe and Sweden follow, before closing reflections on the messaging development process and how the data could provide rich opportunities for other initiatives aiming to improve the health of pregnant and post-partum women and babies.

Together with deliverable 3.3 'Report on predictive heat warning thresholds' the findings from this report will feed into the deliverable 3.4 'Developed ClimApp EWS prototype', due March 2024.

2 Background and study rationale

Evidence that highlights the potential dangers associated with extreme heat exposure for pregnant and post-partum women is mounting. These hazards include adverse birth outcomes, such as preterm birth and low birth weight. As climate change intensifies extreme heat events globally, a significant portion of

the population will face heightened exposure. Pregnant and post-partum women caring for their newborns should be aware of these risks and of the protective measures that they could adopt.

2.1 Increasing heat

The frequency and intensity of temperature extremes, high ambient temperature (above the 90th percentile), and heatwaves have increased in the past four decades and are projected to continue rising. Current average global temperatures are now reported to be 1.1°C higher than the pre-industrial period (Chersich et al., 2020; Hoegh-Guldberg et al., 2019; Turek-Hankins et al., 2021). Crossing the heat threshold (over 1.0°C) has severely impacted natural and biological systems but accumulating evidence shows strong links to adverse human health outcomes and mortality (Hoegh-Guldberg et al., 2019). It is also estimated that 54% of the global population will be exposed to more than 20 days of deadly heat per year by 2100 (Zhao et al., 2021).

Africa has been shown to be vulnerable to climate change and growing extreme heat events. Over the past decade, heat extremes (above 45°C) were observed in some regions of the continent such as North Africa and Southern Africa (Iyakaremye, 2021). Studies also show that mean temperatures in regions such as Central Africa and the sub-tropics have risen at double the global rate (Almazroui et al., 2020; Iyakaremye, 2021). Machine learning and mathematical modelling techniques project an increase in frequency and intensity of extremely hot days (when maximum temperature exceeds 35°C) across the African region, which poses a great challenge because of already low disaster management capabilities, low adaptive capacities, poor land use, and existing socio-economic inequalities (Almazroui et al., 2020; Iyakaremye, 2021).

Vulnerable populations, such as pregnant women and infants, face heightened risks of adverse outcomes when exposed to high ambient temperatures. Several studies have found significant associations between high temperatures and

adverse pregnancy outcomes, including an increased incidence of hypertensive disorders of pregnancy (Cil et al. 2017, Qu et al. 2021) antenatal and postpartum haemorrhage (Qu et al. 2021), preterm prelabour rupture of membranes (Gat et al. 2021) as well as a rise in emergency caesarean sections (Frölich et al. 2012). Furthermore, adverse infant outcomes linked to such exposure include preterm birth, low birth weight, stillbirths, elevated rates of neonatal intensive care admissions, and an overall increase in perinatal mortality (Chersich et al. 2022).

2.2 Early Warning Systems for heat

Early Warning Systems serve as crucial gateways for targeted interventions and have been endorsed by the United Nations as one of the most cost-effective adaptation strategies against the adverse effects of climate change (GCA 2019). The UN has set a target for everyone in the world to be covered by an EWS by 2027 (WMO 2022). In several developed countries such as the UK and the USA, EWS play a pivotal role in the health sector's response to heat waves (Met Office UK; NWS USA). Heat EWS operate by issuing warnings intended to trigger a series of tiered interventions when weather forecasts indicate the likelihood of surpassing a pre-specified temperature threshold. According to our review, most heat EWS, however, currently exclude environmental exposures other than temperature, and seldom provide messaging that is tailored to local contexts or designed in collaboration with local communities.

HIGH Horizons aims to produce an EWS that provides guidance and information to pregnant and post-partum women, in a landscape where many EWS are based on sharing heat stress cut-off thresholds that address an entire population, and do not adequately stratify warnings by level of vulnerability of different groups. The guidance provided alongside warnings tends to be generally applicable, lacking the necessary customization to suit the specific resources and protective measures available in a given locality. When cautioning pregnant women and mothers about an impending heat event, it is essential to complement the alert

with a comprehensive set of messages and information detailing specific protective actions they can undertake. Crafting effective interventions, including messaging, to coincide with heat warnings necessitates a deep understanding of the perceptions and real-life experiences of women and communities in relation to extreme heat, as well as their lifestyles, behaviours, and social contexts (Scorgie et al. 2022). It is evident that the messages and services accompanying warning notifications should align with established cooling practices and the available resources for mitigating heat exposure in a particular environment.

The EWS in HIGH Horizons will be delivered in the form of a mobile phone App called ClimApp-MCH (based on the existing ClimApp but adjusted for maternal and child health). Women will create profiles and be able to log in to view the climate information in their area and receive push notifications. As such, messages developed need to be appropriate for mobile phones and user practices.

2.3 Messaging study

In this study, we will apply a participatory research approach using Photovoice, in depth interviews, qualitative transect walks and focus group discussions to develop messaging to assist pregnant and post-partum women to take protective actions against heat stress, based on their particular contexts and circumstances.

The key output for this study will be a set of messages for further refinement and incorporation into the ClimApp-MCH and other distribution methods. The assessment of the App's usability, effectiveness, and the reception of the messaging will be thoroughly evaluated as part of the HIGH Horizons project, with the anticipated completion by the end of August 2026.

2.4 Objectives

Understanding women's experience of heat and their coping strategies to reduce heat exposure is important to any efforts to improve their circumstances with heat (Spencer et al. 2022), including to guide the development of locally-adapted

messaging for an EWS. **The aim** of this study in South Africa, Sweden and Zimbabwe is to develop messages that will help to increase pregnant and postpartum women's knowledge about the risk of heat for them and for their infant up to one year of age and awareness of coping strategies to reduce negative effects on themselves and their babies. The messages will consist of a set of warnings, more detailed advice specific to context, and infographics based on photographic images created in this study.

Few studies have been carried out on this topic in our geographical areas of intervention, and this is considered to be the development phase of a specific early warning system method based primarily on message alerts provided by an app. Based on a review of the evidence and discussions within the HIGH Horizons group, it was anticipated that the following key broad behaviours during this project would be included for messaging: liquid intake to stay hydrated; avoiding direct sun exposure (e.g., during certain day times), childcare (clothing, exposure, hydration, breastfeeding); avoiding strenuous activities (e.g., avoiding heavy work during certain pregnancy months and/or during certain hours of the day when very hot and/or during certain seasons). Results from the situational assessment may show us that other behaviours should be targeted as well. We also aim to learn about perceived symptoms related to heat and heat stress. As such, the approach remains flexible and responsive to the findings that result during the period of research.

Primary objective:

To co-design and develop locally adapted messages, to be transmitted through a mobile application for heat early warning, for pregnant and postpartum women using inputs from pregnant and postpartum women and community health workers and partners.

Secondary objectives:

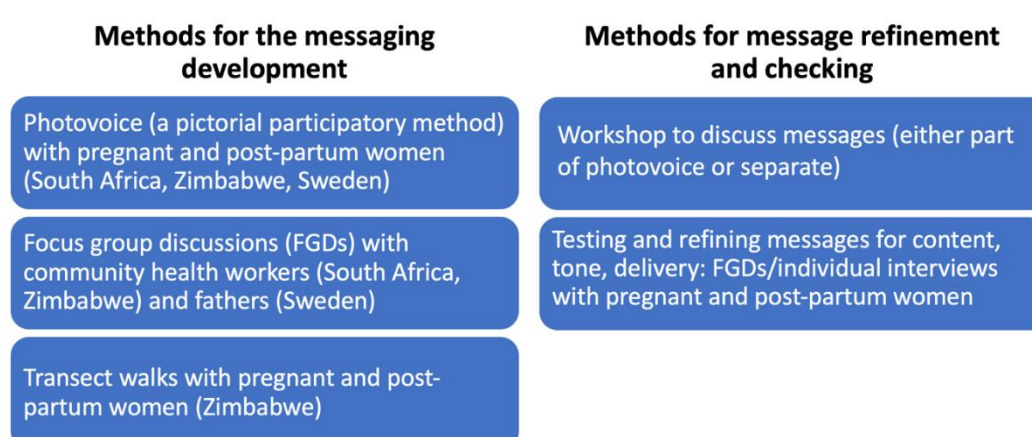
- To explore the knowledge and lived experiences of pregnant and postpartum women in relation to extreme heat and to identify their challenges and coping strategies;
- To elicit key insights and recommendations from pregnant and postpartum women, community health workers and other relevant actors on the dissemination of heat early warning messages, with a focus on accessibility, language, timing, and delivery channels.

3 Methodology

3.1 Overall approach

This is a qualitative study inspired by an intervention mapping approach (<https://www.interventionmapping.com/>) to develop messages to help pregnant and post-partum women cope with heat for themselves and their babies. We adapt this into an abbreviated approach and focus on the steps that involve 1) conducting a situational analysis to understand the problem and identifying which issues surrounding heat, if any, are important, and for whom; 2) identifying specifically the practices and knowledge that should be addressed by the early warning system interventions; 3) integrating findings and results into the proposed intervention content.

Figure 1. Overview of main methods for the development of messaging



The backbone of the study consists of the following qualitative research methods to drive the situational analysis and co-create the content for the intervention (Figure 1): Photovoice (a pictorial participatory method) with women, focus group discussions (FGDs) with community health workers (CHWs) or fathers, and transect walks with women. Photovoice will be conducted in all three countries (South Africa, Sweden, and Zimbabwe) while FGDs with CHWs will be conducted in South Africa and Zimbabwe and with fathers in Sweden, and transects will be conducted in Zimbabwe only. The additional component in Zimbabwe is necessary to help understand the best platforms and ways to communicate the EWS messaging to pregnant women as the research area is rural with low cellphone penetration and messages may need to be delivered through CHWs. Table 1 outlines these methods and proposed sample sizes.

Messages for women are co-created with women and other stakeholders during participatory data collection, reviewed and refined by the research team, and tested and validated with women before being submitted to the EWS team who will incorporate them into the ClimApp-MCH. There they will be trialled through the use of the app and other distribution methods.

Table 1. Planned activities and enrolment across sites

Method	Country		
	South Africa	Sweden	Zimbabwe
Photovoice			
Women	24	24	24
Workshops	2	2	2
Interviews			
Interviews with women	-	24	24
FGDs			
FGDs with CHWs	2	1	2
CHWs	12-16	6-8	24
FGDs with fathers	-	2	-
Fathers	-	12-16	-
Transect walks			
Women	-	-	10

3.2 Methods

Brief descriptions of each of the methods follow:

Photovoice in this study is used with pregnant and post-partum women. It is a participatory research method introduced by Wang and Burris in 1994, that combines photography and storytelling to empower individuals or communities to express their experiences, perspectives, and concerns. Participants are given cameras to document aspects of their lives that are meaningful to them. The photographs are then used as a form of communication to stimulate dialogue, and, through discussion, convey life experiences, expertise/knowledge, and insights regarding particular subjects that are assigned by a researcher or facilitator (Wang & Burris, 1998). Through constituting, sharing, reflecting on and discussing these images, they leverage the visual medium to highlight both strengths and challenges within themselves, their families, and their communities (Nykiforuk, Vallianatos, & Nieuwendyk, 2011). Using Photovoice to gather data about women's experiences with heat gives them the opportunity to have more time and different triggers and input (compared to a one-time face-to-face interview) to help express their ideas about how heat shapes their experiences and what they do to cope under these circumstances. In this activity, we will be including both group discussions (all countries) and one-on-one interviews about the photographs (Zimbabwe, Sweden).

Qualitative transects in this study are walking interviews through participant communities and/or homes that allow the researcher to explore and ask questions, drawing out details and aspects of the surroundings that the participant may not notice anymore due to familiarity and may not mention were the interview to be a standard "sitting" interview (Eelderink 2019). They allow for the opportunity for observational data to be collected alongside the narratives of in-depth interviews. We are using transects as a participatory method with pregnant and post-partum women to understand practices and experiences surrounding heat in

relation to women's living environments, day-to-day practices, resources and spatial parameters in the areas that they live in. They will allow the researcher to be aware of how women live and envision what types of messaging are realistic for their surroundings.

Focus group discussions (FDGs) are undertaken with community health workers (in Zimbabwe and South Africa) and fathers (Sweden). This is a qualitative research method that involves assembling a group of 6-8 individuals to engage in discussions and share their perspectives, attitudes, and experiences related to a specific topic of interest. A moderator guides the conversation, encouraging participants to express their views and interact with one another, providing valuable insights into the perspectives and dynamics within the group. This method is commonly used to gather in-depth information, explore perceptions, and uncover underlying attitudes on various social and cultural issues. Specifically, the objectives of the FDGs in this study are to establish the best approaches and platforms for messaging and to collect descriptive data that will inform the co-design of messages. FDGs are appropriate for this study because they allow for an exploration of social consensus and the opportunity to debate potentially controversial issues through collective discussion (Barbour & Kitzinger 1998). In part, data from the FDGs will also serve to triangulate findings from the Photovoice workshop with women (described above).

A group facilitator guides message development during the 2nd Photovoice workshop, during which participants craft messages based on their photographs, exercises, prompts and exchanges within the group. In a separate step the evidence, data, and recommendations provided by participants are consolidated and integrated by the researchers into a set of messages on the main behaviours targeted. The content, language, phrasing and tone of the **messages will be pre-tested with women** either in one-on-one interviews or in small groups, where interpretation and perceptions of the messages will be sought. Researchers will

thereafter refine the package of country-specific messages based on the results of the pre-testing, potentially requiring several iterations to ensure the intervention content is right for each population group. As such, feedback from participants will be sought and iteratively incorporated to improve the intervention.

We follow the core methodology described above across the three countries to develop the messages for pregnant and post-partum women. Country teams have adapted this core protocol according to country contexts and to the anticipated use and testing of the EWS system in each setting.

More detail on country-specific methods and the parameters surrounding them are provided in the sections below. The team in South Africa has already undertaken some components of their fieldwork and are able to report on more details, while Zimbabwe and Sweden report on their preparations and plans for upcoming fieldwork.

4 Current status of project: South Africa

Fieldwork has commenced in South Africa and the Photovoice phase with pregnant and post-partum women has been completed and further described below. Preparations are underway for the FGDs with CHWs.

4.1 Study setting

The focal area for this study is Mamelodi in Tshwane District, Gauteng Province. We recruited participants from an antenatal and child immunisation clinic at a primary healthcare facility that serves a population of about 260,000.

The hottest months of the year in the region are usually December, January and February, and the maximum, minimum, and mean temperatures across this period are 30°C, 17°C, and 23°C, respectively. This study was planned to coincide with the hot season.

Females make up 48% of the population and head 33% of the households in Mamelodi. Most residents have at least secondary education to some extent (84.4%) and 47.9% have completed secondary education or higher. The literacy rate in Gauteng province is estimated to be 95% (Khuluvhe 2022).

Mobile phone penetration is high in South Africa. Approximately 96% of urban households have a mobile phone (DHS data) and smartphone coverage is estimated to be 91.2% (ICASA, 2020). In addition, urban areas of Gauteng province have 100% 4G coverage. Therefore, it was anticipated that most women in the area have access to a smartphone and the EWS is planned to only be delivered through the ClimApp-MCH. This assumption can be validated in this formative research.

4.2 Overview of country specific methods

In the South African site, data to inform the development of locally-appropriate heat messaging are being collected through the use of two inter-linked, qualitative methods. Firstly, an **adapted Photovoice methodology** is being implemented with a small group of pregnant and postpartum women, to capture photographic images, generate verbal group discussions about the project themes, and create a draft set of messages designed to offer advice to women to reduce their risk of heat stress. Secondly, following a review of these draft messages by the study team, together with other data from the Photovoice project, they will be further refined in a set of **FGDs** with CHWs based in the Stanza Bopape Community Health Centre.

4.2.1 Photovoice

Our use of the Photovoice methodology to gather insights into women's daily lives and how heat affects their health and wellbeing follows four key steps or phases:

1. An introductory workshop for participants on the study aims and research questions, and an introduction to the Photovoice method, incorporating training in visual narratives and basic photographic skills;

2. A two-week period in which workshop participants take photographs relating to the study themes in their homes and communities;
3. A selection of the best photographs (most evocative and relevant to the study themes) to create a curated sub-set for further consideration);
4. A second workshop with the same group of participants to reflect on and discuss the selected photos, and to generate accompanying narratives and key messages for use in the EWS intervention.

4.2.2 FGDs with community health workers

We plan to conduct two FGDs with CHWs. The FGDs will take place after the Photovoice workshops have been completed and are intended primarily to gather views and opinions from CHWs on the messaging developed by the Photovoice participants. In part, data from the FGDs will also serve to triangulate findings from the Photovoice workshops with women.

All CHWs working from the focal health facility regularly engage with women in the community during and after pregnancy. Being involved in the health of pregnant and post-partum women means they are likely to offer insightful input on the relevance of the messaging. Importantly, CHWs may have a key role to play in the next stages of the study when the early warning messages are distributed. Specifically, as the messages will be delivered through a smart phone application, CHWs may serve as a means for the delivery of messages to women under their care who do not own smartphones.

4.3 Progress

The team received ethics approval from the University of Witwatersrand Human Research Ethic Committee (HREC) for this study. Further approvals were received from the National Health Research Committee and the health facility.

All four phases of Photovoice have been completed. The first workshop was conducted on the 4th of December 2023 and all disposable cameras were collected on the 22nd of December 2023. The 2nd workshop took place on the 25th of January 2024, following the Christmas summer break. Focus group discussions have not yet commenced.

The South African section of this document reports on activities up until the 2nd Photovoice workshop.

4.3.1 Photovoice

4.3.1.1 Recruitment of participants for Photovoice

Recruitment of participants commenced on the 22nd November 2023 and as per our protocol, we successfully enrolled 24 participants consisting of 12 pregnant women in their second or third trimester and 12 postpartum women within 3 months of childbirth. Pregnant women were recruited from the antenatal clinic and postpartum women were recruited from the childhood immunisation clinic at the local clinic. With the permission of facility management, recruiters from the study team gave a brief (5 minute) presentation to women in the waiting areas of the two clinics in both English and local languages. Interested women were then given further details in a private area at the clinic and informed consent was obtained from women who agreed to participate.

Enrolment of study participants occurred over a 1-week period in the facility and sampling was purposive in order to recruit a diverse mix of ages, and both primi- and multiparous women. Throughout participant enrolment, the recruiting team monitored stratification of the sample to ensure an even spread of participants across the sampling criteria.

4.3.1.2 Introductory Photovoice workshop

The introductory workshop was conducted on the 8th of December 2023. As the workshop was scheduled to last approximately 4-5 hours, we sought to make it as accessible as possible by allowing new mothers to bring their infants along. In addition, we arranged amenities including changing areas and cots for the babies to sleep in. The participants much appreciated this.

The workshop was held during a Gauteng heatwave, which prompted a lot of discussion around heat, but also contributed to fatigue and restlessness for participants and their babies. Despite this, the event provided valuable insights and generated meaningful discussions around their experiences of heat and their coping strategies.

Fourteen women completed the 1st workshop, with an even distribution between pregnant and postpartum women. Among the 10 participants who did not attend the workshop, reasons for non-attendance included having other commitments on the day (n=3), caring for an unwell child (n=1), unexpected relocation (n=1), too hot to attend (n=1), and loss of interest (n=1). Two of the 10 participants could not be contacted on the day, and one person, despite confirming they were on the way, never appeared.

Socio-demographic details of the 14 women who attended the workshop are provided in Table 2.

Table 2. Demographic characteristics of Photovoice workshop attendees, South Africa

Age (years)	Mean: 31.3; Range: 19-42	
Pregnancy status at enrolment		
	n	col%
Pregnant	7	50%
Post-partum	7	50%
Parity		
	n	col%
Primiparous	4	29%
Multiparous	10	71%
Number of children		
	Mean: 2.07; Range: 0-5	
Home language		
	n	col%
Sepedi	5	36%
Setswana	2	14%
IsiNdebele	1	7%
Xitsonga	1	7%
IsiZulu	3	21%
Sesotho	1	7%
IsiXhosa	1	7%
Education level		
	n	col%
Some high school	3	21%
Completed high school	8	57%
Some tertiary education	1	7%
Completed tertiary education	2	14%
Marital status		
	n	col%
In a stable relationship (but not married)	7	50%
Single (never married)	4	29%
Married common-law	3	21%

Employment	n	col%
Employed part-time	1	7%
Not employed but looking for work	10	71%
Self-employed	2	14%
Employed full-time	1	7%
Source of income		
Income earned informally	6	43%
State grants	3	21%
Salary from formal employment	1	7%
No Income	2	14%
Other	2	14%
Monthly income		
no income	2	14%
R1-R500	4	29%
R501 - R1000	4	29%
R1001 - R2000	2	14%
R2001 - R3500	2	14%
Type of home		
House, brick or concrete structure on a separate stand	3	21%
Informal dwelling NOT in backyard	5	36%
Informal dwelling or shack in backyard	2	14%
House, flat or room separate from main dwelling in backyard	4	29%
Home ownership		
Government subsidized housing	5	36%
Renting the property	3	21%
Own the property	6	43%
Access to mobile phone		
Yes	14	100%
No	0	0%

4.3.1.3 Workshop activities: Mapping experiences of heat

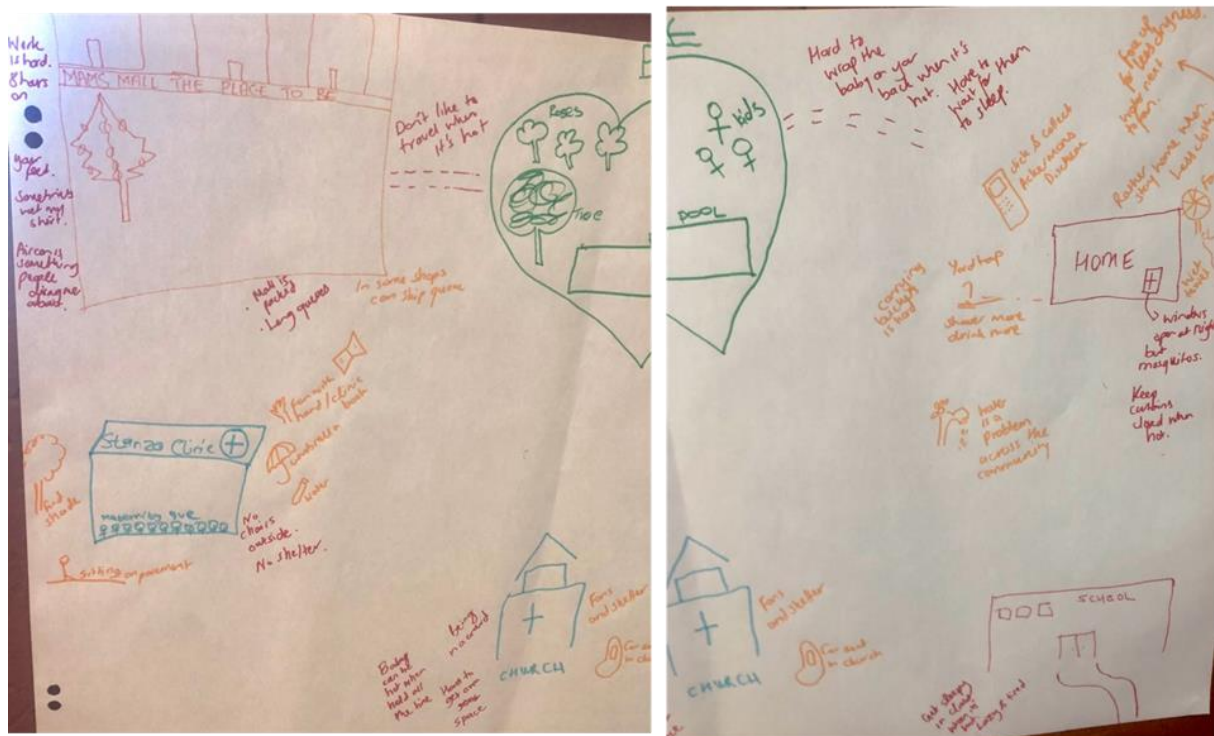
Two exercises were used in the workshop to gather insights into participants' experiences of and responses to heat for pregnant women, mothers, and newborns: a **heat-sensitive community map** and **body mapping**. For these exercises, participants were divided into three groups. One group of five participants collaborated on the community map, while two smaller groups of three co-created the body maps.

a. Heat-sensitive community mapping

To guide the women through this exercise, the facilitator asked women to describe places that they regularly visit and how they navigate these spaces during periods of extreme heat (see Figure 2).

Importantly, participants explained how they limited their travel on hot days, preferring to stay at home as they felt this was more comfortable for them. At home, participants could wear fewer items of clothing, be bare foot, and undress their babies.

Figure 2. Community mapping, South Africa



"And then when you are at home, it's the most convenient space that we all have cause you can take off your clothes, walk around with your tights in the house, with your bra, you get more fresh air, you have a fan, you have a wet cloth, whether it's a towel or what, you can just wrap yourself with that. And then it's more convenient to be home than to be outside in the sun." (Workshop participant)

They also had several other strategies to cool down at home: covering themselves in a wet towel, opening the windows, keeping the curtains closed or turning on a fan. Electric fans were used in moderation around babies, however, as this was said to dry out their nasal passages.

"For me it [the fan] helps, I just face it up and then it blows even the flies out. And then the room temperature, it stays cool. Blow it the whole day, close the door...keep your room closed, even the curtains, that shade from the curtains, it keeps the room cool." (Workshop participant)

"...when you're pregnant is better than [when you have a] baby. When you're pregnant you can use a fan, it's better, you can use a fan, but [when you have] the baby you can't use anything maybe you can bath the baby only, maybe that thing can make the baby become better..." (Workshop participant)

At home, both mother and child could also bathe regularly in cold water, assuming water was available. One of the major challenges participants described facing in coping with heat in their everyday lives was poor access to water. Under normal circumstances, women collected water in buckets from a yard tap. These are heavy for pregnant women to carry. To keep their hands free (so that water buckets and similar can be handled), new mothers tie their babies on their back – but this can make both mother and child even hotter.

"...cause putting the baby at the back, you also sweat and then you are transferring your heat to the baby, plus the blanket that you are putting on the baby [to tie the baby onto their back], yo, it's a lot. The baby will definitely cry." (Workshop participant)

On the day of the workshop, many participants were experiencing water outages in their communities. Some were getting water delivered by trucks. But this, too, required participants to collect and carry heavy containers of water back to their homes, which was near impossible. Since a hot day would usually encourage participants to drink more water and bathe more regularly, insufficient water was a significant obstacle to coping in the heat.

"We all know we [are] struggling with water lately in our community. So, it's very hard to get water. You need to walk maybe a mile to go get water somewhere. You're having a baby from your back, that creates another problem for baby and mother with the heat. So, we just hope this issue with the water thing can be resolved. Because it's giving us problems as mothers because you need to go get water for doing washing, you need to go get water for cleaning, for bathing. So, it's a must-have thing that you need to go out and get while you're having a small baby like this, walking in the sun with your bucket on your head. It's a problem." (Workshop participant)

Even on hot days when they wanted to stay home, there are some trips that participants mentioned could not be avoided, such as buying groceries and baby items (which they had to do very often), dropping children off at school, and or attending clinic appointments. When going out in public, shopping malls and parks with shade were two of the places women frequented in order to stay cool.

"When you go to the mall, when it is hot, at least when you go inside the mall it is much calmer, it is cool, and then it just relaxes your body and you become free." (Workshop participant)

"With the park, we all know that if you go to the park, there is trees that you can sit under there, there's pools that you can swim just to cool off your body...The kids playing there. While your kids are playing there, you can just sit under the tree or under the car ports because most of the parks there have the car ports. You can just sit there...it is much calmer, and you can also relax from there." (Workshop participant)

To avoid having to go out, some women used online services like 'click-and-collect' or at home delivery to purchase goods remotely. These included orders of clothing, pharmacy items, and grocery items. Purchasing online helped women avoid long queues at the mall, which were particularly difficult in the heat. Some areas of the mall had air-conditioning and allowed pregnant women to skip the queues, but others did not.

Participants shared their experiences of attending the clinic for antenatal visits. They described queuing from the early hours of the morning in the outdoors, without chairs. Sometimes they sit on the pavement or under the shade of a nearby tree. Because each person in the queue is allocated a number, one can leave the queue to sit in the shade without losing one's place. Clinic books are sometimes used as fans for mothers and babies.

Many participants attended church on weekends. Some churches had air conditioning and fans. Others did not. It was acknowledged that crowds and close contact were difficult during the heat. Some mothers used car seats so that they did not have to hold their baby in church, as this made both mother and baby hotter.

"With the church, some of the churches they do have amma aircons. Some of them they don't have aircons...To those who have aircons, it's a win situation, is much better because at least you feel relaxed while you are worshipping. You feel calm. And then with us who have small babies, at least you can just get yourself a car seat, put your baby there, the aircons are blowing, then the babies also relax, you are not going to have a crying baby, like, around you. And then remember when your baby starts crying, when you start holding your baby doing like this 'shushu baby' thing, you also getting hot. Your body temperature rises. You are holding a baby, the baby as well is getting hot, it's becoming like too much for both of you. So, with the aircons, they help a lot." (Workshop participant)

b. Body mapping

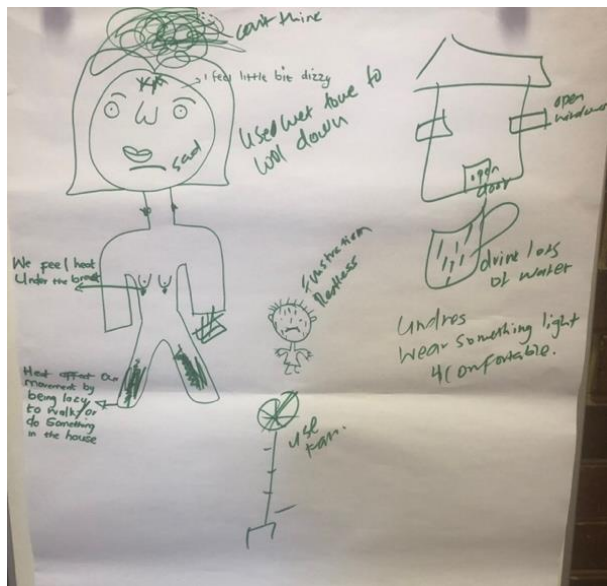
Body mapping is a participatory, qualitative research method that involves inviting participants creating visual representations of their own bodies to explore and communicate their experiences, perceptions, life stories, and/or emotions in relation to a particular theme. In this workshop, participants were provided with large sheets of paper and coloured markers and were instructed to draw an outline of their bodies. On the drawing, they were asked to indicate where they specifically felt symptoms of heat stress, either for themselves or their infants.

Women were guided through this exercise by thinking about the following questions:

- *Where do you feel heat on your body?*
- *How does heat affect your movement?*
- *How does the heat affect your emotions?*
- *How does heat affect your thinking?*
- *How does heat affect how you interact with your child?*
- *What is the different about your experience of heat as a pregnant woman?*
- *How does your child experience heat on their body?*

Participants' body maps illustrated where on their body they felt heat – under the breasts, on the neck, often all over their bodies. Many said their experience of heat when they are pregnant is at least twice as severe as when they are not. Their movement is slowed, and their feet swollen. They experience dizziness, impaired thinking, restlessness, and frustration (see Figure 3).

Figure 3. Body mapping, South Africa



"When I'm pregnant, it's double."

"I feel heat times 10!"

"You can't think, like you can't think."

"You can't think straight when it's hot."

"We become lazy to walk or do something in the house."

Participants said their babies were also often restless and unhappy during the heat, particularly at night, when many babies were reported to cry consistently. Participants reported feeling helpless in being able to cool their babies down, or comfort them, since holding and rocking them would only make them feel hotter.

"You feel frustration, even the baby, he or she doesn't feel good when it's hot, she or he feels like to cry only just because of the heat, you don't even know how to hold the baby...you don't know what to do because of this heat so you too become sad, you don't know what to do."

(Workshop participant)

"They [babies] feel frustration, restless, and sad. They cry because they can't talk." (Workshop participant)

Following the completion of both exercises, participants returned to the larger group to share insights and provide feedback on their respective activities.

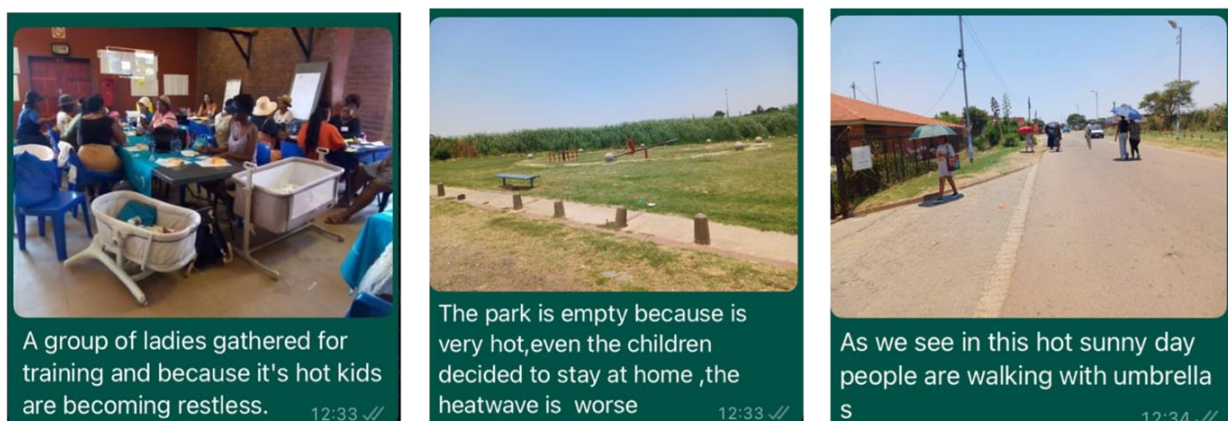
4.3.1.4 Workshop activities: Photovoice training

After the community and body mapping exercises, participants were introduced to Photovoice as a research methodology. Together with the workshop facilitator, they collectively interpreted and reflected on some examples of Photovoice from other settings, building a visual language and learning key photographic techniques including how to use the disposable cameras.

The logistical aspects of their 2-week photovoice exercise were explained along with the research questions the study would seek to explore. Together, the group discussed some of the ethical questions that might emerge in the field. These included the risk that community members would be suspicious of their intentions. Some thought that community members might accuse them of using the photographs to make money, or for witchcraft. The group discussed tactics for handling such situations and how to ensure they took photographs without including people's faces. Participants were also provided with flyers translated into 3 local languages (English, SeSotho and IsiZulu) to explain the study to community members and bolster the legitimacy of their photograph-taking.

Finally, participants were given an opportunity to practice capturing and captioning images that reflected their experiences of the workshop. This was done using their mobile phone cameras. Some of these images and captions are presented below in Figure 4.

Figure 4. Images and captions from photography practice session, South Africa



Before departing from the workshop, each participant was provided with a disposable camera (39 exposures) and a notebook to document their thoughts pertaining to the photographs or any reflections on their experience with heat or the Photovoice task. All but one of the women indicated that they would be able to use their camera phones to capture images in addition to the disposable camera. Women were asked to take a maximum of 24 images.

WhatsApp was selected as the preferred platform for sending the images due to its user-friendly interface and end-to-end encryption. A study phone number was provided to workshop participants, along with clear instructions to send their photos to this number. The photos would then be retrieved and safely stored by the study coordinator.

4.3.1.5 Photography in the community and selection of photographs

Over the 2-week period following the introductory workshop, the 14 participants were contacted by the study team at least twice to check how they were progressing with the task and address any challenges that were coming up.

A total of 303 photographs were taken by the participating women. Almost half of these (n=141; 46,5%) were taken with a camera phone and sent in electronically on the WhatsApp platform, and the remainder (n=162; 53,5%) were captured with the disposable cameras (see Table 3).

Table 3. Image source and number of selected photographs

	Number of WhatsApp photos	Number of disposable camera photos	Total number of photos	Number of photos selected for workshop*
Total	141	162	303	96
Average number per participant	10.1	11.6	21.6	6.9
Range per participant	0-40	0-33	7-40	5-11

*Note: *Reasons for non-selection include duplicate or repetitive photos/shots, under/overexposed images, images not relating to heat or women's experiences of heat.*

In preparation for the second workshop that concludes the Photovoice process, three members of the study team individually assessed and scored all the pictures taken by the participants. A set of ranking criteria was used to guide this process, as described in Table 4 below. Team members then met to compare and discuss their rankings and decide on the selection of photographs to be used at the 2nd workshop.

Table 4. Criteria and ranking scale for assessing photographs

Responsive to project themes	Quality of photos	Narrative quality
1=Not responsive	1=Very poor (out of focus, over/under-exposed, poorly framed)	1=Poor (little coherence; photos don't really tell a story)
3=Moderately responsive	3=Adequate	3=Adequate (some coherence; potential for a story to emerge from images; something possibly unusual or unique)
5=Highly responsive	5=Very good (clear pictures, sharp, good use of lighting, well-framed)	5=Good (coherent and fluid; participant is really telling us something through the images; unusual or unique images worth exploring further)

Images were assigned higher scores if they depicted women's direct experience of heat for themselves or their infants, rather than portraying heat in a more general sense, for example. In our selection of photographs (see Figure 5), we sought to capture the full range of cooling and coping strategies that they appeared to be showing, rather than only selecting a pre-determined number of photos per participant. In the final selection, some participants therefore have a larger set of curated photos than others.

Figure 5. Some images and captions submitted by participants demonstrating experiences of heat and coping strategies



In this picture I came back home from the mall, and I've got my mother sitting under the shelter. And that day the sun was really hot, so I thought maybe how about I put some blanket on top of them and try to make another shelter from them. Because the sun was moving across the net and was moving on top [of] the child. (ZA-PV-014)



I had to travel for about an hour to do my washing, because there was no water on that day. Being pregnant comes with a lot [of] baggage. On that particular day, I had to stand in for a long queue to drill water for my washing. Furthermore, I had to carry back my washing back home. (ZA-PV-019)



The baby feels the heat, the baby was crying because of the heat so I decided to bathe her to cool her off. After I have done bathing her, she stopped crying when she was inside the water. (ZA-PV-008)



...it was a sunny day and it was hot, the temperature was 27 degrees, I was also pregnant at the same time. My legs were swollen because of heat, the way it was hot. I had to come up with an idea of putting my legs in a bathtub, in that bathtub I had to put some ice and lemons just to reduce some swelling for a period of time. (ZA-PV-007)



Am sitting down on the floor, am sitting next to the opened door for some fresh air cause it was hot inside in the shack and next to me there is [a] 2 litre [bottle] of cold water (ZA-PV-008)



Going to clinic for baby monthly check-ups. It was very hot and walk a 1 hour distance to our local clinic. Feeling tired already. The shade from umbrella was a help. (ZA-PV-021)

4.3.1.6 Closing workshop

The second (final) Photovoice workshop was conducted on January 25th, 2024. Thirteen of the 14 participants from the 1st workshop were in attendance, with one participant unable to attend as she had travelled out of the area.

The groundwork for message development was laid during this workshop and entailed the following:

1. **Photograph sharing and storytelling:** To start with, each woman described one of her photographs to the group. This provided an opportunity for the women to see the different types of photographs that were captured and share in each other's story.
2. **Writing captions:** Participants then received guidance on creating impactful captions such as keeping it simple and clear, highlighting the main point and using emotions. The women then composed captions for each of their pre-selected photographs while thinking about the advice they wish to convey to other women.
3. **Collaborative message generation:** In small groups, participants then collaborated to develop a set of messages derived from their individual captions. These messages were subsequently presented to the broader group for collective discussion, refinement, and consensus-building.
4. **Integration of external insights:** The women were then introduced to additional recommendations from relevant literature that may not have surfaced in their prior discussions. The group collectively assessed the feasibility of incorporating these insights based on their local context and, if relevant, crafted messages for any additional recommendations. They were also encouraged to contribute any other messages that may not have been captured in their pictures or derived from the literature.

The photographs, captions and messages are currently being collated for analysis; however, messages have been categorised into 8 themes as shown in Table 5.

Table 5. Draft messages generated during 2nd workshop, South Africa

Theme	Messages
STAY HYDRATED	<ul style="list-style-type: none"> ▪ Drink lots of water to stay hydrated ▪ When pregnant and walking long distances always carry water to drink and take rests on the journey
ADJUST CLOTHING	<ul style="list-style-type: none"> ▪ Dress yourself/ your baby in light clothing when it is hot ▪ Take off your clothes or your baby's clothes to cool down ▪ Avoid heavy, tight clothes and dark colours ▪ Take off shoes to cool down
DIRECTLY COOL THE BODY (SELF/BABY)	<ul style="list-style-type: none"> ▪ Use cold compress to cool down and help with swollen feet ▪ Swim or cool yourself in water when pregnant ▪ Use a fan to cool yourself when pregnant ▪ Put on wet towel to cool of the body ▪ Put feet in cold water with ice ▪ Bath the baby regularly to cool the baby down
STAY IN COOLED ENVIRONMENTS	<ul style="list-style-type: none"> ▪ Try to create or identify space for cooling ▪ Open windows to ensure well-ventilated space – especially for sleeping ▪ Sit outside or in a place with shelter from the sun when pregnant ▪ Sit by an open door to get fresh air ▪ Avoid sitting on the bed to avoid trapping the heat [floor/ground is cooler]
AVOID/LIMIT DIRECT SUN EXPOSURE	<ul style="list-style-type: none"> ▪ Carry an umbrella and/or a sun hat when walking in the sun ▪ Avoid going outside on very hot days without a cap ▪ Avoid long distance travelling during the day when it's very hot
PLAN AHEAD	<ul style="list-style-type: none"> ▪ Get house chores done earlier when the sun is not yet out or when it's still cooler to avoid the sun ▪ Try to store water in a Jojo tank, 5 litre bottles, 20 litres containers
TAKE CARE OF YOURSELF	<ul style="list-style-type: none"> ▪ Avoid hard labour during pregnancy ▪ Take a chair to seat while waiting for your buckets to fill up ▪ When taking long walks, take regular breaks to sit down/rest ▪ Elevate your feet when sitting down to avoid swelling ▪ Do exercises as a pregnant woman to distract yourself from feeling the heat e.g., water splash games ▪ To cope with your own frustration, take a nap or do something relaxing like a hobby or watch tv, write a journal, listen to a preacher, even have a cup of tea
UTILISE SUPPORT STRUCTURES	<ul style="list-style-type: none"> ▪ Request help when fetching water ▪ Get assistance for the baby when you have to do outdoor activities to avoid exposing your infant to the sun or direct heat ▪ Reach out for support from family ▪ Always ensure environment with family in case of an emergency

4.3.1.7 Photovoice challenges and lessons learned

An early-identified challenge arose when, despite providing women with data bundles for uploading pictures, several encountered difficulties as their phones had existing subscriptions to services that rapidly consumed the provided data. Consequently, a strategic decision was made to meet with the women in person and facilitate a hotspot connection, enabling them to directly upload their pictures to a secure folder.

Additionally, two women experienced the onset of labour during the two-week period, posing a temporary hindrance to their ability to capture images for a few days. Despite this, both women resumed photographing after the birth of their babies.

Upon reflection, and if time had allowed, it may have been beneficial to extend the duration of the first workshop to two days, as this would have allowed for more practice and an improved understanding of the assigned task. In addition, ongoing engagement with participants throughout the photo-taking period is necessary in order to improve adherence to the research questions.

4.3.2 Progress on focus group discussions

For the FGDs, we planned to enrol 12-16 CHWs with a minimum of 2 years of experience in their roles, operating from the local health facility. Eligible CHWs were identified with the help of the CHW manager.

Two FGDs will be conducted, each with 6 to 8 CHWs. At the time of drafting this report, we have successfully enrolled 8 CHWs for participation. FGDs are scheduled for the end of February 2024. The study team has established contact with the CHW manager, who has expressed flexibility and a willingness to accommodate our schedule for the FGDs on any suitable days.

The FGD will explore participants' observations of how heat exposure affects pregnant and postpartum women, and their views on the feasibility of a heat early

warning system provided through an App. Participants will then be shown selected photos and the draft messages from the Photovoice activity and asked to provide input on the content, relevance, and suitability of this material for the local context. Additionally, participants will be encouraged to share insights on potential barriers and enablers they identify within the provided messages.

4.3.3 Message development

Following the conclusion of the second workshop, the research team will conduct a review of the formulated messages. These messages will then be shared with the CHWs during the FGDs as described above. The insights gathered from both the workshops and FGDs will be consolidated following which the compiled set of messages will be presented to the wider HIGH Horizons group for finalisation. This collaborative step will involve the refinement of messages and the creation of icons or other visualisation methods, tailored as necessary for incorporation into the App.

5 Current status of project: Zimbabwe

In Zimbabwe, preparatory work is underway for the data collection and co-creation steps, for which fieldwork has yet to begin at the time of reporting. This section details the current status of activities.

5.1 Study setting

In Zimbabwe, study recruitment will occur in Mount Darwin district, which has been described as a low socio-economic setting, located in Mashonaland Central Province. In this district, there were 92 days per year with maximum apparent temperature $\geq 32^{\circ}\text{C}$ (extreme caution needed) from 1979 to 2014 (Garland et al. 2015). The projected change in temperature between the years 2041-2060 under various mitigation scenarios, relative to 1979-2014, is an increase to 171 days (Engelbrecht et al. 2016).

The main livelihood source is subsistence farming, food, and cash (cotton and tobacco) crops. Women are also involved in informal economic activities including vending. Artisanal small-scale mining popularly known as gold panning is another source of income that sustains many households in the district and province. In Mashonaland Central province the percentage of household questionnaire respondents who are aware of and report household having ever received assistance or external economic support is 65.8%. 42.4% reported receiving food such as drought relief, communal gardens, or agricultural inputs (Population and Housing Census, 2022).

In Mashonaland Central province, almost 96% of women aged 15-49 years with a live birth were attended to at least once by skilled health personnel (8.1% Medical Doctor, 87.7% midwife/ nurse). Only 4.2% did not access antenatal care. The percentage distribution of women aged 15-49 years with a live birth who gave birth in a health facility was 85.9%, while 9.2% gave birth at home. 4.9% (other). 77.4% of those who gave birth received post-partum care in a health facility for 12 hours or more (Zimbabwe National Statistics 2016).

While mobile connections at a national level have improved significantly (estimated to be at 98.5% in 2021), smartphone penetration remains low (estimated to be at 52%) (Econet 2021).

With the high number of women in contact with the health system, and yet relatively low personal mobile phone coverage, the application of the EWS in Zimbabwe is planned to use community health workers to disseminate messages about heat to women. This means that messages produced by this activity should be crafted with the community health worker as a centre point to the intervention delivery.

5.2 Protocol and regulatory approvals

Ethics approval has been obtained from the Medical Research Council of Zimbabwe in addition to local facility approvals for collaboration.

5.3 Progress

5.3.1 Training of researchers

A training for the research team charged with undertaking the Messaging fieldwork took place during the week of 8th January 2024. This training focused on the project's objectives and familiarizing the team with the qualitative data collection methods specific to this research, in particular photovoice and transect walks, in addition to FGDs and IDIs. The training aimed at promoting an in-depth understanding of the project protocol, as well as specific standard operating procedures (SOPs) related to participant recruitment and the consenting process. Following the training, each team member was assigned individual responsibilities for the project, which have been ongoing in the weeks thereafter.

5.3.2 Recruitment

In January 2024, sensitization activities for the recruitment of pregnant and postpartum women were initiated through the assistance of nurses and community health workers from three focal healthcare clinics. The research team has been liaising with nurses in charge to recruit healthcare workers for the CHW FGD as well as with the nurse in charge and CHWs from three clinics about who will assist in the recruitment of pregnant women who meet the study characteristics.

5.3.2.1 Recruitment for photovoice, transect walks and interviews

The recruitment of women involves a purposive selection of women who are in their second and third trimester and postpartum. Other inclusion characteristics involve first time birth, multiple births, age and geographic location. Women are

selected based on the accessibility of their location and underlying health conditions.

Participant recruitment is anticipated to start in the 2nd week of February 2024. For Photovoice, following the protocol, 12 women who are pregnant in the second and third trimesters and 12 who have given birth within three months will be selected. For the transect walks, 10 different women will be selected: 5 in their third trimester and 5 post-partum (within three months of delivery).

Two strategies are employed for the recruitment of women in Photovoice and transect walks to ensure that both healthcare facility users and non-users are included in the study.

The first strategy is to recruit through the health facility. This will be done with the assistance of the nurses in charge at the three focal clinics. The study team will use a database of pregnant and postpartum women that has been compiled to recruit participants based on factors such as age of participant (<16 years), gestational stage (i.e., second or third trimester), and for diverse experiences it will include number of births thus, whether the woman is multiparous or primiparous.

The second strategy involves enrolling participants with the help of CHWs. This entails asking CHWs to identify women who are pregnant or who have recently given birth during the designated time frame—that is, during the second and third trimesters for pregnant women, and within the first three months for postpartum women. The research team will visit identified pregnant and postpartum women for verification, informing them about the study and setting a date for consenting to participate.

5.3.2.2 Recruitment of CHWs for FGDs

Field preparations and procurement of all required materials for the FGD workshop have been completed. With assistance of the nurse in-charge, the study team will recruit 24 community health workers for two FGDs, with about 12

participants each. CHWs will be included in the study if they are: willing to provide informed consent and to be audio-recorded during the FGD workshop; acting in their role as CHWs for at least 2 years; operating within the catchment areas of the focal hospital; prepared to meet at the focal hospital (the FGD venue).

FGDs are envisioned to be conducted in the third or fourth week of February. During the time of report writing, the study team has managed to mobilise all participating CHWs through the nursing staff. For the FGD workshop activities, the study team has assigned each team member roles (participant mobilisation, workshop logistics, consenting, venue, registers, refreshments, facilitation) during the FGD activity.

5.3.3 Plans for message development

The second Photovoice workshop is expected to last six hours or a full day and will bring together a variety of stakeholders: women enrolled in the Photovoice project (n=24), CHWs who participated in the FGDs (n=24), and community stakeholders including village leaders and citizen representatives (n=8-10). The aim is to allow the opportunity for an array of actors to both vocalise and listen to the experiences of pregnant and post-partum women as well as to co-create context sensitive messages that educate participants about the subject matter.

Women will display their selection of the top 10 photos that they took on boards that will be located in a viewing area at the workshop venue. Women will be invited to speak about the meaning behind their pictures, encouraging discussion about the impact of heat on their lives and what measures can be taken to improve their situations, and what is unrealistic. Through discussions, groups at the workshop will define emerging themes centred around the images and experiences, and conversations will be facilitated by the activity leaders to develop messages. The outputs of this workshop will be collated and revised by the study team, and the messages later tested with women in small focus groups for interpretation, clarity and content before possible further revision and submission to the EWS team.

6 Current state of project: Sweden

For the messaging study, the Swedish HIGH Horizons principal investigator partners with social scientists at Karolinska University's Department of Global Public Health. Preparations are underway for data collection and co-creation, which at the time of writing have not yet begun.

6.1 Study setting

The climate in Sweden (particularly Stockholm, where this research will be conducted) includes the four seasons, where winters generally last from November to February when the temperature drops below 0 degree Celsius, and summers are in general not too warm with mean temperatures of 23°C, but hot days can occur with temperatures of up to 35°C. Women will all be recruited from urban areas, in Stockholm (which has a greater metropolitan area population of about 2.5 million inhabitants).

In the region of Stockholm there are 69 antenatal care (ANC) clinics, and each midwife is expected to care for 105 women during every year. The ANC programme entails a minimum of 12 visits during pregnancy. The first antenatal care visit takes place on average during the 9th gestational week. In particular for migrant women, there is a system of community health promoters that liaise with them and the health system, to encourage better communication and use of services.

In 2022, an estimated 26% of Stockholm's population was foreign-born (OECD 2019). The largest segment of Sweden's foreign-born population in 2022 consisted of individuals born in Syria, numbering nearly 200,000 residents. The second-largest group among foreign-born citizens was from Iraq (approximately 147,000 residents), with Sweden's neighbouring country Finland ranking third.

Women are expected to have access to personal mobile phones and to use the ClimApp-MCH themselves; this will be analysed during the course of data collection.

6.2 Progress

As the study is yet to start in Sweden, here we report on the plans and preparations to date. Approval for ethics has been submitted to the Karolinska University Hospital ethics committee.

6.2.1 Recruitment

The four sites selected for the recruitment of women in Sweden are all urban antenatal care centres. These centres are tasked with attending women during both pregnancy and postnatal care. Many of the antenatal care centres refer women to Karolinska University Hospital, where the majority are high risk pregnancies. Karolinska serves both affluent and less affluent areas. The reason for including three of the centres is the higher proportion of migrant populations in the catchment area of these centres. A fourth centre serves a medium-income area.

6.2.2 Photovoice and interviews

Participants will include 12 women in their third trimester and 12 women who have given birth within the last three months. In terms of the participant profiles, women aged 18 years and older, both foreign-born and Swedish-born, and will also be selected based on parity. Recruitment will take place at the ANC clinics mentioned above. Women will be invited to participate during their antenatal and postnatal care appointments by the midwife in charge. Those that agree will be approached by the researcher and the study will be explained to them, where they will have another opportunity to decide whether they would like to participate in the study.

6.2.3 Focus group discussions

Six to eight partners of women participants – fathers of newborns – will be included in two FGDs to better understand the circumstances surrounding women's experiences with heat and the role of partners. One FGD with 6-8 community health promoters who work with pregnant women will also be held.

6.3 Adaptations of protocol to Swedish context

To meet internal project deadlines, this research is being carried out in the same period as in Zimbabwe and South Africa, though it falls during the Swedish winter. We have adapted the methods to take the cold weather at the time of fieldwork into account and see this as an opportunity for trying different ways to prompt discussions on the impact of heat on pregnancy and post-partum practices and well-being.

- In addition to the first Photovoice workshop serving as the venue to explain the research objectives, the activities involved, and how participants will engage with the project, it will also be geared towards creative thinking and offering prompts for women to recollect the impact of heat on their pregnant or post-partum bodies, practices and well-being during hot periods. These exercises will be particularly important given that the workshops take place during the winter.
- Women will be invited to include photographs from their personal libraries that demonstrate their experiences of heat on their pregnancies and/or post-partum lives. We are adopting this strategy as a way of evoking warm temperatures during the winter fieldwork period to encourage them to reflect on their experiences during the warmer summer months and envisage how they felt, any changes in habits, routines, or practices that they instituted, and what resources they had at their disposal, sought out, or would have required. Ethical guidelines for photographs, explained

during the first workshop, will also apply to the inclusion of the selected photographs for study.

- Individual in-depth interviews will be carried out with women about their photographs in addition to the 2nd group workshop discussion. This direct and personal link between researcher and participant is intended to encourage more in-depth discussion about women's relationships to heat and their pregnancies, as well as other topics for discussion, including their use of health information services.
- While the research team considered undertaking focus group discussions with community health promoters (*Hälsoinformatörer*) as in the other country contexts, we also decided to include women's partners, or babies' fathers, as interview partners in the study. In the Swedish context a family is frequently composed of one or two parents and children. It is not the rule, but common for parents to share childcare and both take parental leave. The other parent's awareness of risks during pregnancy, neonatal and infancy is an important factor contributing to health outcomes.
- A sub-objective of this study in Sweden is to analyse migrant and non-migrant women's experiences with heat and their coping practices. Participants in the study will include foreign-born and Swedish born pregnant and post-partum women. Including both women and their partners in study activities serves to gather views on how women from immigrant backgrounds perceive heat and health issues related to climate change, and will inform whether and how the content and formulation of messages should be modified to cater to women with different migrant profiles in the same setting. In addition to the messages, we expect that this work will shed light on other linked aspects, such as: women's use of the health system for antenatal and postnatal care; receipt of information and guidance regarding antenatal and post-natal care (comprehension, sources,

health seeking); differences in practices and habits in terms of coping with extreme or unpleasant heat; resources available to improve.

These modifications are intended to achieve the main project aim, namely the co-production of contextually appropriate messages for the EWS, but also make use of the opportunity to explore pregnant immigrant experiences in Sweden in terms of communication, health information, use of space and services, and well-being (particularly in relation to episodes of extreme heat).

7 Discussion

The inclusion of this activity in HIGH Horizons is in sync with recent calls in the literature to address exposure to incorporate women's perspectives on their adaptation and coping strategies (Desai & Zhang 2021) and improve awareness among pregnant and post-partum women about the effects of extreme heat on their and their offsprings' well-being (Pandipati et al. 2023).

Initial findings from South Africa show that with guided activity and discussion, women are forthcoming about the impact of heat on their pregnancies and post-partum periods. Heat creates situations of discomfort and disease, in intense periods shaping how they go about their daily lives, with women saying that in some cases heat is experienced twice as severely when pregnant. Examples of the increased challenge of caring for babies were also shared, a primary concern being able to keep them cool, rested and able to sleep. Women explained how structural shortcomings – such as electricity outages or water shortages – played a role in how they could cope with extreme episodes of heat.

These are aspects that need to be taken into consideration when crafting messages. The suggestions of the Photovoice group indicate that women were able to develop messages that resonated with their experiences, and shape

evidence-based-recommendations into guidance that made sense to their lives, given their surroundings, facilitators and constraints.

7.1 Reflections on cross-country analysis

At this point in the work, conclusions about the results and their implications cannot yet be drawn across countries. Once data collection and the co-creation process is complete, we plan for our analysis to be both country specific as well as comparative across the three sites.

Given the synergies and differences of the contexts, the three sites offer several aspects that we will be examining in our analysis of the data, for example:

- The use of intermediaries in the form of CHWs to deliver the EWS in Zimbabwe. What does messaging look like when it is delivered through people rather than solely through an App? Does the crafting of the messages differ knowing that a human, personal touch will be incorporated into the EWS?
- Women participating in the study in Sweden and South Africa are from urban areas, while those in Zimbabwe largely live rurally. Can we discern differences in the way heat impacts women's pregnancies and their care for their babies between the two settings? Which women (in terms of age, occupation, ethnicity, economic status) appear to be more impacted than others, and in which ways? How do rural and urban characteristics affect coping and adaptation mechanisms?
- In Sweden, we plan to explore immigrant and Swedish-born women's experiences with heat during pregnancy and post-partum. Despite the low numbers, are there themes that emerge here, and could they resonate with the results from Zimbabwe and South Africa?
- The three countries clearly have different heat profiles, with Sweden also encountering considerable cold temperatures for a good duration of the year. Can we learn something from women's coping and adaptation

strategies in relation to overall climate characteristics, and how infrastructure supports or hinders women's agency to improve their comfort and well-being during extreme heat events?

7.2 Implications for the ClimApp-MCH

In the lead-up to fieldwork and the participatory process of creating messaging for the EWS, the wider team had several discussions with the ClimApp-MCH design team. These conversations were geared towards understanding what the EWS needed from the qualitative researchers to help inform the content and roll-out of the app, and for the qualitative researchers to better grasp the system into which the messages would be released.

To develop the protocol and plan for this messaging development activity, a number of considerations were debated across partners. One of the first discussion points the team debated in the planning and preparation for this activity was aligning with the ideas for the evaluation of the messages and the EWS, organized by another HIGH Horizons team. Therefore, deciding whether messages should focus on behavioural change, or on acquisition of knowledge, was relevant. For two main reasons, it was decided that we focus on knowledge rather than behavioural change: 1) Extensive intervention is commonly required to bring about behavioural change, based on a comprehensive understanding of what underpins behaviours (Michie & West 2021). The HIGH Horizons project already had laid out the platforms for the delivery of the intervention (the EWS), thereby limiting flexibility surrounding the application of potential findings from a situational analysis that might inform which strategies should be employed to best bring about change. As such, we decided that aiming for knowledge acquisition and tailoring the messages for this purpose would be our goal. 2) The evaluation of the EWS and the messages will occur at a later stage. Determining changed behaviour beyond self-reported behaviour for practices related to coping with heat would at best require an array of observational data collection steps. The fact

that the evaluation planned mainly consists of self-reporting also contributed to the focus on knowledge acquisition.

Secondly, during our discussions about the specificity and nuance of the messages, and in consultation with the scientific literature, we considered whether messages should be tailored to the individual profiles of women, taking factors such as age, body mass index (BMI), parity, underlying health conditions and lifestyle factors into account. Other variables include women's stage of pregnancy at which extreme heat exposure is more likely to occur. Nevertheless, some limitations of the app at this early stage of development make this level of detail not yet supported by the ClimApp-MCH. Furthermore, the nature of some of the exposures to risk could mean that the app is not the most suitable way to offer protective advice. For example, the potential negative outcomes extreme heat has on foetal health in the first weeks of pregnancy (Samuels et al. 2022) and pre-eclampsia (Part et al. 2022) – before many women even recognise that they are pregnant or may consider using a pregnancy app.

Another theme that emerged was the recognition that both language and icons used in the App must be intelligible and interpretable by the women enrolled into the program. This means that the visual images used must be crafted to both appeal to the diversity of women seeking guidance from the App in each setting, but likely also vary across country contexts. These design and selection of these icons are also informed by this qualitative research and co-creation process. These icons will require additional testing once the messages are incorporated into ClimApp-MCH to determine the user friendliness of the presentation

8 Next steps

As outlined above, the three countries involved in this piece of work are at different stages of the research and development process. In Zimbabwe and Sweden, fieldwork and the development of messages is yet to begin, while in South Africa the active Photovoice activities have been completed and analysis and further stages towards message building are underway.

In summary, the next stages in February and March 2024 include:

- Complete recruitment of women, community health workers and fathers to the study (Zimbabwe, Sweden)
- Undertake Photovoice activities (Zimbabwe, Sweden)
- Analyse Photovoice material produced during photography period and workshops with women (Zimbabwe, Sweden, South Africa)
- Conduct FGDs with community health workers or fathers (Zimbabwe, Sweden, South Africa)
- Further participatively generate messages and images (Zimbabwe, Sweden, South Africa)
- Test messages with a selection of women and refine them (Zimbabwe, Sweden, South Africa)
- Submit messages and images to the EWS team for integration into the program (Zimbabwe, Sweden, South Africa).

9 Conclusion

This study focuses on learning about pregnant and post-partum women's experiences with heat and takes an approach that offers them space to not only construct the narratives that make up the data, but also involves them in creating the messages that the EWS will broadcast to women like themselves to better cope with heat for their and their baby's health and well-being.

Preliminary results have indicated that through employing qualitative methods, we can gather valuable insights into various aspects of women's well-being in relation to heat. Triangulation with perspectives from partners, community health workers, and observation should reveal supplementary dimensions. Beyond the development of messaging for the ClimApp-MCH, we see that the data can be analysed to yield potential benefits and outputs, including the following:

Further health and adaptation recommendations, disseminated through other channels: In this HIGH Horizons task, the platforms for the circulation of messages were already prescribed, with the intention of investigating the potential of the ClimApp-MCH. Our findings may indicate that other avenues and platforms are more appropriate for sharing messages.

Methodological advancements: Reflections on the use of Photovoice as employed in this study can inform about how this method can be used to collect data on women's experiences of heat and its contribution to the development of messages. Adaptations made in the different countries, such as including retrospective photographs and the addition of observations through transect walks, give us the opportunity to comment on the agility of the method and how its potential can be maximised given various limitations. These adaptations could be a way of dealing with contextual, climate and timeline challenges in similar studies.

Contribution to guidelines: More ambitiously, combined with literature and further research, the analysis of this data could contribute to local antenatal and postnatal guidelines on how to manage heat exposure during pregnancy and post-partum periods, minimizing potential risks to both the mother and the newborn.

Community awareness and response: Dissemination of these results – particularly if the public advocacy event as part of Photovoice is carried out – could encourage the generation of local initiatives, support groups, or outreach efforts

aimed at providing assistance and resources to women facing challenges related to heat exposure.

Through the application of participatory qualitative methods, this research can yield insights that go beyond individual experiences, potentially influencing public health practices, policies, and support systems to enhance the well-being of pregnant and post-partum women in the context of heat exposure.

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