Heat Indicators of Global Health (HIGH Horizons): Monitoring, Early Warning Systems and health facility interventions for pregnant and postpartum, infants and young children and health workers

Protocol:

HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

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Contents

Acronyms and definitions

Acronym	Definition
ANC	Antenatal care
AT	Apparent Temperature
CHC	Community Health Care
CS	Clinical services
CSV	Comma separated values
ELISA	Enzyme-linked immuno-sorbent assay
EU	European Union
EWS	Early Warning Systems
GAD	General Anxiety Disorder
GDPR	General Data Protection Regulation
HCW	Health care worker
HIV/AIDS	Human immunodeficiency virus/acquired immunodeficiency syndrome
HMIS	Health Management Information Systems
IDI	In-depth interviews
IM	Intervention Mapping
MNCH	Maternal, Neonatal, and Child Health
NCD	Noncommunicable diseases
OCPD	Chronic obstructive pulmonary disease
ODK	Open Data Kit
PCR	Polymerase chain reaction
PHC	Primary Health Care
PHS	Public Health Services
PIS	Participant information sheet
PNC	Postnatal care
POPIA	Protection of Personal Information Act
PSS	Perceived Stress Scale
QoC	Quality of care
SA	South Africa
STAMP	Suggested Time-motion Procedures
TB	Tuberculosis
UK	United Kingdom
WBGT	Wet-bulb globe temperature
WHO	World Health Organization
WOMBAT	Work Observation Method by Activity Timing
WP	Work package

Study synopsis

Rationale: The frequency and intensity of temperature extremes, and heatwaves have increased in the past four decades and are projected to continue rising. Accumulating evidence shows strong links to adverse human health outcomes because of heat exposure. Infants, children, pregnant women, the elderly, and manual and outdoor workers are most vulnerable. Health care workers (HCWs) are also vulnerable to heat because of long working hours and unsatisfactory working conditions in poorly ventilated structures. Existing research on occupational heat exposure focuses on outdoor and manual laborers with limited research in HCWs and limited evidence from Africa. This study forms part of a larger project, the HIGH Horizons project, looking at the impact of climate change, heat specifically, in maternal and neonatal health. The study will enable us to present detailed analyses of how heat influences the health and work activities of maternal and neonatal HCWs; to co-design interventions based on a thorough understanding of the clinical contexts; and to establish a baseline for comparison with endline findings in the evaluation of health facility heat adaptation interventions.

Importantly, the study is designed to address a highly relevant question with great importance to society, and to future research in this area. This study will be conducted across multiple sites in three countries, which will increase international representation and generalisability.

Objectives:

(A) To explore and measure how ambient temperature influences HCWs':
  i) Work performance and productivity
  ii) Perceived wellbeing
  iii) Physical health
  iv) Quality of care

(B) To describe current practices for reducing the impact of heat exposure on work productivity, perceived wellbeing, physical health, and quality of care

(C) To provide empirical evidence for informing the co-design of heat facility-based adaptation interventions and the baseline data for the evaluation of the interventions in South Africa and Zimbabwe

(D) To explore the feasibility and attitudes to interventions commonly used in heat adaptation

(E) To quantify thermal exposures in the selected health care facilities through observation and continuous monitoring of the indoor thermal environment, and through HCW personal wearables

Study design: This study encompasses mixed methods research, including a repeated measures study design, participant observation, in-depth interviews, key informant interviews, and a time motion assessment. The study will be conducted in three countries, South Africa, Sweden, and Zimbabwe. All activities are complemented by monitoring of the thermal environment in participating health facilities.

Methods: The study consists of the following components (sample size for each component):

- Participant observation in the antenatal, labour, postnatal, and neonatal health wards (2-4 weeks per facility)

- In-depth interviews (3-5 HCWs in the smaller facilities and 10-15 HCWs from the larger facilities in the respective countries)
- Key informant interviews (5-15 participants per country)
- A time motion assessment (together with the measurements of heart rate, body temperatures, and number of steps taken) (3 maternity wards in total, 1 in each country – observations performed over a period of 3-5 weeks)
- A self-administered survey by health workers together with biological measures of dehydration, done in the hot season and in the cooler season (160 HCWs overall, 80 in South Africa)
- Secondary analyses of routine facility services and human resource data
- Thermal exposure measurement within facilities

Mixed-method assessments will take place in antenatal, labour, postnatal, and neonatal health clinics/wards. The facilities selected in South Africa, Mamelodi District Hospital and Stanza Bopape Community Health Centre, are found in the Tshwane district. In Zimbabwe, Chitse Clinic, Dotito Clinic and Mt Darwin District Hospital are all in Mt Darwin District in Mashonaland Central province. The site selected in Sweden is Karolinska University Hospital in the northern part of Stockholm.

Population: The study population for the participant observation, in-depth interviews, time-motion assessment, and survey comprises HCWs, aged 18 years and older, currently working in a health care facility. All sexes are eligible. The health care facilities all have dedicated maternal and neonatal health services. The study population for the key informant interviews comprises policymakers, facility managers and other stakeholders who understand potential responses to heat exposure in facilities, and the kinds of interventions that may be feasible.

Ethical considerations: All participating sites will obtain approval from relevant local ethics committees. Prior to each participant's enrolment into the study, informed consent will be obtained in accordance with local and international ethical guidelines. Participation is voluntary and consent may be withdrawn at any time. There are minimal risks associated with participation in this study. The risks are primarily around data protection, which are mitigated through data security measures to ensure confidentiality and data protection. All study data and documents will be regarded as confidential, and the anonymity of participants must be maintained. Participant identification numbers will be used to label study documents and specimens. Researchers will ensure that interruptions to patient care are kept to a minimum. If any abnormal clinical outcomes are uncovered during the study, the participant will be referred for further care.

Dissemination: Outputs from this study will support co-production activities as part of the HIGH Horizons project. We will host co-production workshops with relevant stakeholders to co-design a set of interventions to mitigate the impacts of heat on health in health care facilities in South Africa and Zimbabwe. Data collected in this study will be shared with stakeholders when co-producing interventions. Additionally, study results will be disseminated among study participants, local, provincial and national government officials, advocacy groups, and researchers to support policy changes.

Funding acknowledgments: Research that will be conducted in this study is supported by the European Union (EU) under the Environmental and Health Call, Award number: 101057843 under the Framework Programme for Research and Innovation (2021-2027).

1. Study partners and investigators

1.1 Study partners

Name of institution	Country	Address
Climate and Health Directorate, Wits RHI, University of the Witwatersrand	South Africa	22 Esselen Street, Hillbrow Health Precinct, Hillbrow, Johannesburg, 2001
Centre for Sexual Health & HIV & AIDS Research (CeSHHAR)	Zimbabwe	4 Bath Road, Belgravia, Harare
Denmarks Tekniske Universitet (DTU)	Denmark	Nker Engelundsveji, Bygnin 101A, 2800
Karolinska Institutet	Sweden	Department of Medicine, Solna, 17177, Stockholm
London School of Hygiene & Tropical Medicine Royal Charter (LSHTM)	London	Keppel Street, WC1E 7HT, London

The other collaborating partners in the HIGH Horizons consortium are:

- Ghent University (UGENT) - serves as the overall project coordinator.
- Lunds Universitet (ULUND) - offers unique technologies for early warning systems (EWSs) and critical capacity in coding for tailoring the ClimApp to the target audience and optimizing its functionality.
- World Health Organization (WHO) - provides guidance on indicators and surveillance and ensures the project findings are adequately exploited at the EU and global level.
- University of Graz (UNI GRAZ) - provides support in societal impacts of climate change, social vulnerability, and inequality analysis.
- Aga Khan Health Services (AKHS) Kenya - supports the measurements of the carbon emissions in health facilities with the Aga Khan Development Network's Carbon Management Tool.

1.2 Study investigators

Name of institution	Investigators
Wits RHI, Climate and Health Directorate	Dr Gloria Maimela (Principal Investigator), Mr Craig Parker, Prof Matthew Chersich, Dr Darshnika Pemi Lakhoo, Dr Fiona Scorgie
Centre for Sexual Health & HIV & AIDS Research (CeSHHAR)	Dr Nelson Muparamoto (Principal Investigator) Thabani Muronzie, Prof Stanley Luchters
Karolinska Institutet (KI)	Dr Nathalie Roos (Principal Investigator)
London School of Hygiene & Tropical Medicine (LSHTM)	Prof Veronique Filippi (Principal Investigator), Dr Giorgia Gon, Dr Isabelle Lange (international coordinating team working together with Prof Debra Jackson)
Technical University of Denmark	Prof Jorn Toftum (Principal Investigator)

2. Introduction and study rationale

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. The increase is to such an extent that current average global temperatures are 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 pertinently 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 South 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, low adaptive capacities, poor land use, and existing socio-economic inequalities (Almazroui et al., 2020 Iyakaremye, 2021).

Health care workers (HCWs) are at high risk of adverse outcomes due to heat exposure and are at a higher risk of heat exposure due to poor working environments. Many public health facilities in low and middle-income settings do not have optimal structural features and have poor or no centralised air-cooling or ventilation systems. Secondly, HCWs globally may be involved in work that is exertional in nature, over long working hours, in heavy, and warm personal protective clothing, further increasing their exposure to heat. With heat exposure, physical and emotional coping capacities may become strained, leading to poor work performance, increased rates of absenteeism, and poor job satisfaction. In South Africa, evidence already shows that sub-optimal working conditions are some of the key reasons HCWs are dissatisfied with their jobs (Payne et al., 2020). Additionally, repeated exposure to extreme indoor heat is likely to lead to heat-related illness and possibly hospitalization for those who are physiologically vulnerable (such as those with chronic conditions) which may in turn further strain the health care system. HCWs in labour wards and neonatal care units are required to be quick in their response and reactions under strict guidelines (in cases of obstetrical and neonatal emergencies) otherwise the health of patients may be compromised. An added burden of extreme heat exposure to already strained HCWs – facing long working hours, occupational burnout, stressful social and environmental conditions among other issues (Myers et al., 2011; Turek-Hankins et al., 2021) - is a huge concern.

Existing research on occupational heat exposure focuses only on outdoor and manual laborers such as agricultural and factory workers, because of exposure to direct heat and a dress code that may impair heat regulation (Flouris et al 2018). Current evidence concerning other occupations and heat exposure includes a systematic review conducted on 111 studies, which shows that 35% of individuals working under environmental heat stress conditions experienced heat strain (i.e., physiological consequences, such as core body temperature >38°C, ≥1 occupational heat strain symptom, such as serum creatinine concentration of >1,2 mg/dL, heat-associated self-reported nausea or vomiting) and 30% experienced reduced productivity (defined as loss of labour time, performance, or absence from work due to

occupational heat strain). However, no study included, focused on heat stress conditions among HCWs globally (Flouris et al 2018).

Climate change and heat impact policies in South Africa, Zimbabwe and Sweden are impeded by major gaps in surveillance and observational research, including for essential occupations such as HCWs.

2.1 Description of the overarching HIGH Horizons project

The work outlined in this protocol is part of a larger project looking at the impact of heat and climate change in maternal and newborn health. The HIGH Horizons project (Figure 1), over four years, involves six partners in Europe, three in Africa and one international organisation (WHO) and centres on pregnant and postpartum women, infants, and health workers, groups heavily affected by climate change (https://www.high-horizons.eu/). It is funded by the European Union under the Environmental and Health Call.

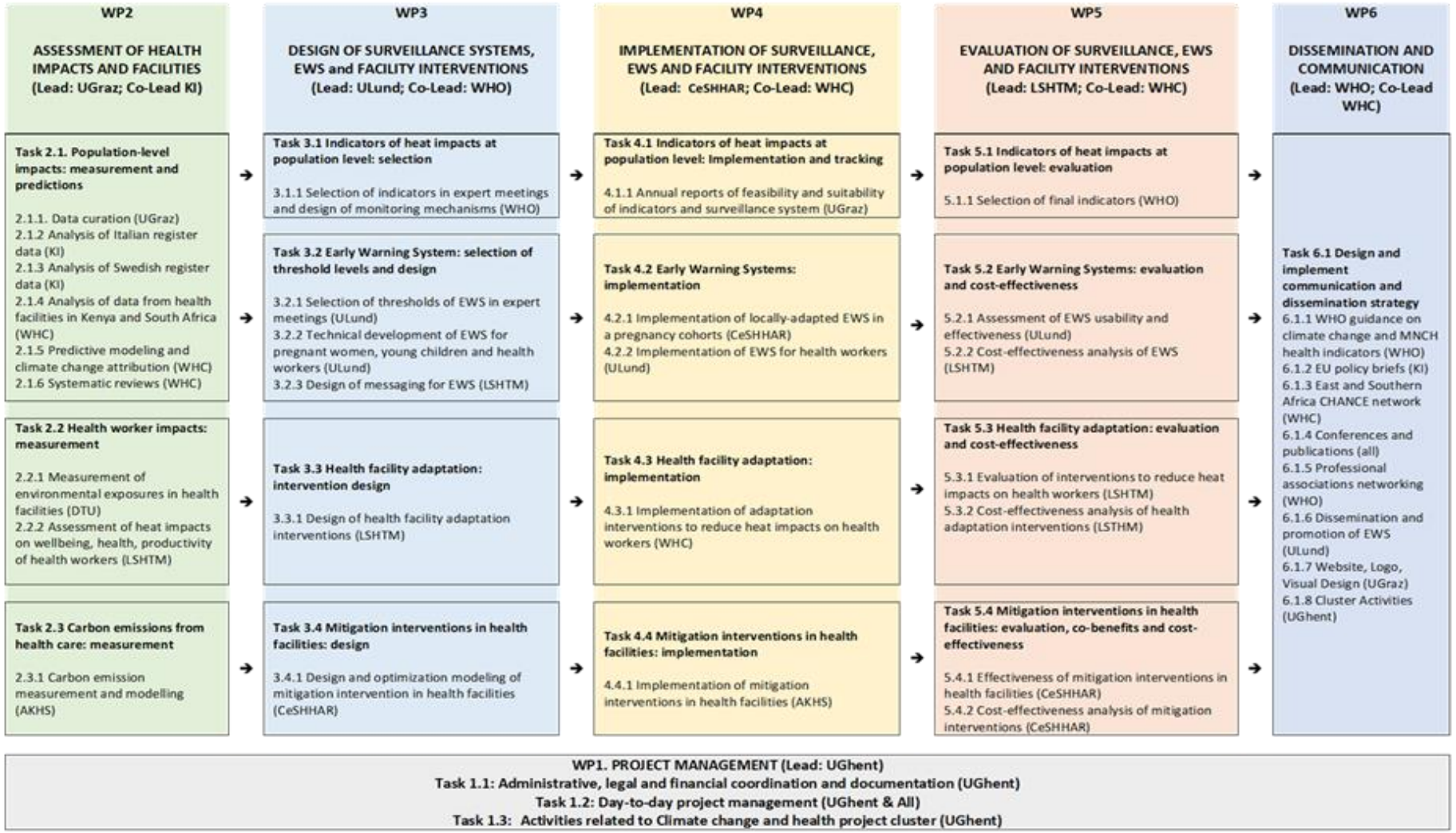


Figure 1. Outline of the HIGH Horizons project organised according to work packages.

The broader HIGH Horizons project has six main components organised as work packages (WPs), each with specific tasks. The WPs/tasks serve to achieve four project objectives:

1. Identify and select suitable indicators for quantifying and monitoring global, EU, and national-level health impacts of extreme heat.
2. Develop and test an Early Warning Systems (EWS) using a smartphone app to provide individualized and locally adapted heat stress warnings.
3. Identify cost-effective, integrated adaptation-mitigation interventions to alleviate heat impacts on HCWs, and to reduce carbon emissions associated with health care.
4. Support global and EU climate policies and activities on the monitoring of direct and indirect impacts of climate change on health, and the strengthening of Early Warning Systems through guidance documents, and risk assessment and cost-benefit analysis.

2.2 Contribution of this sub-study to HIGH Horizons

This study protocol falls within WP2 of High Horizons (assessment of health impacts and facilities), task 2.2 (health worker impacts: measurement). Measurement of environmental exposures in facilities and assessment of heat impacts on health workers will inform WPs 3, 4 and 5 - to develop adaptation interventions in healthcare facilities. Hence, our study will focus on documenting how working in heat stress conditions in demanding maternal and neonatal services affect the productivity, quality of care, and wellbeing of HCWs. In addition, the study explores potential interventions that might be implemented to counter the impacts of heat. Here, we aim specifically to understand:

i) What is currently being done to reduce heat impacts? How effective are these measures and what barriers do they face?

ii) What interventions do HCWs suggest might be done?

iii) What are the perspectives of HCWs towards commonly used heat adaptation measures?

Overall, the study will enable us: to present detailed analyses of how heat influences the health and work activities of HCWs working in maternal and neonatal services; to co-design interventions based on a thorough understanding of the clinical contexts; and to establish a baseline for comparison with endline findings in the evaluation of health facility interventions.

3. Overall research objectives

The objectives for the multi-country (in South Africa, Sweden and Zimbabwe) study are:

(A) To explore and measure how ambient heat influences HCWs':
   i. Work performance and productivity
   ii. Perceived wellbeing
   iii. Physical health
   iv. Quality of care

(B) To describe current practices for reducing the impact of heat exposure on work productivity, perceived wellbeing, physical health, and quality of care

(C) To provide empirical evidence for informing the co-design of climate change facility adaptation interventions and the baseline data for the evaluation of the interventions in South Africa and Zimbabwe

(D) To explore the feasibility of and attitudes towards interventions commonly used in heat adaptation

(E) To quantify thermal exposures in the selected healthcare facilities through observation and continuous monitoring of the indoor thermal environment, and through HCW personal wearables

4. Methodology

4.1 Overall study design

This study consists of mixed methods research, including a repeated measures longitudinal study design, participant observation, in-depth interviews, key informant interviews and a time and motion study. The study will be conducted in three countries, South Africa, Sweden, and Zimbabwe. All activities are complemented by monitoring of the thermal environment in participating health facilities. In South Africa and Zimbabwe, the mixed-method study will also inform the subsequent development of a facility-based heat adaptation intervention. Some measures applied in this assessment constitute the baseline for the 'post' evaluation of an intervention study. We will compare the baseline measures with those in the endline survey. The protocol for the endline survey will be submitted in a separate ethics submission.

The study consists of the following components:

- Participant observation
- In-depth interviews with HCWs in the selected facilities
- Key informant interviews
- A time and motion assessment (together with the measurements of heart rate, body temperatures, and number of steps taken)
- A self-administered survey by HCWs (together with biological measures of dehydration), done in the hot season and again in the cooler season
- Secondary analyses of routine facility services and human resource data
- Thermal exposure measurement within facilities

The timing of each of the components is not dependent on the completion of other components. Tools for these assessments have been designed to have a standard format and content that allows for cross-country comparison of key data elements. However, some modifications have been made to the tools to include setting-specific elements where relevant. Once all data are collected, triangulation will be done across the component, and findings from analyses will be collated into a report disseminated among local stakeholders who will be involved in selecting the final adaptation and mitigation package.

We will compare the findings of each component between the different sites, to identify important differences and similarities. At a higher level, the overall conclusions drawn in each site from analysis of all the different components will be compared across sites. While some components provide unique information (e.g. thermal measurements), several interrogate the same topic, but with using different research methods. For example, assessing heat symptoms in structured interviews, and

then in in-depth interviews. Together these data provide a richer understanding of the data and allow one to explore particularly important findings in more detail.

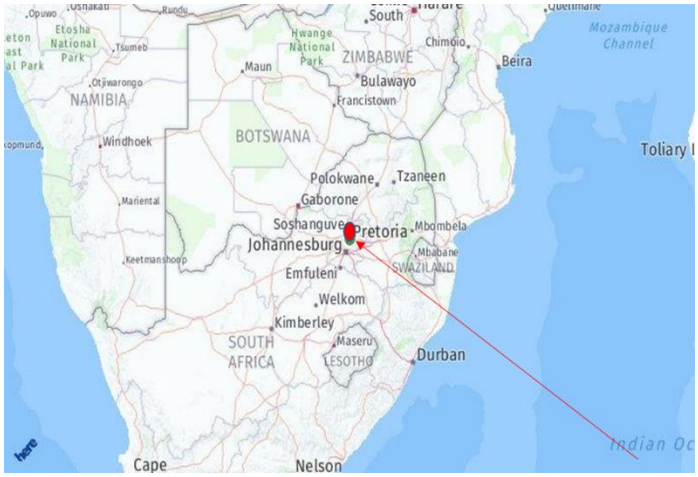
4.2 Research setting

Study sites

Mixed-method assessments will take place in antenatal, postnatal, and neonatal health care facilities. The study will take place in one hospital in Sweden, two facilities in South Africa and three in Zimbabwe (Table 1).

South Africa:

In South Africa, the catchment areas of the two facilities are situated in Region 6 in the Tshwane district; Gauteng Province (see Fig.1 below), Regions 6 covers an area of approximately 333 km^2.



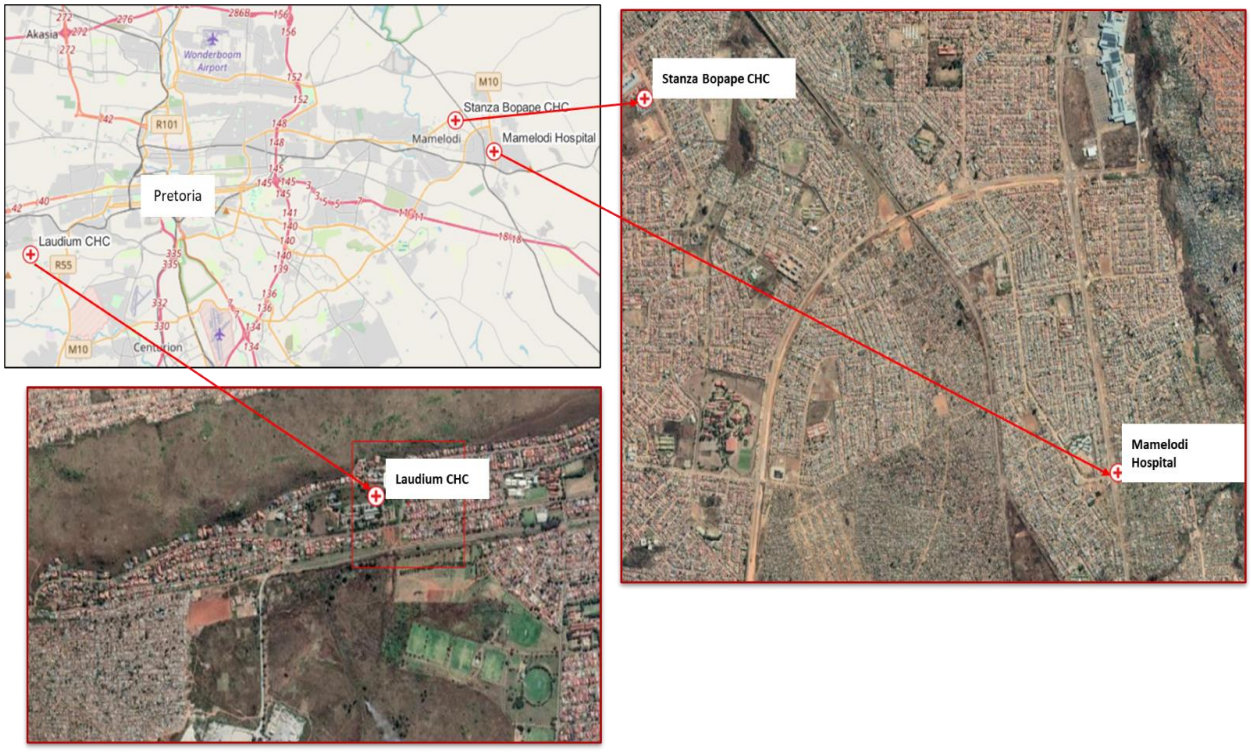


Figure 1. Location of the hospital and CHCs in South Africa.

Mamelodi District Hospital and Stanza Bopape Community Health Centre:

Mamelodi District Hospital and Stanza Bopape Community Health Centre (CHC) are in region 6 East of Pretoria. Stanza Bopape CHC is a primary health care facility and serves a population of 261 989. Mamelodi Regional Hospital is situated at 3.5 km from Stanza Bopape CHC and is a referral centre for patients requiring a higher level of care including pregnant women with obstetric emergencies from Stanza Bopape CHC and other surrounding feeder clinics. The hospital has a catchment population of 334 577 and offers the following services: clinical specialties in fields of Medicine, Surgery, Obstetrics and Gynaecology, Paediatrics, Psychiatry, Radiology, Emergency Medical Services, Trauma, non-communicable diseases (NCDs), and clinical management of HIV/AIDS, and TB (including preventative therapy), screening and laboratory (e.g., cervical screening and colposcopy services, HIV testing (ELISA and PCR) and TB (including drug-resistant TB)).
The hottest months of the year are in the region selected for the study are usually December, January and February, and the highest, minimum, and mean temperatures are: 30 °C, 17 °C, and 23 °C, respectively. Whereas the coldest months of the year are usually June/July, and the highest, minimum, and mean temperatures are 20/21°C, 5°C, and 13°C, respectively.

Zimbabwe:

The study will take place at three public health care facilities which are within Mashonaland Central Province, Mt Darwin District. Mt Darwin District has a total area of 459 219 Hectares. The three sites are Mt Darwin District Hospital (urban), and Chitse and Dotito Rural Health Care Clinics. Mt Darwin is approximately 155 kilometres from the capital city Harare in the north-eastern direction. It borders Shamva district to the South, Mozambique to the North, Muzarabani to the West and Rushinga to the East. According to the latest census 2022 report by Zimbabwe National Statistics Agency, Mt Darwin District had a population of 240 727 with 122 706 females and 118 021 males (Population & Housing Census 2022). The district has 40 wards and people living in this area mainly survive with communal and subsistence farming and a bit of artisanal gold mining. The average temperature in the district is 24°C in summer and 14°C in winter. The hottest months in the year are usually October, November and December while the coldest months are June and July.

Mt Darwin District Hospital, Chitse Rural Health Care Clinic, Dotito Rural Health Care Clinic

Mt Darwin District hospital is a primary care and a referral facility for the district. A range of services are offered which include curative, preventative, maternity, postnatal, inpatient, outpatient, male and female ward, theatre, laboratory and pharmacy. Chitse Rural Health Care Clinic is situated 18 km from Mt Darwin Hospital. Services offered include curative, maternity related services, postnatal care, outpatient, and inpatient related services. Dotito Rural Health Care Clinic is the oldest facility in the district. It is a primary care clinic situated 28 kilometres from Mt Darwin District Hospital. The clinic is managed by a nurse in charge who oversees all departments. Services offered include curative (chronic condition screening, treatment, monitoring and follow-up, TB screening, initiation, and management), maternity-related services (antenatal care, booking follow-up visits, delivery, postnatal care), visual inspection with acetic acid and cervicography for cancer, and lastly outpatient and inpatient related services.

Sweden - Karolinska University Hospital:

The site selected in Sweden is Karolinska University Hospital in the northern part of Stockholm (Solna) and is a national referral centre for high-risk pregnancies and deliveries as well as regional referral centre for specialised high-risk pregnancies and deliveries.

The Karolinska University Hospital has 3700 births per year, the majority are high risk pregnancies. This is to be compared with a high volume and low risk delivery ward in a large hospital serving the south of Stockholm with 7600 births per year.

The climate in Sweden includes the four seasons, where winters are 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.

Table 1: Description of facilities

Name of proposed facility sites	Facility level	Number of women attending ANC (first visit) per month (average)	Number of deliveries per month (average)	Number of HCWs employed in antenatal care and delivery units (auxiliary midwives, nurses, midwives, doctors)
South Africa				
Stanza Bopape CHC	Primary health care facility	250	74	82 (77 Professional Nurses, 5 Doctors)
Mamelodi hospital	District hospital	(High risk cases from PHC)	780	108 (101 Professional Nurses,7 Doctors)
Zimbabwe				
Mount Darwin District Hospital	District hospital (Primary care and referral for district)	205	164-180	12 midwives, 2 doctors, 14 nurses and 6 nurse aides
Dotito rural health care centre	Primary health care facility	28	25-30	5 nurses and 1 midwife whole clinic, no doctor.
Chitse rural health care centre	Primary health care facility	30	18-20	5 nurses and 1 midwife, no doctor whole clinic.
Sweden				
	Tertiary level	N/A (high risk pregnancies receiving basic ANC in a primary health care centre)	308	Auxiliary nurses, Midwives, obstetricians. Exact numbers to be confirmed (approx. 12-16 Ob/Gyn, 25 midwives and 20 auxiliary nurses)

4.3 Study population

The study population for the participant observation, in-depth interviews, time-motion study, and health worker survey comprises HCWs, aged 18 years and older, working in a health care facility in one of the study sites in South Africa, Zimbabwe or Sweden. All sexes are eligible. The health care facilities all have dedicated maternal and neonatal health services.

The following groups of HCWs will be eligible for enrolment:

- Nurse of any grade, including professional nurse, auxiliary nurse, and neonatal nurse
- Midwife
- Obstetrician /Gynaecologist
- Paediatrician/Neonatologist

- Other type of doctor (e.g., intern, medical officer)
- Allied health worker such as physiotherapist
- Clinical associate
- Other staff working in the ward, including cleaning staff, community health care workers, phlebotomist and porter

The specific study populations will differ across the study components.

Key Informant Interviews will be conducted among policymakers, facility managers and other stakeholders who understand potential responses to heat exposure in the facilities, and the kinds of interventions that may be feasible.

5. Study components

5.1 Participant observation

Ethnographic participant observation will be carried out in the antenatal, labour, postnatal, and neonatal wards of the selected facilities, over a period of 2-4 weeks.

5.1.1 Objective

The objective of these observations is two-fold: (1) to understand how heat and other thermal climate factors can affect HCWs' wellbeing, physical health, and productivity in the workplace (aligns with study objective A), and (2) to document existing practices in the facilities to reduce the negative effects of heat (aligns with study objective B).

5.1.2 Sampling

There is no 'sampling' in this method *per se*, but rather a field of observation, which is wide and encompasses all HCWs who deliver care, patients, visitors, and other facility staff who are present in this field (i.e., in the above-mentioned wards) or pass through it during the observation periods. However, **the main focus of the participant observation will be the HCWs**. Patients, visitors, and other facility staff will not be specifically observed; only when they interact with the HCWs being observed will their behaviour be recorded by the researcher in their notes.

5.1.3 Data collection

A trained research nurse or a qualitative social science researcher with experience in clinical settings will conduct participant observation (which includes informal conversations) at the health facility, paying attention to the work and structural environment and to people's activity in the relevant clinics or wards. Particular attention will be paid to the organisation of care in the wards; interpersonal dynamics (both amongst staff and between HCWs and patients); interaction with the built environment (points of refuge, relief, and discomfort); signs of stress; and work practices, including quality of care and respectful care. Through observations and informal conversations with staff, the researcher will also capture how health workers are reacting and responding to heat, and the coping strategies they have developed.

Observations will be undertaken for 2-4 weeks per facility, at varying shifts throughout the day and night. Wherever possible, observations will be timed to coincide with days with high temperatures, and with the warmest times of the day. An observation guide (Appendix 1) will provide structure on which aspects to observe, based on the two study objectives (A and B) that this component addresses. Based on this guidance, a journal will be kept by the observer in a format decided within

the team (written and/or audio), with the notes transcribed and fleshed out to generate 'thick descriptions', as soon as possible after each observation and typed up for analysis. Information and insights from this component will feed into the development of the topic guide for the IDIs.

At times the researcher may pose questions or engage in informal conversations with HCWs, but only at the convenience of the HCW and without interfering with the care being provided to women. HCWs will be reassured that our observations will be anonymised, are not intended to document poor practice or clinical 'errors' and will not be shared with their supervisors. Prior to the commencement of observations, the research team will meet with facility managers to explain the observation process and to reassure them that the functioning of their facility will not be unduly impacted by this research.

5.1.4 Data analysis

Using qualitative data analysis software (e.g., NVivo), transcribed fieldnotes will be open-coded by members of the research team, following a Grounded Theory approach (Glaser and Strauss, 1967). Development of analytical codes will be an iterative process and will involve constant reflections and discussions within the research team until a full codebook has been developed. The codes will be developed inductively but also aligned with the central research questions. A portion of the dataset will be independently double-coded to check reliability of code allocation. Codes will then be clustered together and grouped under broader categories, from which key themes will be identified and written up in a report. This report will be read and discussed by the research team, and its contents used to inform the final topic guide for the in-depth interviews.

5.2 In-depth interviews (IDIs)

5.2.1 Objectives

The IDIs in this study are designed to align with study objectives A, B, and C. Specifically, the objectives of the IDIs are: to gain an understanding of how heat affects HCWs' work performance, quality of care, health, and wellbeing; to document HCWs' coping mechanisms and heat adaptation behaviour; and to collect descriptive data that will inform the co-design of heat adaptation interventions that are appropriate for health facility settings. Semi-structured, in-depth interviews allow the interviewer to develop a strong rapport with participants and encourage richer and more detailed responses to questions.

5.2.2 Sampling

Participants will be purposively sampled from HCWs in maternal and newborn care and will include a mix of genders, ages, and roles (midwife, obstetrician, etc.). Throughout participant enrolment, stratification of the sample according to these criteria will be monitored to ensure an even spread across genders, ages, etc. In South Africa and Zimbabwe, approximately 10-15 HCW staff in each of the larger facilities and 3-5 in the smaller facilities will be recruited for in-depth interviews, while in Sweden, 10-15 health worker staff at the hospital will be recruited. The study team will request assistance from facility managers to identify eligible staff and will then meet with these staff members to explain the study and request their participation.

5.2.3 Data collection

In-depth interviews will be conducted with enrolled HCWs using a semi-structured interview topic guide in English. Participants may be encouraged to use local languages such as isiZulu, Sesotho or Shona if that allows more free and comfortable expression. A provisional interview topic guide has been developed, based on the relevant study objectives (Appendix 2), and may be further amended

to incorporate insights from the participant observations. The finalised topic guide to be submitted to Wits HREC as an amendment.

Interviews will last approximately 1 hour. Written informed consent will be obtained from participants, and all IDIs will be recorded with a handheld digital device. The recordings will be immediately uploaded to an encrypted online repository on SharePoint that is only accessible to members of the research team. Interviewers will also be required to write extensive field notes that will be used as part of the data analysis process.

Findings from other data collection methods (time-motion assessment, survey) will be applied and probed during the IDIs, thereby allowing for triangulation of the data.

Anonymity: All participants will be assured that their information will be held confidentially, with access restricted to within the research team undertaking fieldwork and analysis. All identifying features of their interview will be masked or removed.

5.2.4 Data analysis

Interview recordings will be transcribed verbatim for analysis. Quality checks on the transcriptions will be carried out by the research team, where a sample of transcripts will be spot-checked against the audio to ensure fidelity of transcription. If a substantial portion (i.e. more than 30%) of a transcript has been translated into English, this translation will be checked through back-translation into the original language and then reviewed by a native speaker of this language. Analysis of transcripts will be an ongoing process during data collection, to ensure that early findings and insights can be used to inform the later interviews.

Qualitative data analysis software (e.g. NVivo) will be used to manage and code the data. A thematic approach to analysis will be taken, based on methods described by Braun & Clarke (2006). Researchers will develop a coding tree that will be based on core research questions and include themes that emerged throughout fieldwork, from reading the literature, and from discussions with the wider team involved in this sub-study and related work packages. Coding trees can be adapted to country contexts and reflect issues related to each setting or to the interests of researchers. Researchers will conduct a thematic analysis and produce an analysis report, and the overall qualitative findings will be applied and combined with the results from other study components to inform the development of heat adaptation interventions specific to each setting.

5.3 Key informant interviews

Key informant interviews will be held with health facility, district, and regional managers to gain contextual information central to the development of strategies and interventions to cope with high heat in each setting. Additionally, we may interview a small number of other individuals in the community and in other posts of expertise/authority identified through fieldwork as being sources of information on extreme heat adaptation strategies, HCW wellbeing, and quality of care. The interviews will focus on what is known about the impact of heat on the community and the health facility, and heat adaptations that are being undertaken in other institutions or with the community.

5.3.1 Objectives

The objectives of these interviews are to learn about key informants' perspectives on the impact and gravity of heat exposure and climate change in each setting and their opinions on the feasibility and acceptability of extreme heat adaptation strategies. Interviews will gather data on practices in the community or in other institutions that are employed for adaptation to hot temperatures –

information that may have implications for the design of appropriate adaptation interventions (aligned with study objective D). Findings from these interviews are intended to inform the development of the intervention in later stages of the project.

5.3.2 Sampling

Health facility management, policymakers as well as others in the health system who oversee or are involved with managing facility or district health operations, or those who have experience working in climate change adaptations or who have information about heat adaptations, and who agree to be interviewed, are eligible for enrolment. During interviews and participant observation at the facilities, the researcher may become aware of additional individuals in the community with heat adaptation experience. In this case, the researcher may contact these individuals and invite them for an interview. We anticipate that 5-15 participants will be enrolled per country. We will sample purposively to ensure enrolment of a range of different types of participants with diversity of expertise.

5.3.3 Data collection

Interviews will be conducted in a language and in a private setting convenient for the key informant (Appendix 3). The participant will receive an information sheet, be offered the opportunity to ask questions about the study, and their written informed consent will be obtained prior to the start of the interview. We anticipate that interviews will last between 45-60 minutes. As with the IDIs, the interview will be digitally recorded, with the participant's consent. Written notes will also be taken by the interviewer. The recordings will be immediately uploaded to an encrypted online repository on SharePoint that is only accessible to members of the research team. We will follow Standard Operating Procedures for data security, especially during storage and transmission of data.

Anonymity: All key informants will be assured that their information will be held confidentially within the research team undertaking fieldwork and analysis. Parts of their interview that may identify them will be masked or removed.

5.3.4 Analysis

Interview recordings will be transcribed verbatim (and translated into English, where relevant) for analysis. Quality checks on the transcriptions will be carried out by the research team, where a sample of transcripts will be spot-checked against the audio to ensure fidelity of transcription. Where a substantial portion (i.e. more than 30%) of a transcript has been translated into English, this translation will be checked through back-translation into the original language and then reviewed by a native speaker of this language. Interview transcripts will be analysed using the same methods described above for the in-depth interviews.

A process of synthesising the findings and insights from all three qualitative methods will be undertaken at their conclusion, to draw connections between common themes in the different datasets and identify key areas and findings for taking forward in the co-design of the intervention.

5.4 Time-motion assessment

5.4.1 Objectives of study component

1. To capture quality of care using instruments such as the safe birth checklist, as a means of documenting the impacts of heat on quality of care
2. To create ‘’workflow time charts’’ through observing and recording the sequence of activities carried out by HCWs in labour wards, as a means of documenting how heat exposure may influence workflow

5.4.2 Rationale for selecting time-motion methodology

Time-motion methodology is well suited to direct observation activities conducted over time to capture workflow, interactions and disruptions in health care facilities with the aim of understanding whether these affect efficiency and quality of care provided by heath care workers (Lopetgui et al., 2014; Tanzini et al, 2021). The use of time-motion studies is novel in investigating HCWs and heat exposure and will complement more classic ethnographic methods we employ in health facilities such as participant observation, informal discussions and interviews. Close observations provide an opportunity to capture the significance of such aspects as lethargy and patient interactions that may otherwise be overlooked.

5.4.3 Location and sampling

The study will be conducted in maternity wards within high-volume hospitals. We will conduct the study in three hospitals with approximately 800-1000 deliveries per year each (1 in Zimbabwe, 1 in SA and 1 in Sweden). A list of all eligible nurses will be accessed from department heads or relevant authorities, and recruitment activities will be conducted in labour wards (e.g., High Horizon study nurse requests to join staff meetings and present the HCW study or approach the nurses one person per time). A list of all potentially eligible nurses will be drawn up and participants randomly selected using computer generated random number sequence and enrolled into the observation study following informed consent procedures.

5.4.4 Study procedures

All the study procedures will follow Suggested Time-motion Procedures (STAMP) (Zheng et al., 2011). Here the study will comprise two main components. Firstly, we will capture/assess medical supply/instrument availability by using a survey adapted from the WHO Safe Birth Checklist (WHO SCC). The objective of this component is to check the availability and functionality of essential birth supplies in designated rooms or areas (e.g., duty rooms, labour or delivery room and the neonatal ward), and that data will be used to understand dimensions and barriers to quality of care (QoC). The data will also be used to determine whether those reflect international guidelines and signal functions for caring for mother and the newborn, and for providing comprehensive obstetric care (WHO, 2015b).

In the second component, we will use the Work Observation Method by Activity Timing (WOMBAT; Westbrook & Ampt, 2009) tool (see Fig. 2) a computerised tool to collect multiple dimensions of clinical work patterns (who, what, when and why) as well as comprehensive contextual information (patients and colleagues) and interrupted tasks. The time taken for each of the dimensions and completeness of the task is recorded on the tool. WOMBAT covers six broad work task categories, and each task is designed to cover (i) activity being undertaken (ii) other people involved in the task (iii) the method of task performance. The tool also allows researchers to add more detail to work task categories. These are also called workflow charts. When a birth attendant performs an action, the observer will record the action using a tablet. We will use continuous observation because the timing of procedures, particularly delivery itself, is typically unpredictable. If there is a case where an action has multiple dimensions that need to be recorded, the software will automatically timestamp the interval of each task together with any other additional selection. The tool allows interruptions (i.e., response to external stimuli) and multitasking (i.e., one or more tasks performed simultaneously) to be recorded with timestamps. We will aim to perform observations over a period of 3-5 weeks for each period (cool vs hot) and at different times of the day to be able to capture patterns across the shift. The number of hours of observations are based on the volume of deliveries

during the observation period. This process will be implemented on days with forecasted high temperatures and cooler days. The data will be captured by an observer using a tablet.

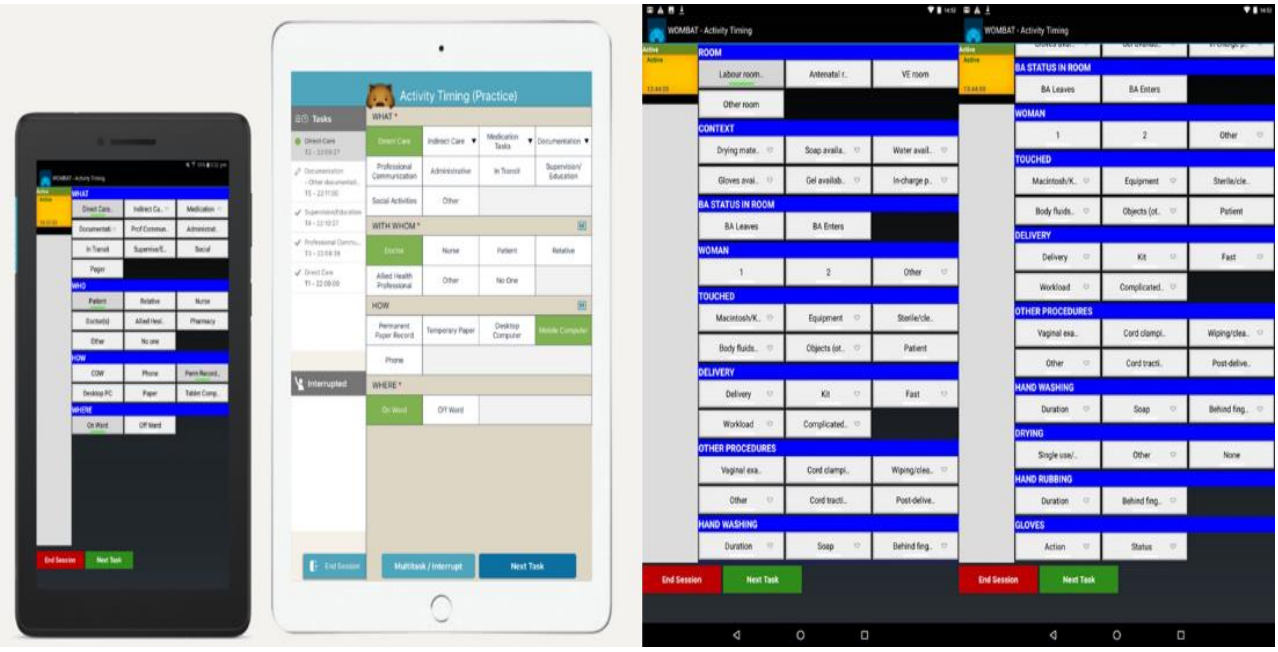


Figure 2. WOMBAT time-motion data collection tool

5.4.5 Data collection

A nurse or junior social science researcher will conduct the time-motion methods with supervision from an experienced social scientist. Wearable sensors will be used by HCWs to assess steps taken during a shift, heart rate and heart rate variability. Health workers will be able to view their heart rate and other results of their sensors. This may alter behaviours, introducing bias. Health workers will be given the devices prior to the study so that they become accustomed to them, and likely the biases will not be influenced by temperature. We will also measure the core temperatures of health workers (see details in the Assessment of thermal exposures section).

These observation-based methods are flexible, which is needed in the context of childbirth, for example, where there is a large amount of uncertainty (volume of clients, transition from one to two patients – mother and baby – and unpredictable complications) (Gon et al, 2020).

5.4.6 Data analyses

We will compare the completion of the different components of care that are observed to the recorded temperatures.

Data management and analyses will be conducted in STATA or R. Time expressed in each time category will be expressed as a proportion of total observation time. Descriptive analyses will be used to describe the outcomes, contextual variables, and potential confounders for the relationship of the study outcomes with temperature. Observational data collected by study staff will be linked with information on the number of steps performed by health workers, to investigate if there are any differences in workflow efficiency based on temperature exposures. We will determine whether

there is a reduction in steps at higher temperatures. We will compare all of the study data taken during the hot period with data during the cooler period. The changes in heart rate and other data collected from the sensors will also be compared across periods and used to evaluate potential causal pathways, where, for example, a reduction in activity with temperature is accompanied by an increased heart rate. We will use chi-square tests for comparing categorical data and Student's t-tests for continuous data that has a normal distribution, and Wilcoxon Rank Sum for continuous data that has a non-normal distribution.

5.5 Survey of health care workers

An electronic survey will be administered through a tablet among HCWs across the three countries (Appendix 4). It will consist of two phases, one in the hot season (November – January in SA) and one in the cooler season (June - August in SA). The survey in the hot season will be timed, where possible, to take place when the temperature is above the 25°C threshold. In total, 160 HCWs will be invited to participate twice in the survey, of which 80 will be from South Africa. We will enrol the same participants in the first and second surveys where possible. If we are unable to interview the same participant in the second round, we will recruit additional health workers to reach our target number (n=160).

5.5.1 Objectives of the survey

1. To obtain data on HCW characteristics, especially on their perceived health status and mental health

2. To document the impact of heat exposure on health worker wellbeing and work performance (study objective A)

3. To understand the perspectives of health workers towards interventions currently used to reduce heat exposure in the workplace, and views on what additional interventions might be implemented (study objectives B and D)

5.5.2 Study population

All HCWs and other staff working in the antenatal clinics, obstetric units, including labour wards, or neonatal wards or clinics. The study population consists of the following HCW cadres:

- Nurse of any grade, including professional nurse, auxiliary nurse and neonatal nurses
- Obstetrician /Gynaecologist
- Paediatrician/Neonatologist
- Other types of doctors (e.g., intern, medical officer)
- Clinical associate
- Allied health workers such as physiotherapists
- Other staff working in the ward, including community health care worker, phlebotomist, cleaning staff and porters

Inclusion criteria

Participants will be enrolled in this study only if they meet ALL the following criteria:

1. be aged ≥ 18 years
2. Be working in antenatal, labour ward or neonatal ward during the period of the study
3. willing to provide consent to participate in the study

Participants who have participated in any of the other study components will not be excluded from this component.

5.5.3 Sample size

In each of the two phases of the study, we aim to enrol 160 participants (estimated 80 participants in South Africa, 40 in Zimbabwe, and 40 in Sweden), with the number varying depending on willingness of staff to be interviewed. The sample size was determined by the maximum health workers available in the setting and resource constraints, rather than calculated based on an anticipated outcome measure.

5.5.4 Study measures

The survey will measure the HCW's wellbeing (WHO Well-being Index for Health Workers tool[1]), psychological status (Cohen's perceived stress scale (Cohen, 1986; PSS-4), and General Anxiety Disorder (GAD-7), perceived heat stress and thermal comfort, and how the health workers perceive their health status and working conditions.

Wellbeing stress and anxiety tools mentioned above have been used and/or validated in several languages and countries and for a range of sub-populations. The tools and versions we will use are:

A) The WHO Well-being Index for Health Workers provides a measure of self-reported mental health status. It includes the same five questions as the WHO-5[2], which is available in 30 languages (Topp et al, 2015).
B) Psychological status (perceived stress scale) includes questions on general feelings and thoughts of stress over the past month, with 5 categories of responses: ("never" to "very often"). We will use the PSS-4 version (Vallejo et al, 2018).
C) GAD-7's introductory question is "Over the last 2 weeks, how often have you been bothered by the following problems?". As its name indicates it has 7 questions, each with 4 possible response categories ("not at all" to "nearly everyday") (Swinson, 2006; Spitzer, Kroenke & Williams, 2006). The choice of the exact cut-off-point for establishing anxiety will depend on context (Plummer et al, 2016). The validity of GAD-7 has been assessed in South Africa (Kigoli, 2019), and will be used in this study.

Many survey questions for perceived heat stress and thermal comfort have been adapted from occupational health tools used in Hothaps (Kjellstrom, 2014) and HeatShield (Messeri, 2019) projects across different settings as well as from the Heat Strain Score index (Dehghan, 2013).

5.5.5 Study procedures

Recruitment

In South Africa, sampling of HCWs will be random, where a list of all potentially eligible health workers will be obtained from facility managers or similar, and a random selection invited to participate in the study. In Zimbabwe and Sweden, all the eligible HCW in the facilities will be invited to participate.

Enrolment procedures

[1] https://www.measureevaluation.org/rbf/indicator-collections/structural-indicators/who-well-being-index-for-health-workers.html
[2] WHO-5 questionaire - English (psykiatri-regionh.dk)

Participants that have been selected will be provided with information regarding the nature of the study, study activities, the risks and benefits of participation and the approximate time it will take to complete the survey. All this information will be presented verbally during meetings with staff. All potentially eligible staff will be provided a participant information sheet (PIS). This information will clearly state that participants may withdraw from the study at any stage without any prejudice and with no obligation to give a reason. Participants will be given an opportunity to ask questions. If HCWs are interested in participating, they will sign an informed consent form prior to partaking in any study procedures. For this study, consent will be obtained in wet ink after the participant has confirmed that they have read the PIS. The informed consent procedures will be conducted by a research staff member that is trained in study procedures and has expertise in research ethics. Enrolment will be complete once the target sample size is reached.

Assignment of study identification number

Once a participant is enrolled into the study, an alphanumeric (country code, followed by facility code, followed individual number ranging from 1-200) participant identification number will be randomly generated and used to key code the participants into the data storage. This participant identification number is pseudonymised and will be unique to the participant. Participants details will be stored separately from the other study documents, with the key to linking participant identification numbers and personal identifying information stored securely by a data manager or other appropriate research staff member.

Survey procedures

The HCWs will be invited to complete a self-administered survey questionnaire on a tablet or a smartphone (using a common open-source mobile data collection platform such as ODK). The questionnaire will be in English. Data will be collected at entry to the study during the cooler time of the year, and then repeated during hotter season . Where possible, we will time the interviews with days that have high forecasted temperatures. HCWs will be invited to complete their questionnaires wherever possible at the end of a day shift.

Additionally, the participants weight and height will be measured by a research staff member using standardised techniques and instruments.

Urine specimens will be collected on the same day as the interview, at the end of the shift. The urine specific gravity, a commonly used biomedical marker for hydration status, will be measured using handheld optical refractometer on site, by a suitably trained research staff member. The device we will use is the Per Scientific portable clinical Refractometer 300005. We will also test urine osmolarity. Urine specimens will be discarded after testing, strictly adhering to waste procedures at the site.

If a participant chose to withdraw, a case of withdrawal will be documented. The data that has already been collected will not be deleted, unless requested so by the participant. Withdrawal or deletion of data may be required at the discretion of study staff in case of incorrect enrolment, such as in the case of a failure to meet inclusion/exclusion criteria. Any protocol violations will be reported to the ethics committee.

Data sources

There are three sources of primary data for this study component. The first source is the data obtained from participants that self-complete the survey. This will include a wet ink signed informed consent form. The second data source is the urine test results, and the third source is weight and height results. These data will be linked to the same study participant using anonymised participant ID numbers.

5.5.6 Data analyses

1. **General considerations**

   Analysis will be done using STATA or R.

2. **Analysis population**

The total pooled population from all three sites (South Africa, Zimbabwe and Sweden) will form the primary population for analysis, though exploratory site-specific analyses will also be done.

3. **Descriptive analyses**

   Prior to the data being analysed for addressing the study objectives, the study population and data will be described to understand the main characteristics. We will, for example describe age and type of HCW in a table, by study site. We will also tabulate participant characteristics in the first and second phase of the study should there be some replacement of participants in the second round. Temperature and other environmental exposures will also be summed and presented in a table, by site and survey round.

4. **Analysis of study outcomes**

   A primary outcome of assessment is mild-moderate hypovolaemic dehydration during a work shift, operationalised as a binary variable (yes, no, missing). Dehydration is defined as urine specific gravity >1.015. A chi-square test will compare dehydration levels between sites and cooler and hotter seasons. Multilevel linear models will be used to account for the clustered nature of the data (clustered per facility and at individual level) and the influence of confounders. The continuous thermal environment monitors inside the facilities will provide information about the actual heat exposure on each day, allowing us to assess if there is an association between the thermal exposures and any of the survey responses or hydration measurements.

   Other secondary outcomes will also be assessed. We will compare, for example, the number of heat symptoms reported by participants during the study phases and all the other measures of wellbeing related to heat.

   Analyses will be done using data pooled across all the three sites, but we will also assess whether there are differences between countries, and by phase in each country.

5.5.7 Limitations of the health worker survey component

Selection bias, either in the selection of study sites and participants for the study may affect internal validity. Selection bias will, however, be reduced by the selection of multiple study sites, and inviting all health workers to participate in the study in Zimbabwe and Sweden, or using a random selection of eligible participants from sites in South Africa.

Most information is self-reported and there is no mechanism the verify the accuracy of information provided by the participant. Self-report can incur recall and other related biases. We aim to improve the quality of the data by programming logic and validation checks into the survey and having a study staff member available if any questions arise during the completion of the survey. The use of biological measures such as urine specific gravity does help to reduce the extent of this bias.

We are comparing multiple secondary outcomes across the time periods, which incurs the problem of multiple testing and the possibility for introducing Type I errors.

There are also concerns around potential confounders due to the relatively long time lag between surveys, and systemic changes may have occurred in the work environment over that time that were unrelated to the study.

There are multiple challenges to service delivery in health facilities in South Africa. These challenges fluctuate and may vary considerably between months. It may be difficult to disentangle these issues from impacts of heat, and health workers may draw spurious links between heat exposure and some of the constraints, while the problem may be due to supply chain concerns or electricity load shedding, for example.

5.6 Extraction of routine information

Health services and human resources data will be extracted from registers and health information systems over the past 4-5 years to collect additional information on the quality of clinical care, service utilisation and, if possible, to estimate absences and reasons for absence among MNCH HCWs during and outside periods of extreme heat.

5.6.1 Data extraction

- We will seek permission from the Department of Health to access data from maternity health records. This will be done through a letter to the relevant health authorities seeking permission to access the data. The letter will include specific details on how we plan to ensure confidentiality of data obtained in compliance with the POPI Act and other relevant legislation in SA. Once approval is obtained, we will extract information retrospectively from paper-based (South Africa and Zimbabwe) and electronic (Sweden) medical registers in maternity units, human resources registers and HMIS, to measure over the past four years (2019-2023). Information to support these indicators will be sourced from individual maternal clinical records and registers that are used during labour. To access individual maternity records, we will review maternity admissions registers between 2019 and 2023, randomly select 400 file numbers and then retrieve up to 250 maternity records for review, accommodating the fact that some of the records might be misfiled or be missing.
- The following indicators of quality of care, workload and productivity will be collected:
    - use of partograph, intrapartum stillbirths, other adverse events, on administration of key procedures in antenatal or postnatal care (syphilis screening, hepatitis B vaccines), referrals to and from other facilities,
    - Service utilization data (ANC,PNC, Caesarean section, vaginal deliveries, other)
    - Providers' absences and reasons for absence, if available

Data extraction will be carried out onto a RedCap database in South Africa. The period of data extraction will include the period of data collection for this study, to take into account the effects of heat on the number of patients and its influence on quality of care (Si et al, 2019). We anticipate challenges with the quality of retrospective data – e.g., incomplete or missing data in the source

documents. We will overcome this through pre-screening of the files, selecting only files that meet a minimum quality threshold – at least 80% of the required fields available for extraction.

5.6.2 Data analyses

The main exposures for the data analyses will be time-series recordings (daily, weekly or monthly) over several years and values of temperatures, windspeed, air humidity, and outdoor temperatures obtained for the same time points (daily, weekly or monthly) from a source such as www.tutiempo.net (Part et al, 2021). Indoor temperatures that have been obtained from procured temperature monitors placed within the facility will also be available over the study period and will be linked with the routine information we extract. We will perform linear regression analyses to determine whether there is a correlation (r statistic) between number of absences and temperature.

The potential influence of external factors such as COVID-19 will be taken into account by collecting data on the period of occurrence of key variables such lockdown and COVID-19 prevalence. We will stratify findings by COVID-19 study period to assess potential effect modification during that period. If we note patterns were considerably different over a period of lockdowns, for example, then we may exclude that data from the analysis.

5.6.3 Limitations of study component

The ability to access maternity records in public health facilities may be a challenge due to sub-optimal filing systems. Moreover, there may be data quality concerns, most especially around missing data that may impact on the information required for the study.

5.7 Assessment of thermal exposures

Thermal exposure assessments aim to measure the building's thermal environment, to make observations to characterize the building and its installations, and to examine how the buildings and its occupants can adapt to moderate their thermal exposure. Standardised indices will be used to evaluate and interpret thermal exposures. If feasible, measurement of air quality indicators could be included in the measurement framework.

5.7.1 Monitoring of the thermal environment

Indoors, humans exchange heat with the surroundings mostly through convection, radiation, and evaporation (Olesen and Madsen 1995). The building thermal environment should therefore be characterized through monitoring that includes at least the three parameters: air temperature, globe temperature, and air humidity. Globe temperature can be used to evaluate the mean radiant temperature. Ideally, measurements should include air speed, but this measurement is complicated and expensive and therefore not included in the study. Appendices 5 and 6 detail the building and room checklists that will be used to measure the thermal environments.

ISO 7726 (1998) describes the relevant parameters, requirements to instruments and standardized measurement procedures. The following description of indoor thermal exposure parameters is based on this standard.

Air temperature: The temperature of the air around the human body. The air temperature determines the heat transfer to or from the body by convection.

Globe and mean radiant temperatures: The amount of radiant heat exchanged between the body and the surroundings depends on the radiant heat fluxes exchanged by exposed body parts with the surrounding surfaces. Indoors, surface temperatures may deviate considerably, in particular with intense and prolonged solar irradiation on the building envelope and in poorly insulated buildings,

creating a highly asymmetric radiant field. The mean radiant temperature can be used to evaluate the radiant heat fluxes and thus the amount of radiant heat exchanged between persons and the enclosure. With a known air temperature (and air speed), the globe temperature can estimate the mean radiant temperature.

A simplified globe thermometer consists of a globe (ping-pong ball) in the centre of which is placed a temperature sensor (Simone et al. 2007). The temperature measured by the sensor element is an integrated measure of the radiant and air temperatures and it depends on the energy balance between the convective and radiant heat exchanges of the globe. The mean radiant temperature, and consequently the operative temperature, is not uniform in the room, but vary according to the location.

Air humidity: The air humidity influences the evaporative heat loss from a person. Under comfortable conditions, typically at temperatures below 26°C and in sedentary activity, air humidity has only a modest influence on the heat loss, but a considerable influence at higher temperatures or activity levels. Air humidity is thus a crucial parameter when assessing heat exposure.

To illustrate the configuration of a measurement device, Figure 3 shows custom-made air- and globe temperature sensors connected to a data logger. The air temperature sensor is shielded from radiation by the polished metal cylinder covering the pt-100 sensor element (the component that measures temperature). The cylinder allows the air to move around the sensor element. At the center of the ping-pong ball another pt-100 temperature sensor measures the globe temperature. The whole array of devices can be mounted on a small plate for easy installation on a suitable wall. The data logger used with this instrument has a built-in air humidity sensor.

Figure 3. Custom-made device for the measurement of air temperature, globe temperature and air humidity.

Information on the staff clothing and their activities is needed to assess heat stress with the indices wet bulb globe temperature, apparent temperature and predicted heat strain (described briefly below).

Thermal insulation of clothing: For HCW participating in the time-motion study, the clothing thermal insulation will be estimated with a short self-completed tick-off questionnaire reflecting the garments worn by the HCW (Appendix 7). This information will be used to inform the assessment of

relation between temperature and health worker activity, where warm clothing can be a key factor mediating the impacts of heat. Based on tabulated values of garment insulation values, the intrinsic clothing insulation will be estimated (ISO 9920-2009). See table below. Water vapour permeability of the clothing will be estimated at standard value of 0.45, unless particularly non-permeable garments are worn (apron or similar) (ISO 9920-2009).

	Clothing	I_{cl} (clo)
Thermal clothing insulation	1. Briefs, short-sleeve shirt, fitted trousers, calf length socks, shoes	0,5
	2. Underpants, shirt, fitted trousers, socks, shoes	0,6
	3. Underpants, coverall, socks, shoes	0,7
	4. Underpants, shirt, coverall, socks, shoes	0,8
	5. Underpants, shirt, trousers, smock, socks, shoes	0,9
	6. Briefs, undershirt, underpants, shirt, overalls, calf length socks, shoes	1,0
	7. Underpants, undershirt, shirt, trousers, jacket, vest, socks, shoes	1,1
Permeability	Normal clothes	0.38

Metabolic rate (activity level): Metabolic rate quantifies the conversion of chemical into mechanical and thermal energy and gives a numerical index of the activity. In particular in hot climates, high levels of metabolic heat production associated with muscular work may aggravate heat stress, as large amounts of heat need to be dissipated, mostly by evaporation of sweat (Kerslake 2007). For HCWs participating in the time-motion study a wearable device attached to the wrist will be used to measure heart rate, heart rate variability and count the number of steps taken during a work shift.

Body core temperature: Body core temperature is a useful heat stress metric (Huizenga et al. 2004, Davie & Amoore 2010). Conventional measurement of body temperature usually involves ingestion of an electronic pill or use of a rectal thermometer, which will not be feasible in this field study. Instead, body temperature of the HCWs involved in the time-motion study will be estimated with a non-invasive sensor attached to torso with a strap or a medical patch such as the following the following core sensor: CORE Body Temperature Sensor at corebodytemp.com.

5.7.2 Observations of building and installation properties

The specification of the health care facilities and their installations will be characterized through checklists. Two checklists are appended as Appendices 5 and 6 – one for the building and one for each of the rooms where environmental measurements are made.

These specifications are also needed as input to the modeling of the effect on heat exposures and energy use of potential interventions.

Where: Measurements with the available instrumentation cannot be carried out in all rooms in a facility, and locations should be selected to represent where the staff has the longest or highest exposure, i.e., measurements should cover both critical and representative locations. When the exposed person changes work location between areas with different environmental characteristics, the evaluation or measurements should be made in each area and the sequence of time periods spent by the worker in the different areas should be recorded. These locations are likely to be rooms used for the provision of antenatal care, care of women in labour (surgical theatre, delivery unit), postnatal wards, and special care unit for newborns.

When: Measurements should be made throughout the study to cover the variability of indoor and outdoor conditions. Environmental parameters (air temperature, globe temperature, air humidity) are logged continuously at 10-15 min intervals during the period.

5.7.3 Indices to evaluate heat stress based on measurements

We use a range of heat indices to describe the heat exposure of health workers, each measure captures a different aspect of heat exposure.

Wet Bulb Globe Temperature (WBGT): ISO 7243 describes determination and assessment of thermal exposures with WBGT. WBGT is a screening method to establish the presence or absence of heat stress. If more detailed analysis of the heat exposure is necessary, the Predicted Heat Strain described below is recommended.

Without solar load as is often the case indoors in buildings, WBGT may be calculated from

$$WBGT = 0.7 \cdot t_{nw} + 0.3 \cdot t_g$$

With solar load, WBGT is adjusted for the effect of radiation:

$$WBGT = 0.7 \cdot t_{nw} + 0.2 \cdot t_g + 0.1 \cdot t_a$$

t_{nw} is the natural wet bulb temperature that can be estimated with the Stull formula from measurement of air temperature and relative air humidity (Stull 2011):

$$T_w = T\,\mathrm{atan}[0.151977(\mathrm{RH\%} + 8.313659)^{1/2}] + \mathrm{atan}(T + \mathrm{RH\%}) - \mathrm{atan}(\mathrm{RH\%} - 1.676331) + 0.00391838(\mathrm{RH\%})^{3/2}\,\mathrm{atan}(0.023101\mathrm{RH\%}) - 4.686035.$$

Apparent Temperature (AT): The apparent temperature of a set of meteorological conditions may be defined as equal to the air temperature at low wind speed, no extra radiation and at moderate humidity and activity (Steadman 1984).

With reasonable accuracy, the Apparent Temperature can be approximated by:

Indoors: $AT = -1.3 + 0.92 \cdot t_a + 2.2 \cdot p_v$

Outdoors in the shade: $AT = -2.7 + 1.04 \cdot t_a + 2.0 \cdot p_v - 0.65 \cdot v_{10}$

Outdoors in the sun: $AT = -1.8 + 1.07 \cdot t_a + 2.4 \cdot p_v - 0.92 \cdot v_{10} + 0.044 \cdot Q_g$

In which t_a is the ambient (air) temperature (°C), p_v the vapour pressure (kPa), v_{10} the wind speed measured 10 m above the ground (m/s), and Q_g the net extra radiation per unit area of body ($W \cdot m^{-2}$).

Predicted Heat Strain (PHS): ISO 7933 describes a procedure for analytical evaluation and interpretation of thermal stress experienced by a person in a hot environment (ISO 7933-2004). Based on a comprehensive model of the heat transfer between the body and surroundings, the procedure evaluates thermal strain by excessive core temperature increase or water loss for a standard subject. In addition, the procedure allows determination of the exposure time during which the physiological strain is acceptable. As the procedure predicts physiological strain for standard persons it needs to be adapted if it should be used to assess thermal strain among vulnerable populations.

6. Data management

Data management will be carried out in accordance with the Data Management Plan developed for the EU and dated 30 November 2022. The data management will also meet requirements in accordance with the Protection of Personal Information Act South Africa. In accordance with this plan, our data management has the following characteristics, which is common to all components, unless stated otherwise:

- Each participant will have a unique identification number, which will be the same in each quantitative and qualitative sub-study (possible example: country code, followed by facility code, followed individual number ranging from 1-200). This allows us to link data of individuals who participate in multiple components. All hard copies of patient identifying data will be stored in a locked cabinet.
- All of the quantitative data will be collected electronically on a tablet or smartphone, and backed up as per the Wits RHI Standard Operating Procedures.
- All of the data will be analysed electronically.
- Data will be fully anonymised or pseudonyms will be used in reporting of the qualitative research, for example, when participant quotes are used.
- Each partner will store the data collected on its institutional network, on a secure server protected by two-level authentication.
- Data storage on local devices will be avoided at all times. If storing a copy of the data on local machines is necessary (e.g., the study statistician), then the data will be password protected and only include deidentified data.
- Access to data will be restricted to a limited number of study staff that have appropriate training to manage data.
- Data will not be sent by email but transferred safely using encryption or secure tools like Filesender.
- As most data are health-related, personal and sensitive, we cannot provide full open access to our datasets. As such, the datasets will not be entirely openly available, and conditions will be attached to access the data (i.e., restricted access). We will take actions to limit the restrictions, i.e., to have our datasets "as open as possible, as close as needed", by pseudonymisation/anonymisation of personal data where possible and by agreeing on a limited embargo.
- Non-personal data (e.g., environmental or ambient temperature data) will be made openly available unless sourced from a commercial source.
- Data ownership will be with the country teams in South Africa, Sweden and Zimbabwe.
- All data will be stored in accordance with GDPR legislation and recognised data security standards. In South Africa specifically, data will be archived once study results are analysed for a minimum of six years.

Further details of data management for each study component are provided below.

6.1 Qualitative enquiry datasets

Qualitative data will be managed in the first instance by each country partner. Interview recordings will be transcribed, quality checked, and securely stored for two years after research findings are published, or for six years if the findings are not published, in accordance with South African research ethics protocols, and then destroyed. Researchers will type up fieldnotes, producing an anonymised version that can be shared only within the research team. Files will be analysed by each

of the country teams of researchers and anonymised data will be securely transferred to the LSHTM server for cross-country analysis. Participant consent for sharing of anonymised outputs with project partners will be sought during data collection. Participants will be asked to consent for further follow-up and for keeping their contact details securely on countries' respective servers for the duration of the project.

6.2 Time-motion assessment

Data on health workers behaviours captured using the computerised direct observation methods consist of electronic data linked to individual providers with unique identification numbers. Data will be rendered fully anonymous during analyses. Data generated in the course of research will be kept securely in electronic format as appropriate, in accordance with good practice in the storage of primary data, record keeping, ethical issues, GDPR legislation as well as the POPI Act in South Africa. Identifiable material will be stored separately from any observation notes and kept locked in drawers or protected computers, for example, where there are hard copy informed consent forms.

6.3 Survey of health care workers

Quantitative data from the structured interview survey will be collected electronically using an electronic platform such as ODK. Once collected, electronic data will be transferred to a secure password protected server at each site. The survey is self-administered; hence participants will enter all data directly onto a secure web data entry form. Data logic and validation checks will be configured into the survey, where possible, so that participants will receive warning messages at time of entry of inconsistent, incomplete or invalid data, to ensure quality and completeness of information. The self-reported data will not be queried for clarification or correction by study staff after electronic submission of the survey.

Each site will anonymise and clean data to ensure the confidentiality of the participants and data quality. Each site will use the data for their in-country analysis. Files will subsequently be securely transferred to the LSHTM server for cross-country analysis. Participant consent for sharing of anonymised outputs will be sought during data collection. Participants will be asked to consent for storing of their contact details securely on country's respective servers for a further 2-3 years after study completion. This is to be able to invite them to participate in evaluation studies post implementation of adaptation interventions.

6.4 Extraction of routine data

These are daily/weekly/monthly counts of aggregated data on number of events (i.e., caesarean section) extracted from registers and collected on a tablet (the list of variables is defined in Section 5.6).

6.5 Assessment of thermal exposure

Data on thermal exposure consist of time-series of temperatures and air humidities representing the entire measurement period. Data will be retrieved from the instrumentation in CSV format for further processing and analysis in statistical software as Stata or R. Data is stored on the logging devices and will be read out regularly by researchers visiting the facilities. Combined with data on clothing insulation and activity, indices for the assessment of the thermal exposure will be calculated and interpreted based on guideline values provided in the relevant standards.

7. Dissemination and use of data for co-design workshops

We will synthesize and apply the tool-specific data analysis relevant to each of the methods (e.g., statistical analysis for time in motion studies, routine data extraction and survey instruments, and thematic analysis for qualitative data). We will draw on the different data sources and identify common themes, or areas where interventions might be done. Once we have identified common themes or potential interventions, we review the available data form each sub-study to identify whether the data support or points against use of the intervention. We will triangulate our data analysis and collate the assessment findings into a report, disseminated among study participants and local stakeholders such as department of health officials, facility managers, community leaders, and CHWs not participating in the study who will be involved in selecting the final adaptation and mitigation package.

The adaptation and mitigation intervention will primarily be implemented in South African and Zimbabwean facilities. The potential cost-benefits of interventions in Sweden will be assessed as there may only be marginal improvements in facility adaptation required.

Selection of the interventions will occur at each of the local health facilities or in a joint workshop in each country. We will host a full-day co-design workshop to discuss the findings of the baseline assessment reports, and to select several candidate adaptation and mitigation interventions.

The findings from the mixed-methods health worker assessment will be considered together with the assessment of indoor heat exposures. A report on the facility emissions mix based on the Aga Khan Development Network carbon emission tool will also be produced. That activity is covered by another Work Package in the HIGH Horizons project and a separate ethics submission. All of these sources of evidence will be brought together in co-design workshops hosted by the study team that will include health workers, community leaders, facility managers, and local and regional governments. Experts in thermal modelling, architecture, and emissions reductions will also attend. For example, they can contribute by modelling building-related interventions and calculating what these mean for exposure and energy use (if relevant).

The study team will use the Intervention Mapping (IM) approach (Eldredge et al., 2016; Fernandez et al., 2019), an established planning framework for developing an intervention in a stepwise manner, which has been used to guide public health interventions for decades. It involves an iterative path from problem identification to problem solving or mitigation, which will allow us to identify which interventions are to be targeted for change, and change techniques will be most effective. IM is grounded in participatory research methods to ensure that the intervention design match the context and target population needs. At heart, the study relies on a strong co-design element, where key intervention stakeholders are involved at each step. The workshops will culminate in the selection of several adaptation and mitigation interventions for thermal, emissions and cost-benefit modelling. These interventions will be tested in the next phase of the study, which will involve a separate ethics submission.

8. Ethical considerations

8.1 Informed consent

Before each participant is enrolled into the study, informed consent will be obtained in accordance with local and international ethical guidelines. The participant will be given a copy of the informed consent form, a copy of which will be retained by the research team. The informed consent form will be attached to a participant information sheet that will provide further information about the study,

with an emphasis about voluntary participation. Participants will be asked to provide separate written informed consent for each of the study components. Participants can decline participation in all or some components of the study without disadvantages or repercussions. They can withdraw their consent for study participation at any time. Appendices 8-13 include all informed consent forms for each study component.

There are several important ethical considerations regarding the participant observation activity. Principally, it is important that people know that they are being observed, what the purpose of the observation activity is, and how the data gathered through observations will be used. We will do this in several ways, tailored to each group being observed.

For **patients**, we will develop a simple, easy-to-read poster for display in the areas where the observations are taking place. The poster will explain the process of observation, the nature of data being collected, and how the privacy and confidentiality of those being observed will be maintained (for example, throughout all observations in facilities, the researcher will not observe sensitive procedures and they will position themselves in such a way as to ensure maximum privacy for the patients). The poster will also make it clear that the focus of the observation activity is actually the HCWs and not the patients. Also explained on the poster will be the fact that patients may opt out of being observed if they so wish, that they have a right to decline participation, and that no negative consequences for their care will follow. It is important that patients are aware of this and feel comfortable to opt out if this is their choice, since many of have no alternative place to access their healthcare, and because there are often stark power dynamics between HCWs and patients.

To opt out of the activity, patients need to inform the researcher, who will be wearing a clearly visible, identifying badge. The researcher will then ascertain whether the patient consents to being observed (because they are in the researcher's field of vision) but does not consent to information about themselves being recorded in the observation notes for that day. In these cases, the researcher will continue with their observation but refrain from entering into the notes any information about the actions or words of the patient in question. If the patient does not consent to the researcher remaining in the room/ waiting area where the patient is visible at all, the researcher will move out of the area until that patient is no longer present. To keep track of which patients have opted out, we will pair the researcher with an assistant, who will keep an ongoing record of this and ensure that opted out patients do not appear in the observation record.

The poster containing information for patients will be made available in appropriate local languages such as English, isiZulu and seSotho in South Africa, and will make use of clear images to cater for illiterate patients. This poster will be submitted to Wits HREC at a later stage, as a protocol amendment. We will also inform the established community advisory boards of the study processes and procedures and emphasise that the study will not affect patient access to care.

For **HCWs** stationed in the wards where the observation is taking place, prior to the commencement of the observation activity, we will inform them collectively (in a meeting) of the purpose of the observations and what they will entail. We will explain that no personal identifying information will be collected on the individuals who are observed. HCWs will be given a chance to ask questions and express any concerns about the activity, and these will be addressed by the study team either in the same meeting, or privately if requested. It will be explained that participating in the observation activity is voluntary, and refusal to participate will have no repercussions for the individuals concerned. Written informed consent will then be obtained individually from all HCWs who agree to

be observed. This consent will apply to the entire period of observation in each facility. Research staff will also be available to verbally respond to any concerns from patients and other staff in the healthcare facilities. In cases where a HCW being observed is interacting with an individual patient, the researcher will seek opportunities to verbally inform the patient why they are there and what the observation activity is about. This explanation will draw on the information sheet that has been developed (Appendix 13) for distribution to patients to keep.

8.2 Risks

There are minimal risks associated with participation in this study. The are risks around data protection which is mitigated through data security measures to ensure participant confidentiality detailed further in the data management plan.

Participating in this study may be psychologically uncomfortable and stressful for some participants as some questions on their wellbeing and productivity may be considered personal. Participants may also be uncomfortable with the experience of being observed. These risks will be explained to the participants.

The collection of biomarkers (urine) and data on stress and anxiety may reveal staff who might benefit from clinical attention. Staff will have access to their results if they wish to have these. Staff who have gone above certain thresholds suggesting that they might benefit from clinical or mental health services will be informed and offered referral to a healthcare professional in public/private/occupational setting of the participant's choice, after discussion with the lead clinical researcher in each setting. The urine testing, and measurement of heart rate, body temperature and number of steps are unlikely to lead to physical discomfort.

The study will aim to avoid any interruptions to patient care and service delivery in the healthcare facility, by limiting the time taken to complete research components, and doing them outside of working hours where possible.

8.3 Anonymity, confidentiality and safety

See data management section. We will collect anonymised/pseudonymised data only. In each country, a file linking names and unique identification number will be kept electronically using encryption and password protection and be accessible only to the qualitative researcher and the lead quantitative researcher. If participants have been involved in different components of the study, their study identification will remain the same to allow researchers to link data across components if required. No information that has personal identifiers will be shared with the participant's employer or any external partners.

The study results will be published for scientific purposes, but anonymity will be protected at all times, and we will ensure that as far as possible, no results can be linked to specific individuals.

8.4 Monetary reimbursement

All study participants will incur no costs for participation in this study. Participants in South Africa will be reimbursed a once off fee of R400 for participation in each study component where informed consent is signed. This will exclude casual conversations and general observations for example. This is in accordance with the South African Health Products Regulatory's (SAHPRA) time, inconvenience, and expense model. In Zimbabwe, participants will be given a small token in line with the Ethics board recommendations.

8.5 Review boards

All participating sites will obtain approval from relevant local ethics committees. The site PI's will ensure that the trial protocol, participant information sheet, informed consent forms, and any other supporting documentation have been approved by the appropriate research ethics committee that is responsible for the study site prior to study start. This protocol and accompanying ethics review committee documents cover study activities in South Africa only. The other sites will prepare a site-specific protocol and secure local ethical clearance, specifically obtained from:

- LSHTM ethics committee in the UK
- National Ethical Review Board in Sweden
- Human Research Ethics Committee of the University of the Witwatersrand in South Africa
- Medical Research Council in Zimbabwe
- Research Council of Zimbabwe

8.6 Other approvals

In South Africa, in addition to ethical approval, approval will be requested through National Health Research Database (NHRD) from provincial and local health departments. In addition, approvals will be requested from hospital and facility managers. Requests will include permission from management to install temperature and similar measurement devices in selected rooms in the healthcare facilities.

9. Timeline

For the measurement of how heat influences work, quality of care, and wellbeing, the same fieldwork will take place over a 2–3-month period during the hottest season and during a cooler 2–3-month period for comparison. In addition, we will use qualitative and quantitative methods to observe health workers across all work shifts (morning, afternoon, and night).

Project month (2022-2024)		1 Sep	2 Oct	3 Nov	4 Dec	5 Jan	6 Feb	7 Ma	8 Ap	9 May	10 Jun	11 Jul	12 Aug	13 Sep	14 Oct	15 Nov	16 Dec	17 Jan	18 Feb	19 Mar
Task 2.2.2																				
Brainstorming/ planning																				
Ethics submission countries and permissions from province and facilities	LSHTM																			
	SA																			
	Zim																			
	Swe																			
Refine tools & fieldwork prep																				
Fieldwork (rounds I and II for hotter and cooler temps)																				
Assessment of thermal exposure	SA																			
	Zim																			
	Sweden																			
Fieldwork cold (2-3 months)	SA																			
	Zim																			
	Sweden																			
Interim analysis	SA																			
	ZIm																			
	Sweden																			
	SA																			

Fieldwork hot (2-3 months)	Zim																		
	Sweden																		
Extraction of routine statistics	SA																		
	Zim																		
	Sweden																		
Final analysis	SA																		
	Zim																		
	Swe																		
Overall synthesis	SA																		
	Zim																		
	Swe																		
Next steps: intervention design workshop	SA																		
	Zim																		
	Swe																		n.a
Possible other info																			

*** in each site the order of fieldwork is anticipated to be as follows:*

- *Qualitative observations and interviews are first*
- *Time and motion is second over 2 weeks*
- *Structured questionnaires will be administered shortly after the time and motion component has been completed*

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Staffing required

In addition to a mixed method researcher to coordinate the study in each site and participate in the analysis, the following staff are required for fieldwork:

Study component	Staff cadre	Number	Duration	Comment
Observations and in-depth interviews	Social science researcher with experience in participant observation, ideally with clinical/maternal health background	1	2-4 weeks per facility for data collection	Preferable same social scientists will be required for a longer duration for data analysis
Time motion	Experienced social sciences researcher or staff with clinical background (e.g., nurse)	1	1 month per facility per season (cool vs hot periods)	None
Survey	Field worker, research assistant or equivalent, supported by a data manager	1	Less than 1 month for data collection per season	None
Data extraction	Research staff with clinical background	1	6 months	None
Temperature measurement	Field worker, research assistant or equivalent	1	1 month per season	None

Appendices

Appendix 1: Participant observation in facilities

Introductory note for the researcher

You will carry out participant observation in health facilities over a period of two to four weeks (depending on size and number of clinics per country), during which you will also carry out interviews and follow-up conversations.

In an introductory group meeting, staff members in the designated areas of the facility (see below) will be informed of your presence as a researcher, the aims of the study, and the purpose of your observation. Consent to participate in the observations will then be sought from all staff members attending this meeting. A poster will be developed for distribution in relevant parts of the facility, that explains the research and its principles of anonymity and confidentiality.

In the first week, you will primarily undertake observations in the facility, being sure to capture different times of the day, services of the hospital, and staff involved in care. Informal conversations are a part of this fieldwork, and you are encouraged to strike up such conversations and engage with those who approach you, while also understanding that these informal conversations should not be conducted as interviews. During this first week, identify potential informants for interviews and try to schedule times for these interviews for the following week, insofar as it is possible. You may choose to have an introductory interview in the first week with a member of staff to clarify certain practices and routines at the facility.

You should aim for a minimum of 4 hours of observation per day (6 hours/day the first week without interviews) and keep a detailed written and/or oral field journal during this time, for further elaboration and consolidation after observation hours, ideally immediately after the session has ended. If you delay completion of each day's journal, you will fall behind and it will become difficult to remember specific details.

In the second, third, and fourth weeks, participant observation continues, and interviews are conducted. Interviews build on and respond to the researcher-observed practices. Interviews will take place at the facility and in the community, in private settings that are comfortable for the participant.

This is a guide with suggestions of what to pay attention to and document during observations, with an eye to keeping the study research questions and objectives at the forefront of your mind. Not every topic needs to be written about extensively, but the listed topics are suggestions of areas that may be significant in terms of influences of and responses to heat and climate change that we may want to pay attention to, especially when comparing between hotter and cooler seasons. The guide should encourage you to remain flexible and curious about the surroundings at the facility and how people go about their work.

The following broad questions should guide the participant observation:

- Underlying sense of what the climate profile is in the location (seasonal and typical daily variations). What are people used to and what is changing?

• Which type of work and practices seem to be most affected by heat in this location, and in which ways?

• How are health workers affected by heat at work (well-being, productivity, quality of care)? How does heat exposure change their capacity to carry out work?

• What are HCWs and other individuals doing, or could they do, to avoid or reduce heat exposures and heat effects at work? (Includes descriptions of current preventive interventions and ideas for new interventions)

Spaces to observe:

- Maternity ward
- Labour ward
- Antenatal care clinics
- Postnatal care clinics
- Recreational, waiting and rest areas
- Follow leads to other spaces at or near the facility

Areas of observation

Part I: Infrastructure

1. Map the facility

Map the physical layout of the relevant departments in the facility, and what is done where. Document the clinical areas, staff rooms, waiting spaces and rest areas.

2. Heat and cooling (staff)

What kind of cooling mechanisms are available at the hospital (fans, air conditioning, shaded passages, cross breeze, water, etc.)? Are they working?

Do staff use these resources? Which staff? How and when?

Are there power outages? How frequent? How are they dealt with?

3. Heat and cooling (patients/visitors)

What infrastructure is available for patients/visitors, and how do they use them?

4. Existence of drinking water and refreshments (staff)

Where do facility staff hydrate, with what, and how frequently?

Is there a cost?

Are containers reusable? Recyclable?

5. Document any waste produced in relation to heat or climate change management

Part II: Clinical practices and patient care during labour and delivery

Movements during labour and delivery

In terms of care during antenatal, labour, and postnatal, pay attention to:

- Number of staff tending to patients, profiles
- Late arrivals and absences: how many and for which reasons given?
- Activity levels of staff members: energetic, active, lethargic, controlled…
- Respectful care during labour and delivery: attention, attentiveness and patience towards woman (and her companions)
- Partograph: standard practice, use of
- Hygiene practices: hand washing, disinfection – frequency, thoroughness
- Record keeping: thoroughness; are records filled out during patient visits or afterwards? Use of partograph
- Mood: collegiality, tension, stress, mutual support
- Practices related to heat avoidance/adaptation for both staff and patient
- Link with clinical aspects observed in time-motion and record extraction studies
- Attention to emergency management of labour
- Breaks: how frequently do staff members take breaks, and where? Do they take them together or alone? What do they do during breaks?
- C-sections – medical indication, does decision-making have any relation to heat factors?

Part III: Staff activities during routine care, antenatal and postpartum care

Section A: Situational set-up

1. What time do staff arrive at work, with which modes of transport? What are the heat indexes associated with the transport modes? (Are they cool, air conditioned, exposing people to the elements)?
2. Is there sufficient staff and do the planned staff arrive each day? Attention to staffing in maternity wards, operating theatre and neonatal units. Are there late arrivals and absences – how many and for which reasons given?
3. Note breaks taken by staff and what they do during them

Section B: Interpersonal relations (staff)

1. Work relations and social relations, team dynamics (cordiality, conflicts, hierarchies, mutual assistance, mutual respect, exchanges between staff about patients, exchanges with patients, type and quality of exchanges, tension, irritation)
2. Workload: possible stress, negative treatment, demotivation – and positive circumstances

Section C: Relations between staff, patients and companions in the hospital

1. Reception of patients (how are they received? Are they informed and oriented/directed? By whom?)
2. Nature of interactions/relationships [do patients and staff talk to each other? language used, use of an interpreter, topics of discussion, influence of the social level of patients in the process of their care (poor/rich, urban/rural, ethnicity, etc.)]

3. Empathy, respect and explanations given to the patient and her family – note time given and patience expressed on the part of all
4. Freedom given to the woman in relation to her preferences for giving birth (positions, right to walk, support and role of companions)
5. Relations with accompanying persons (staff attitudes towards accompanying persons, information given and requests)
6. Care and advice for the mother and the newborn (see what types of care and advice are given to the woman after childbirth, for the maintenance of the baby and for herself)
7. Care and follow-up of the patient and newborn during and after childbirth (is the patient followed up/accompanied?)

Part IV: Informal conversations with staff and administration:

- Draw on the guiding questions at beginning of this guide and the interview guide

Appendix 2: Topic guide for in-depth interviews with health care workers

Explain that this study investigates the ***impact of hot temperatures on maternal and neonatal health care workers*** *(in terms of their personal well-being, their productivity, the working environment, and health/medical outcomes) and that we are interested in learning about what they think about this topic, and* ***whether and how it is significant in their professional lives and care giving****.*

1. Profile of participant

- Age, gender, profession, training
- Role/position at facility
- Length of time working in total and at facility
- (BRIEFLY) Previous positions held (to get a sense of diversity of experience)

2. Introductory questions

2.1. What to you is the ideal temperature range to work in and live your day-to-day life? How so?

> *Probe as to whether these ideal temperature ranges vary for recreational activities and for work, and if so, why.*

2.2. If you think about all the challenges that you currently face in commuting to and from work and in performing your duties at work, where would you rank heat/high temperatures in this list? Tell me why?

OR

2.2. Do you think hot weather impacts on your day-to-day life? How so?

> *Probe about:*
> - *At home*
> - *Commuting to work (e.g., how does it affect choice, costs, time of commute?)*
> - *At work*
> - *Other*

(These are prompts to get a sense of participants' perceptions before asking specifically about these areas – i.e., to know if temperature is important to them and whether issues related to elevated heat are on their radar without direct lines of questioning. Then say that we will move to specific experiences next.)

3. Impacts of heat in the workplace

3.1. Which months are most problematic for heat in this region? Please explain. In which ways?

3.2. Are there times of the day that are more problematic for you and the health facility in terms of heat? When? In which ways are they problematic?

> *Probe:*
>
> - *Work gets interrupted?*

- *Changes that happen in the ward?*

3.3. Can we now return to the question of how hot temperatures affect how you work: please tell me more.

Probe about effects on:

- *Productivity (ability to meet targets in an appropriate timeframe)*
- *Effort and energy-levels (ability to put the required effort and energy into work tasks)*
- *Attention (ability to pay attention to patients and colleagues and to absorb information)*

3.4. How do you think heat affects the quality of care you are able to provide to your patients? Can you give some examples of how this has happened in the past?

Probe:

- *In which ways?*
- *Care given during labour and delivery specifically?*
- *Postpartum/newborn care?*

3.5. How does hot weather affect your colleagues?

Probe:

- *Effects on their work practices? (e.g., taking frequent breaks, finishing a shift early, working slower than usual)*

3.6. How does heat affect your patients?

Probe:

- *During pregnancy*
- *Labour*
- *Post-partum*

3.7. Have you ever taken time off from work in the past because of heat? If so, why and when? If so, how many days have you taken at a time/week?

4. Impact of heat on overall wellbeing and health

4.1. Do you think hot temperatures affect your wellbeing and mental health? In which ways? Can you give specific examples?

Probe:

- *Stress levels affected?*
- *More irritable with patients?*
- *Anxiety?*
- *Other*

4.2. Do you think hotter temperatures effect your physical health? If so, in which ways?

4.3. Do you find yourself interacting differently with your colleagues or with patients when it is hot? How so? Can you give some examples?

Probe:

- *More/less patience?*
- *More/less irritation,*
- *Change in frequency or content of communication, etc.*

5. Adaptation

5.1. What do you do to find relief from the heat? Describe for me a typical day in the hot season/in a heatwave, and what actions you would take to escape the heat or reduce its effects.

Probe:

- *Drink cold water*
- *Use a fan*
- *Switch A/C on*
- *Move to a cooler part of the building, etc.*

5.2. How effective are these methods?

5.3. What are the pros and cons of the different methods you use?

5.4. Do you find yourself changing the amount of fluid you take in during hot weather? Which liquids do you like to drink when it is hot and why? Tell me about how easy/difficult it is to access them?

5.5. In your workplace, do you have access to drinking water, and how much do you have to pay for it (if at all)?

5.6. In your experience, are there any extra financial costs related to coping with hot weather?

Probe:

- *Clothing*
- *Drinking water*
- *Transport*
- *Cooling/climate control/electricity,*
- *Lost wages*

5.7. Do you know whether your employer has safety standards or a formal policy on working in hot conditions? If so, what does that policy say? Is it used in your facility? Is it helpful? How so/Why not?

6. Recommended interventions

In the last part of our interview, we would like to know what you think could be done at the facility you work at, to improve your quality of life and the quality of care you provide when it is hot.

6.1. Let's begin with the things that are within your control as a health care worker working in maternal health during hot temperatures. What can be improved in:

- Adjusting ventilation (e.g., open doors and windows, use fan)
- Adjusting climate control (A/C)
- Increasing fluid intake
- Improving patient awareness of the dangers of heat
- Other?

6.2. In terms of the health system, what recommendations can you make regarding improvements in:

- Provision of reliable AC and/or ventilation
- Building design and materials (e.g., painting roofs white, improving insulation)
- Provision of cold water for staff
- Lighter protective clothing/uniforms
- Enforcement of regular breaks
- Structuring of shifts (e.g. split shifts, earlier starts, shorter shifts)
- Staffing (e.g., increase staffing over summer)
- Other?

6.3. Could you rank the interventions for implementation by the health system, from most important to you to least important?

6.4. What do you think the barriers might be to implementing these interventions?

6.5. Finally, could you reflect on how the weather/climate in your area has changed at all over the last decade? (e.g., hotter summers, spring heatwaves, more frequent/prolonged droughts, flooding, etc.) What do you think is causing these changes?

6.6. In your view, is the health sector acting to meet the challenges of a changing climate? How significant do you think this will be for the health system in coming years?

7. Optional questions: relationships to climate change (solastalgia)

Now I would like to ask you some questions about your experiences with climate change as a whole.

7.1. What do you see is the impact of climate change on your life and environment? (If answered that they noticed climate change in question 6.5) What do these changes mean to you?
(Prompts: farming, food availability, comfort, transport/travel, habits, availability of other goods, etc)

7.2. How do you think these changes will impact those in your community/surroundings? Or those further away from home?

7.3. What emotions do you relate to your feelings about the future and the climate situation?
(Note: This is a key question to probe around.)

7.4. Do you notice a change in your health or the health of those around you, that you relate to climate change? If so, what? Who is affected and how?

7.5. Have you noticed the health sector changing in relation to climate change? If so, in which ways? Please give examples.
(Note: This question ties in with question 6.6, and can be followed up with a question asking for

the opinion of what the health sector could do in response, if this hasn't already been covered previously in the interview.)

Closing

Do you have any other comments considering temperature, work, productivity and well-being?

Thank you for your time and contribution to this work.

Appendix 3: Key informant interview guide

Profile

Job/role/position in community

Length of time in role and responsibilities held

1. Local experiences with heat (general)

Do you believe that hot temperatures and extreme heat events pose a concern to your community?

- [If yes] If so, how? In which ways? For whom? Can you please give some examples?
- Could you reflect on how the weather in your area has changed at all over the last decade, or longer? (e.g., hotter summers, spring heatwaves, more frequent/prolonged droughts, flooding, etc.) What do you think is causing these changes?

2. Health sector experiences with heat

As you know, we are carrying out some research focused on [X] health facility and the impact of heat on health worker well-being, outputs and quality of care.

- Have you heard about heat posing a problem for health workers?
- Have you heard about heat posing a problem for mothers and babies at the health facility?
  - If so, what? Please share examples.
- What do you think could be done at the facility to improve the situation in terms of high heat and your quality of life and care giving?

3. Adaptations for heat

3.1. Are you aware of actions that can be or have been undertaken to cope with extreme heat in the health facility for health workers and patients?

- If so, what are they? Who carries them out – where, since when?
- How effective do you think they are?

Interviewer: Probe after pros and cons of each measure mentioned. Probe after measures that they know of in their geographic area and elsewhere.

3.2. In terms of the health system, what do you think about the acceptability and feasibility of making the following improvements:

(Interviewer: probe in terms of feasibility and acceptability according to the informant's opinion for each one, and ask for examples, if possible)

- Provision of reliable AC and/or ventilation
- Building design and materials (e.g., painting roofs white, improving insulation)

- Provision of cold water for staff
- Lighter protective clothing/uniforms
- Enforcement of regular breaks
- Structuring of shifts (e.g. split shifts, earlier starts, shorter shifts)
- Staffing (e.g., increase staffing over summer)
- Can you think of any others, now that we have proposed some examples?

3.3. Could you rank the interventions for implementation by the health system, from most important to you to least important?

3.4. What do you think the barriers might be to implementing these interventions?

3.5. In your experience, which steps would need to be undertaken to successfully institute the changes you recommended earlier? Which stakeholders should be involved, and how?

3.6. In your view, is the health sector acting to meet the challenges of a changing climate?

- How significant do you think this will be for the health system in coming years?
- Do you believe that this issue is adequately on the radar of decision and policy makers in [x country]? Why or why not?

4. Closing

Do you have any other comments you would like to share with us considering temperature, work, productivity and well-being?

Thank you for your time.

Appendix 4: Health worker survey questionnaire

Question number	Question	Response categories	Skip
Introduction: *Thank you for accepting to take part in HIGH Horizon health care worker study. The questionnaire will take approximately 60 minutes to complete, and can be done in more than one sitting preferably on the same day, towards the end of your shift. Your responses are important.*			
1.1 1.2	Dates and time of starting and completion:	[ ] [ ] / [ ] [ ] / [ ] [ ] (day/month/ year) Started at: [ ] [ ] Hours [ ] [ ] minutes	
Demographic and work variables			
2.1	How old are you?	[ ] [ ] years old	
2.2	What sex/gender are you?	[ ] Female [ ] Male [ ] Other [ ] Prefer not to say	
2.3	What is your highest level of education?	[ ] No schooling [ ] Primary school [ ] Some secondary (high school) [ ] Secondary school (high school) (Grade 12 or equivalent) [ ] Higher certificate, advanced national certificate [ ] National diploma,	

		advanced certificates [ ] Undergraduate degree [ ] Post-graduate degree [ ] Prefer not to say	
2.4	What is your staff position in this hospital?	[ ] Nurse of any grade [ ] Midwife [ ] Obstetrician/ Gynaecologist [ ] Paediatrician or Neonatologist [ ] Other types of doctor (e.g., intern, medical officer) [ ] Clinical associate [ ] Allied health workers such as physiotherapists [ ] Community health worker [ ] Cleaner [ ] Porter [ ] Other, please specify	
2.5	What is the number of years that you have worked in your current role?	[ ] [ ] years	
2.6	In which service did you spend most of your time over the past 7 days?	[ ] Antenatal clinic	

		[ ] Antenatal ward [ ] Labour and delivery room [ ] Surgical theatre [ ] Postnatal ward [ ] Neonatal ward [ ] Other outpatient [ ] Other wards [ ] Outreach [ ] Other/ not in facility	
2.7	How long is/was your shift today?	[ ] [ ] hours	
2.8	How many pauses during your work have you taken today, of 5 minutes or more?	[ ] [ ] pauses	
2.9	Overall, from a scale of 1-10 with 10 being the highest level, how motivated do you feel to work in this facility?	[ ] [ ]	
Health status in general			
We would like to know about your health status.			
3.1	Would you say that <u>today</u> your health in general is: Excellent, very good, good, fair or poor?:	[ ] Excellent [ ] Very good [ ] Good [ ] Fair [ ] Poor [ ] Don't know	
3.2	Have you been diagnosed with any of the following chronic conditions?	[ ] Hypertension [ ] Diabetes [ ] Dyslipidaemia (high cholesterol or triglycerides) [ ] Asthma/COPD [ ] TB [ ] Autoimmune	

		disease, e.g., Lupus, rheumatoid arthritis [ ] Osteoarthritis [ ] Heart disease [ ] Stroke [ ] Epilepsy [ ] Depression/anxiety [ ] Other mental illness [ ] HIV	
3.3	Are you pregnant or were pregnant in the past 12 months [for women only to answer]?	[ ] Yes, pregnant [ ] Yes, pregnant in the past 12 months [ ] No [ ] Not applicable [ ] Don't know	
Your wellbeing: WHO Well-being Index for Health Workers tool			
For each of the five statements, please indicate whether in the last two weeks you have been feeling this way most of the time, more than half of the time, less than half of the time, only rarely, or never.			
4.1	In the past two weeks, I have felt cheerful and in good spirits …	[ ] Most of the time [ ] More than half the time [ ]Less than half of the time [ ] Never	
4.2	In the past two weeks, I have felt calm and relaxed ….	[ ] Most of the time [ ] More than half the time	

		[ ]Less than half of the time [ ] Never	
4.3	In the past two weeks, I have felt active and vigorous…	[ ] Most of the time [ ] More than half the time [ ]Less than half of the time [ ] Never	
4.4	In the past two weeks, I woke up feeling fresh and rested….	[ ] Most of the time [ ] More than half the time [ ]Less than half of the time [ ] Never	
4.5	In the past two weeks, my daily life has been filled with things that interest me…	[ ] Most of the time [ ] More than half the time [ ]Less than half of the time [ ] Never	
Your stress level: PSS-4			
The questions in this scale ask about your feelings and thoughts during the last month. In each case, you will be asked to indicate how often you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question.			
5.1	In the last month, how often have you felt that you were unable to control the important things in your life?	[ ] Never [ ] Almost never [ ] Sometimes [ ] Faily often [ ] Very often	
5.2	In the last month, how often have you felt confident about your ability to handle your personal problems?	[ ] Never [ ] Almost never	

		[ ] Sometimes [ ] Faily often [ ] Very often	
5.3	In the last month, how often have you felt that things were going your way?	[ ] Never [ ] Almost never [ ] Sometimes [ ] Faily often [ ] Very often	
5.4	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	[ ] Never [ ] Almost never [ ] Sometimes [ ] Faily often [ ] Very often	
Your anxiety level: GAD-7			
How often have you been bothered by the following over the past 2 weeks?			
6.1	Feeling nervous, anxious, or on edge	[ ] Not at all [ ] Several days [ ] More than half of the days [ ] Nearly every day	
6.2	Not being able to stop or control worrying	[ ] Not at all [ ] Several days [ ] More than half of the days [ ] Nearly every day	
6.3	Worrying too much about different things	[ ] Not at all [ ] Several days [ ] More than half of the days	

		[ ] Nearly every day	
6.4	Trouble relaxing	[ ] Not at all [ ] Several days [ ] More than half of the days [ ] Nearly every day	
6.5	Being so restless that it's hard to sit still	[ ] Not at all [ ] Several days [ ] More than half of the days [ ] Nearly every day	
6.6	Being easily annoyed or irritable	[ ] Not at all [ ] Several days [ ] More than half of the days [ ] Nearly every day	
6.7	Being afraid as if something awful might happen	[ ] Not at all [ ] Several days [ ] More than half of the days [ ] Nearly every day	
Heat strain score index (validated scale)			
7.1	How do you feel your workplace air temperature?	[ ] Very cold (−3) [ ] Cold (−2) [ ] Slightly cold (−1) [ ] Pleasing air or normal (0) [ ] Slightly warm (1) [ ] Warm (2)	

		[ ] Very warm (3)	
7.2	How do you feel the humidity level at your workplace?	[ ] Dry (a feeling of dryness in the mouth and throat) (−2) [ ] Appropriate and desirable (0) [ ] Wet skin (1) [ ] Clothes sticking to skin surface (2) [ ] Fully wet skin (3) [ ] Sweat loss from skin surface (4)	
7.3	How do you feel the temperature of adjacent surfaces due to contact with your hands?	[ ] I feel too cold (−3) [ ] I feel cold (−2) [ ] I feel cool (−1) [ ] I do not feel cold or hot (0) [ ] I feel hot (1) [ ] Their heat cannot be tolerated (2) [ ] If my skin is in touch with them I will be burnt (3)	
7.4	While you are working, the intensity of physical activity you do is like which of the following conditions?	[ ] very, very easy [ ] easy	

		[ ] starting to get hard [ ] very hard [ ] so hard I am going to stop	
7.5	How do you feel the flow of air in your workplace?	[ ] Existence of cold weather circulation (−3) [ ] Existence of a cold weather current (−2) [ ] A gentle stream of pleasing air (−1) [ ] Sense of stability in the gentle flow of air or warm air (1) [ ] Moderate flow of warm air (2) [ ] An extreme current of hot air (3)	
7.6	How much is the amount of sweating throughout your work?	[ ] I do not feel sweat (0) [ ] I feel the sweat on the armpit and inguinal (1) [ ] I feel sweat on the chest and back (2) [ ] Sweating is so severe that the	

		underwear clothing get wet (3) [ ] Sweating is so severe I feel it on my face (4) [ ]Sweating is so severe it is flowing all over my body (5)	
7.7	How much fatigued are you at work?	[ ] I'm not tired at all (0) [ ] I'm a little tired (1) [ ] I'm tired (2) [ ] I'm exhausted (3) [ ] I'm so exhausted I desire to have a break (4)	
7.8	How much is the intensity of your thirst when you are at work?	[ ] I don't get thirsty (0) [ ] I get a little thirsty (1) [ ] I get thirsty (2) [ ] I get very thirsty (3) [ ] I get so thirsty that my mouth and throat get dry and they can't be wet with saliva (4)	
7.9	How intensively are you suffering from heat?	[ ] I'm not annoyed (0)	

		[ ] I'm a little annoyed (1) [ ] I'm annoyed (2) [ ] I'm very annoyed (3) [ ] I'm so annoyed I want to quit my job (4)	
7.10	How is the ventilation system in your workplace?	[ ] Active and high ventilation (−1) [ ] Appropriate ventilation, it is not needed to be ventilated (0) [ ]Inadequate ventilation (1) [ ] Despite lack of air conditioning, there is no ventilation (2)	
7.11	If there are heat sources in your workplace, what do you feel when you are exposed to them?	[ ] Feeling the thermal conditioning on the face (−1) [ ] Can be detected, feeling of heat radiation but not annoying (0) [ ] Feeling the heat on face (1) [ ] Radiant heat is	

		intolerable on the face (2)	
7.12	How is the sunlight in your workstation?	[ ] Full shadow (−1) [ ] Sun and shadow or mild light (0) [ ] Full sun or intense light (1)	
7.13	How much of your time is spent in a warm environment, in a shift?	[ ] Less than 2 hours (−1) [ ] 24 hours (0) [ ] 4–6 hours (1) [ ] More than 6 hour (2)	
7.15	How do you feel about the size of the workspace within the building?	[ ] Spacious (0) [ ] Appropriate common space (1) [ ] Limited cramped space (2)	
7.16	Do you feel that you are suffering from symptoms of heat stress today (Thirst, sweating, thermal discomfort, headaches, feeling tired, other symptoms?)	[ ] Yes [ ] No [ ] Unsure	
7.17	Have you ever experienced heat stroke in your workplace?	[ ] Yes (3) [ ] No (0)	
7.18	Have you ever taken leave because the weather was very hot? If yes, approximately how many days in a month?	[ ] Yes [ ] No [ ] [ ] days	
Perceptions of heat's influence on quality of care			
8.1	During the hot season, does heat exposure reduce your daily or hourly work input?	[ ] Yes [ ] No [ ] Don't know	I
8.2	*When you think about the last heatwave that occurred in Tshwane, have you observed any of the following during the heatwaves?*		
8.2.1	Reduction of productivity per person?	[ ] yes	

		[ ] no [ ] unsure	
8.2.2	Increased in the number of medical errors?	[ ] yes [ ] no [ ] unsure	
8.2.3	Poorer communication with patients?	[ ] yes [ ] no [ ] unsure	
8.2.4	Poorer communication between health care workers?	[ ] yes [ ] no [ ] unsure	
8.2.5	Patients in less clean environment?	[ ] yes [ ] no [ ] unsure	
8.2.6	Drugs becoming less effective?	[ ] yes [ ] no [ ] unsure	
8.2.7	Equipment faultier?	[ ] yes [ ] no [ ] unsure	
8.2.8	Electricity cuts affecting treatment?	[ ] yes [ ] no [ ] unsure	
8.2.9	Increased clinical workload?	[ ] yes [ ] no [ ] unsure	
8.2.10	Providers less likely to follow guidelines?	[ ] yes [ ] no [ ] unsure	
8.2.11	Supply chain interrupted?	[ ] yes [ ] no [ ] unsure	
8.2.12	Irritability	[ ] yes [ ] no [ ] unsure	
Current heat adaptations			
9.1	Does your workplace have a formal policy about working in hot conditions?	[ ] yes [ ] no [ ] unsure	
9.2	If yes, do you use the formal policy about working in hot conditions?	[ ] yes [ ] no [ ] unsure	
9.3	If no, do you think that such a policy may be useful?	[ ] yes [ ] no [ ] unsure	
9.4	*Could you please rate the availability of the following heat adaptation measures in your clinic/ward?*		

9.4.1	Availability of shading devices to reduce direct sunlight?	[ ] Always [ ] Often [ ] Sometimes [ ] Rarely [ ] Never	
9.4.2	The availability of water for workers in the wards?	[ ] Always [ ] Often [ ] Sometimes [ ] Rarely [ ] Never	
9.4.3	The availability of cold refrigerated water for health care workers in the wards?	[ ] Always [ ] Often [ ] Sometimes [ ] Rarely [ ] Never	
9.4.4	The availability of air conditioning?	[ ] Always [ ] Often [ ] Sometimes [ ] Rarely [ ] Never	
9.4.5	The available of fans?	[ ] Always [ ] Often [ ] Sometimes [ ] Rarely [ ] Never	
9.4.6	The amount of trees outside the ward/clinic?	[ ] Many trees all the way around [ ] Some trees in certain areas [ ] Few trees [ ] No trees	
9.4.7	The availability of spaces to cool down for yourself or your patients when it is too hot?	[ ] Many spaces that are always available [ ] Many spaces that are often available [ ] Few spaces that	

		often available [ ] Few spaces that are rarely available [ ] No spaces available	
9.4.8	Which of the following ways could be used to lower temperature in your ward/clinic during hot weather:	[ ] More windows to increase ventilation during hot weather [ ] More regular breaks [ ] Lighter protective clothing [ ] Air-conditioning [ ] Cold water available for staff [ ] More shading in the ward	

Appendix 5: Building checklist

It may be difficult to retrieve all the information contained in the checklist. Try to be as precise as possible, but feel free to skip questions where information is not available.

00. GENERAL INFORMATION

Building: _____

Address: _____

_____

Date _____

Time _____

Inspector(s): _____

01. BUILDING REGISTRATION

General building characteristics

1. Year of construction _____
2. Year of last major renovation _____
3. Gross floor area _____ m²
4. Net floor area _____ m²
5. Number of floors below grade _____
6. Numbers of floors above grade (including ground floor) _____

Space usage

7. Activity category of each floor (office, foyer/reception, retail, vacant, residential, assembly, multi-use, laboratory, storage, food services, mechanical, parking, other)

Floor Designation	Primary Activity	Secondary Activity	Comments
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Site information

8. Site Characterization (check most representative)

Urban/Industrial	☐	Suburban/Industrial	☐
Urban/Residential	☐	Suburban/Residential	☐
Urban/Commercial	☐	Suburban/Commercial	☐
Rural/Near Urban	☐	Rural/Commercial	☐

Rural/Agricultural ☐ Rural/Industrial ☐

Building facility information

9. Type of ventilation in the building (check all that apply)

Natural ventilation, manual window opening	☐
Natural ventilation, automatic window openers	☐
Exhaust air system	☐
Exhaust and supply air system	☐
Exhaust and supply air system with heat recovery	☐
Other (specify)	☐ _____

In case of mechanical ventilation system:

Filter replacement schedule		_____
Temperature controlled	☐	
CO_2 controlled	☐	
Manually controlled	☐	
Ventilation time/schedule	☐	_____
Not possible to determine	☐	

10. What primary heating system is present in the building?

Air system (heating coil – electrical)	☐	
Air system (heating coil – water)	☐	
Radiators	☐	
Floor radiant heating	☐	
Other, please specify	☐	_____

11. What primary cooling system is present in the building?

No cooling	☐	
Individual room air conditioners (fan coil units)	☐	
Central system with cooling	☐	
Other, please specify	☐	_____

Building envelope characterisation

12. Façade

Brick	☐	
Concrete	☐	
Wood	☐	
Asbestos cement	☐	
Other (specify)	☐	_____

13. Exterior wall construction (inside)

Concrete	☐	
Brick	☐	
Wood	☐	
Other (specify)	☐	_____

14. Interior walls construction

Concrete	☐	
Brick	☐	
Gypsum boards	☐	
Wooden boards	☐	
Other (specify)	☐	_____

15. Which type of insulation is there in the building, if any?

Exterior	☐	
Interior	☐	
In cavity wall	☐	
Other (specify)	☐	_____

THE END

Room checklist

It may be difficult to retrieve all the information contained in the checklist. Try to be as precise as possible, but feel free to skip questions where information is not available.

00. GENERAL INFORMATION

Building _____

Address: _____

Date _____

Time _____

Inspector(s) _____

01. ROOM IDENTIFICATION

Room identification

Floor: _____

Room number/name: _____

Other relevant information (Please be elaborate): _____

_____

Measurement equipment identification

Measurement device installed in room: Other relevant information:

_____ _____

_____ _____

Other measurement equipment installed in office (e.g. Hobo loggers or other):

What: Number or other ID: Other relevant information:

Other 1: _____ _____

Other 2: _____ _____

Floor plan with indication of placement of measurement equipment:

(Remember to draw a compass with the orientation and placement of measurement equipment)

02. ROOM DESCRIPTION

General characteristics

1. Main orientation (of windows) North, South, East, West, Northeast, Northwest, Southeast, Southwest

2. Estimated net floor area _____ m^2

3. Estimated ceiling height _____ m

4. Suspended ceiling Yes, plenum height: _____ cm No ___

5. Room usage

_____

_____

_____

Windows

6. Number of windows to the exterior: _____
7. Number of operable windows: _____
8. Total area of external windows: _____ m^2
9. Percentage of operable windows: _____ %
10. Window shading (overhangs, window treatments, shades) Yes: _____ No
11. Percentage of windows with shading elements _____%

Lighting

12. Which type of lighting is used?

LED	☐	
Incandescent	☐	
Fluorescent	☐	
Other (specify)	☐	_____

Ventilation

13. Total number of supply air devices _____

14. Supply air device type

		Comments
Linear ceiling diffusers	☐	_____
Sidewall diffusers	☐	_____
High sidewall grilles	☐	_____
Floor registers	☐	_____
Perforated ceiling panels	☐	_____
Square or round ceiling diffusers	☐	_____
Floor or near-floor diffusers	☐	_____
Low sidewall grilles	☐	_____
Fan coil units or unit ventilators	☐	_____
Slots around ceiling luminaires	☐	_____
Other (specify)	☐	_____

No supply air devices ☐

15. Total number of return air devices _____

16. Return air device type

		Comments
Ceiling grilles	☐	_____
Ceiling slots	☐	_____
Low sidewall or floor grilles	☐	_____
Slots around ceiling luminaires	☐	_____
High sidewall grilles	☐	_____
Other (specify)	☐	_____
No	☐	

Additional space conditioning equipment

17. Number of space heaters observed in test space _____
    Number of space heaters in use _____
    Number of humidifiers observed in test space _____
    Number of humidifiers in use _____
    Number of dehumidifiers observed in test space _____
    Number of dehumidifiers in use _____
    Number of desk fans observed in test space _____
    Number of desk fans in use _____
    Other (specify) _____

    No ☐

THE END

Appendix 7: Clothing questionnaire

Shirts and sweaters

T-shirt (short sleeves	[Control]	Thin sweater	[Control]
Thin shirt (short sleeves)	[Control]	Thick sweater	[Control]
Normal shirt (long sleeves)	[Control]	Sweatshirt	[Control]
Heavy shirt(long sleeves)	[Control]	Pile	[Control]
Cardigan	[Control]	Thin jacket	[Control]
Sleeveless vest	[Control]	Thick jacket	[Control]

Trousers, skirts, dresses

Shorts	[Control]	Light skirt, above knee	[Control]
Thin trousers	[Control]	Light skirt, below knee	[Control]
Medium thick trousers	[Control]	Thick skirt	[Control]
Thick trousers	[Control]	Light shirtdress	[Control]
Jeans	[Control]	Winter shirtdress, long sleeves	[Control]

Socks and shoes

Thin calf-length socks	[Control]	Shoes, thin soles	[Control]
Thick calf-length socks	[Control]	Shoes, thick soles	[Control]
Thin ankle socks	[Control]	Boots	[Control]
Pantyhose	[Control]	Trainers	[Control]
Sandals	[Control]		

INFORMATION SHEET FOR HEALTH CARE WORKERS – Participant Observation Component

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Sponsor: European Union
Principal Investigator: Dr Gloria Maimela
Institution: Wits RHI
Email: gmaimela@wrhi.ac.za
Contact number: <insert>

Hello, my name and surname is _____ (insert name). I am a_____ (insert designation) at the Wits RHI Climate and Health Directorate. Together with colleagues at Wits RHI, we are conducting a research study to investigate the effect of indoor heat on the physical health and mental wellbeing of health care workers (HCWs) and on productivity and the quality of care provided. We would like to invite you to participate in our study.

What you should know about this research study:

- Before agreeing to participate, we are giving you this participant information sheet and consent form so that you may read about the purpose, risks, and benefits of this research study.
- You have the right to refuse to take part, and you have the right to agree to take part now and change your mind later.
- Whatever you decide, it will not affect your regular work.
- Please review this consent form carefully. Ask any questions before you make a decision.
- Your participation is voluntary.
- Thank you for reading this information. If you decide to take part in the study, you will be asked to complete a consent form.
- If you have any questions, please do not hesitate to ask me.

PURPOSE OF STUDY

You are being invited to participate in a study that seeks to understand the impact of ambient heat on HCWs' working environments, their physical and mental wellbeing, their productivity, and on the quality of care provided. This study focuses only on HCWs working in maternity and newborn care. The results from this study will help to design a program that can improve health facilities' adaptation to heat and thereby improve working conditions and health outcomes. The study is being conducted in Zimbabwe, South Africa and Sweden.

Why am I being asked to participate in this research study?
You are being asked to participate in this study because you are a HCW:

- Aged 18 years and above
- Working full-time at Stanza Bopape Community healthcare Centre (CHC) or Mamelodi Hospital
- Working in antenatal, maternal, labour or neonatal ward/clinic
- Able and willing to consent to provide data for the study

PROCEDURES AND DURATION
The specific component of the study for which we are seeking your consent today is the **Participant Observation** component. Participant observation is a method of collecting data through observation of a set of activities or group of people as they go about their work or engage in other daily activities. In this study, we wish to observe you and other HCWs in your work environment, focusing on how heat affects your wellbeing, physical health, and productivity. Observations will also document what you and other HCWs are currently doing to stay cool and what options exist in facilities for staff and patients to escape the heat.

Researchers trained to carry out observations will be stationed in the antenatal, maternal, labour, and neonatal wards/clinics at different times of the day and on different days of the week. They will move around these spaces but remain unobtrusive, and as far as possible, their observations will not interfere with the duties you carry out as a HCW. Occasionally, the researchers will take written notes about what they are observing.

It is important to be clear that our observations are **not** intended to monitor staff performance or to identify errors in the care you provide. Information gathered during the observations will not be shared with your supervisors, but anonymous information may be shared with relevant stakeholders in government and with our research partners in Sweden, Zimbabwe and the UK. The primary purpose of collecting this observation data is to inform our development of an intervention that will be tested in another component of the study.

Your privacy and confidentiality will be protected throughout, and no personal identifying information will be collected on any individuals who are observed in this activity. No names will be collected or published in our reports or academic articles. No photographs or videos will be taken of any individuals who are observed.

If you do not wish to be observed, you have the right to 'opt out' of these observations. No one except the observer will know that you have opted out of observations.

RISKS AND DISCOMFORTS
The most important risk is breach of confidentiality, but this risk is low as we will use security measures to protect your personal data. An additional risk of participating in this study is that you may be anxious that you are being evaluated, which may make you feel uncomfortable. Our researchers have been trained in creating a supportive environment, without interfering with your regular work. Informal conversations will only be held when it is conducive for you with limited interruption of the work schedule. It is important to know that you can stop your participation in this study at any time, without any consequences.

BENEFITS AND/OR COMPENSATION
There are no direct benefits or reimbursement from participating in these observations. It is expected that the results will inform the development of an intervention intended to improve working conditions at health facilities. You will not need to pay anything to take part in the study. At the end of the observation period, you will be reimbursed R400 for your time and inconvenience.

CONFIDENTIALITY
Your data will be collected, processed, and stored according to the South African Protection of Personal Information (POPI) Act of 2013. To protect your confidentiality, no personal identifiers will appear in any verbal presentations, reports and publications that make use of this observation data. All electronic data will be protected by security access codes. We will use a unique participant identification (ID) number instead of your name when storing and analysing your data. Any written information will be kept under lock and key in a cabinet and separately from any information that identifies you (such as this consent form). After study completion, files/information will be kept securely at the project office for a period of 6 years after all analysis and publications are complete for this study and then will be destroyed. Your de-identified data may be stored electronically for a longer than 6 years for use in other studies if you agree. No identifiable information will be shared with your colleagues or facility managers.

Who may see, use or share the information collected during this study about you?
The researchers that are involved in this study have access to this information. Organizations that may look at and/or copy your research records for ethical, research, quality assurance, and data analysis include:

- Wits Human Research Ethics Committee
- London School of Hygiene and Tropical Medicine Ethics Committee

Additionally, we may share your de-identified information with researchers for use in other research studies if you agree to this. The information will be labelled with a unique code, and we will not share your name.

VOLUNTARY PARTICIPATION
It is your decision to take part in this study or not. Taking part in this study is completely voluntary. You may stop your participation in the study at any time without penalty. No matter what decision you make, there will be no negative consequences to you in any way.

ETHICAL APPROVAL
This study has been submitted to the University of Witwatersrand, Human Research Ethics Committee, and this committee has granted written approval.

If you have study questions, or a study related problem?
If you have any questions about your participation in this study, please contact:

Dr Gloria Maimela
Wits RHI
22 Esselen Street, Hillbrow, Johannesburg 2100

gmaimela@wrhi.ac.za
<insert telephone number>

If you have any questions concerning this study or consent form beyond those answered by the investigator, including questions about the research, your rights as a research participant or research-related injuries; or if you feel that you have been treated unfairly and would like to talk to someone other than a member of the research team, please feel free to contact the University of Witwatersrand Human Research Ethics Committee, via email to Prof. Clement Penny at clement.penny@wits.ac.za or by calling during office hours: 011 717 2301.

YOU WILL HAVE A COPY OF THIS INFORMATION SHEET TO KEEP

Thank you for taking the time to consider partaking in this study.

Health Care Worker Informed Consent Form for Participant Observations

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Principal Investigator: Dr Gloria Maimela

OFFER TO ANSWER QUESTIONS
Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

For Researcher:
Did the participant raise any questions? YES/NO

If Yes, what where they?

Statement of Consent:

Please indicate your response by **ticking or circling** the corresponding response to the statement

Statement		
I confirm that I have read and understood the information sheet. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily.	**Yes**	**No**
I understand that the researchers will always wear clothes/badges that make it clear that they are not a member of staff at the facility.	**Yes**	**No**
I agree to be observed as part of the **participant observation** for this study.	**Yes**	**No**
I understand that all the information collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes.	**Yes**	**No**
I understand that I may, at any stage, without prejudice, withdraw my consent and participation in the study.	**Yes**	**No**
I agree for my contact details to be stored so that the research team may contact me to participate in future research activities related to this study.	**Yes**	**No**
I agree for my information to be shared, processed and transferred anonymously with other researchers, and in trusted data repositories and, where relevant, beyond the juridical borders of South Africa.	**Yes**	**No**
I (of my own free will) declare myself prepared to participate in the study.	**Yes**	**No**

POPIA Compliance

In accordance with the provisions of the **Protection of Personal Information Act 4 of 2013** (as amended), I hereby consent:

a) To my personal information (hereinafter 'data') being collected, processed, shared and stored in accordance with the research protocol as approved by the WITS Human Research Ethics Committee (Medical);
b) To my anonymised data being shared, processed and transferred by third parties and between third parties, and where relevant beyond the jurisdictional borders of South Africa;
c) To all findings and results flowing from my anonymised data being broadly shared and published on the conclusion of the research

PARTICIPANT CONSENT:

		[__][__]/[__][__][__]/[__][__][__][__]	[__][__]:[__][__]
Participant's name and surname (Print)	**Participant's signature**	***d d m m m y y y y***	***Time***

STUDY STAFF:

		[__][__]/[__][__][__]/[__][__][__][__]	[__][__]:[__][__]
Study staff name and surname conducting consent (Print)	**Study staff's signature**	***d d m m m y y y y***	***Time***

WITNESS (if applicable):

		[__][__]/[__][__][__]/[__][__][__][__]	[__][__]:[__][__]
Witness name and surname (Print)	**Witness's signature**	***d d m m m y y y y***	***Time***

INFORMATION SHEET FOR HEALTH CARE WORKERS – In-depth Interview Component

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Sponsor: European Union
Principal Investigator: Dr Gloria Maimela
Institution: Wits RHI
Email: gmaimela@wrhi.ac.za
Contact number: <insert>

Hello, my name and surname is _____ (insert name). I am a _____(insert designation) at the Wits RHI Climate and Health Directorate. Together with colleagues at Wits RHI, we are conducting a research study to investigate the effect of indoor heat on the physical health and mental wellbeing of health care workers (HCWs) and on productivity and the quality of care provided. We would like to invite you to participate in our study.

What you should know about this research study:

- Before agreeing to participate, we are giving you this participant information sheet and consent form so that you may read about the purpose, risks, and benefits of this research study.
- You have the right to refuse to take part, and you have the right to agree to take part now and change your mind later.
- Whatever you decide, it will not affect your regular work.
- Please review this consent form carefully. Ask any questions before you make a decision.
- Your participation is voluntary.
- Thank you for reading this information. If you decide to take part in the study, you will be asked to complete a consent form.
- If you have any questions, please do not hesitate to ask me.

PURPOSE OF STUDY

You are being invited to participate in a study that seeks to understand how ambient heat in the workplace impacts on HCWs' physical and mental wellbeing, their productivity, and the quality of care provided. Results from these interviews will help us to design an intervention to improve health facilities' adaptation to heat and thereby improve working conditions and health outcomes. The study is being conducted in Zimbabwe, South Africa and Sweden.

Why am I being asked to participate in this research study?
You are being asked to participate in this study because you are a HCW:

- Aged 18 years and above
- Working full-time at Stanza Bopape Community healthcare Centre (CHC) or Mamelodi Hospital
- Working in antenatal, maternal, labour or neonatal ward/clinic
- Able and willing to consent to provide data for the study

PROCEDURES AND DURATION
The specific component of the study for which we are seeking your consent today is the **In-depth Interview** component. In the South African site in Tshwane, we will be interviewing up to 20 HCWs in this component.

If you agree to take part in this study, you will be interviewed individually by a researcher trained to carry out qualitative interviews. During the interview, we will ask about your experiences of how heat affects you and other HCWs in the workplace, specifically, how it affects your health and wellbeing, work performance, and quality of care provided. We will also ask about your coping strategies when temperatures are high, and your perspectives on what can be done in health facilities to keep staff and patients cool. There are no right or wrong answers; we are interested to know more about your experiences and ideas. We expect that the interview will take approximately 1 hour.

RISKS AND DISCOMFORTS
The most important risk is breach of confidentiality, but this risk is low as we will use security measures to protect your personal data. An additional risk of participating in this study is that you may be anxious that you are being evaluated, which may make you feel uncomfortable. Our researchers have been trained in creating a supportive environment, without interfering with your regular work. Informal conversations will only be held when it is conducive for you with limited interruption of the work schedule.

Participation is entirely voluntary. It is important to know that you can stop your participation in this study at any time, without any consequences. You can also choose to skip a question if you do not feel at ease.

BENEFITS AND/OR COMPENSATION
There are no direct benefits to participating in this study. It is expected that the results will inform the development of an intervention intended to improve working conditions at health facilities. You will not need to pay anything to take part in the study. You will be reimbursed R400 for your refreshment costs, time and inconvenience.

CONFIDENTIALITY
Your data will be collected, processed, and stored according to the South African Protection of Personal Information (POPI) Act of 2013. To protect your confidentiality, no personal identifiers will appear in any verbal presentations, reports and publications that make use of this interview data.

All electronic data will be protected by security access codes. We will use a unique participant identification (ID) number instead of your name when storing and analyzing your

data. Any written information will be kept under lock and key in a cabinet and separately from any information that identifies you (such as the consent form). After study completion, files/information will be kept securely at the project office for a period of 6 years after all analysis and publications are complete for this study and then will be destroyed. Your de-identified data may be stored electronically for a longer than 6 years for use in other studies if you agree. No identifiable information will be shared with your colleagues or facility managers.

Who may see, use or share the information collected during this study about you?
The researchers that are involved in this study have access to this information. Organizations that may look at and/or copy your research records for ethical, research, quality assurance, and data analysis include:

- Wits Human Research Ethics Committee
- London School of Hygiene and Tropical Medicine Ethics Committee

Additionally, we may share your de-identified information with researchers for use in other research studies if you agree to this. The information will be labelled with a unique code, and we will not share your name.

VOLUNTARY PARTICIPATION
It is your decision to take part in this study or not. Taking part in this study is completely voluntary. You may stop your participation in the study at any time without penalty. No matter what decision you make, there will be no negative consequences to you in any way.

ETHICAL APPROVAL
This study has been submitted to the University of Witwatersrand, Human Research Ethics Committee, and this committee has granted written approval.

If you have study questions, or a study related problem?
If you have any questions about your participation in this study, please contact:

Dr Gloria Maimela
Wits RHI
22 Esselen Street, Hillbrow, Johannesburg 2100
gmaimela@wrhi.ac.za
<insert telephone number>

If you have any questions concerning this study or consent form beyond those answered by the investigator, including questions about the research, your rights as a research participant or research-related injuries; or if you feel that you have been treated unfairly and would like to talk to someone other than a member of the research team, please feel free to contact the University of Witwatersrand Human Research Ethics Committee, via email to Prof. Clement Penny at clement.penny@wits.ac.za or by calling during office hours: 011 717 2301.

YOU WILL HAVE A COPY OF THIS INFORMATION SHEET TO KEEP

Thank you for taking the time to consider partaking in this study.

Health Care Worker Informed Consent Form for In-depth Interview

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Principal Investigator: Dr Gloria Maimela

OFFER TO ANSWER QUESTIONS
Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

For Researcher:
Did the participant raise any questions? YES/NO

If Yes, what where they?

Statement of Consent:

Please indicate your response by **ticking or circling** the corresponding response to the statement

Statement		
I confirm that I have read and understood the information sheet. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily.	**Yes**	**No**
I understand that the researchers will always wear clothes/badges that make it clear that they are not a member of staff at the facility.	**Yes**	**No**
I agree to take part in an **In-depth Interview** for this study.	**Yes**	**No**
I understand that all the information collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes.	**Yes**	**No**
I understand that I may, at any stage, without prejudice, withdraw my consent and participation in the study.	**Yes**	**No**
I agree for my contact details to be stored so that the research team may contact me to participate in future research activities related to this study.	**Yes**	**No**
I agree for my information to be shared, processed and transferred anonymously with other researchers, and in trusted data repositories and, where relevant, beyond the juridical borders of South Africa.	**Yes**	**No**
I (of my own free will) declare myself prepared to participate in the study.	**Yes**	**No**

POPIA Compliance

In accordance with the provisions of the **Protection of Personal Information Act 4 of 2013** (as amended), I hereby consent:

d) To my personal information (hereinafter 'data') being collected, processed, shared and stored in accordance with the research protocol as approved by the WITS Human Research Ethics Committee (Medical);

e) To my anonymised data being shared, processed and transferred by third parties and between third parties, and where relevant beyond the jurisdictional borders of South Africa;

To all findings and results flowing from my anonymised data being broadly shared and published on the conclusion of the research

Appendix 10: Participant information sheet and informed consent form for key informant interview component

INFORMATION SHEET FOR KEY INFORMANTS – Key Informant Interview Component

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Sponsor: European Union
Principal Investigator: Dr Gloria Maimela
Institution: Wits RHI
Email: gmaimela@wrhi.ac.za
Contact number: <insert>

Hello, my name and surname is _____ (insert name). I am a _____(insert designation) at the Wits RHI Climate and Health Directorate. Together with colleagues at Wits RHI, we are conducting a research study to investigate the effect of indoor heat on the health and wellbeing of health care workers (HCWs) and on productivity and the quality of care provided. We would like to invite you to participate in our study.

What you should know about this research study:

- Before agreeing to participate, we are giving you this participant information sheet and consent form so that you may read about the purpose, risks, and benefits of this research study.
- You have the right to refuse to take part, and you have the right to agree to take part now and change your mind later.
- Whatever you decide, it will not affect your regular work.
- Please review this consent form carefully. Ask any questions before you make a decision.
- Your participation is voluntary.
- Thank you for reading this information. If you decide to take part in the study, you will be asked to complete a consent form.
- If you have any questions, please do not hesitate to ask me.

PURPOSE OF STUDY

You are being invited to participate in a study that seeks to understand how HCWs in maternity and newborn care are affected by ambient heat in the workplace. We want to understand the impact of heat on their physical and mental wellbeing, their productivity, and the quality of care provided, as well as how health facilities may be adapted to cope with rising temperatures caused by climate change. Results from these interviews will help to inform our design of an intervention to improve health facilities' adaptation to heat and thereby improve working conditions and health outcomes. The study is being conducted in Zimbabwe, South Africa and Sweden.

Why am I being asked to participate in this research study?
You are being asked to participate in this study because you are:

- Familiar with information on heat adaptation strategies, HCW wellbeing, and quality of care in healthcare facilities
- Aged 18 years and above
- Able and willing to consent to provide data for the study

PROCEDURES AND DURATION
The specific component of the study for which we are seeking your consent today is the **Key Informant Interview** component. In the South African site in Tshwane, we will be interviewing up to 15 key informants, including health facility, district and regional managers, and selected community members with knowledge and/or experience in this area.

If you agree to take part in this study, you will be interviewed individually by a researcher trained to carry out qualitative interviews. During the interview, we will ask about contextual information central to the development of strategies and interventions to cope with heat in health settings. We will also invite you to share your views on the impact of heat on the community and on health facilities, as well as your knowledge of heat adaptations that are being undertaken in other institutions or with the community. We expect that the interview will take approximately 45-60 minutes.

Participation is entirely voluntary. It is important to know that you can stop your participation in this study at any time, without any consequences. You can also choose not to answer a question if you do not feel at ease.

RISKS AND DISCOMFORTS
The most important risk is breach of confidentiality, but this risk is low as we will use a number of security measures to protect your personal data. There may be a time inconvenience for you if the interview exceeds the expected duration.

BENEFITS AND/OR COMPENSATION
There are no direct benefits to participating in this study, but it is expected that the results will inform the development of an intervention intended to improve working conditions at health facilities. You will not need to pay anything to take part in the study. You will be reimbursed R400 for your refreshment costs, time and inconvenience.

CONFIDENTIALITY
Your data will be collected, processed, and stored according to the South African Protection of Personal Information (POPI) Act of 2013. To protect your confidentiality, no personal identifiers will appear in any verbal presentations, reports and publications that make use of this interview data.

All electronic data will be protected by security access codes. We will use a unique participant identification (ID) number instead of your name when storing and analyzing your data. Any written information will be kept under lock and key in a cabinet and separately from any information that identifies you (such as the consent form). After study completion, files/information will be kept securely at the project office for a period of 6 years after all analysis and publications are complete for this study and then will be destroyed. Your de-

identified data may be stored electronically for a longer than 6 years for use in other studies if you agree. No identifiable information will be shared with your colleagues or facility managers.

Who may see, use or share the information collected during this study about you?
The researchers that are involved in this study have access to this information. Organizations that may look at and/or copy your research records for ethical, research, quality assurance, and data analysis include:

- Wits Human Research Ethics Committee
- London School of Hygiene and Tropical Medicine Ethics Committee

Additionally, we may share your de-identified information with researchers for use in other research studies if you agree to this. The information will be labelled with a unique code, and we will not share your name.

VOLUNTARY PARTICIPATION
It is your decision to take part in this study or not. Taking part in this study is completely voluntary. You may stop your participation in the study at any time without penalty. No matter what decision you make, there will be no negative consequences to you in any way.

ETHICAL APPROVAL
This study has been submitted to the University of Witwatersrand, Human Research Ethics Committee, and this committee has granted written approval.

If you have study questions, or a study related problem?
If you have any questions about your participation in this study, please contact:

Dr Gloria Maimela
Wits RHI
22 Esselen Street, Hillbrow, Johannesburg 2100
gmaimela@wrhi.ac.za
<insert telephone number>

If you have any questions concerning this study or consent form beyond those answered by the investigator, including questions about the research, your rights as a research participant or research-related injuries; or if you feel that you have been treated unfairly and would like to talk to someone other than a member of the research team, please feel free to contact the University of Witwatersrand Human Research Ethics Committee, via email to Prof. Clement Penny at clement.penny@wits.ac.za or by calling during office hours: 011 717 2301.

YOU WILL HAVE A COPY OF THIS INFORMATION SHEET TO KEEP

Thank you for taking the time to consider partaking in this study.

Informed Consent Form for Key Informant Interview

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Principal Investigator: Dr Gloria Maimela

OFFER TO ANSWER QUESTIONS
Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

For Researcher:
Did the participant raise any questions? YES/NO

If Yes, what where they?

Statement of Consent:

Please indicate your response by **ticking or circling** the corresponding response to the statement

Statement		
I confirm that I have read and understood the information sheet. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily.	**Yes**	**No**
I agree to take part in a **Key Informant Interview** for this study.	**Yes**	**No**
I understand that all the information collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes.	**Yes**	**No**
I understand that I may, at any stage, without prejudice, withdraw my consent and participation in the study.	**Yes**	**No**
I agree for my contact details to be stored so that the research team may contact me to participate in future research activities related to this study.	**Yes**	**No**
I agree for my information to be shared, processed and transferred anonymously with other researchers, and in trusted data repositories and, where relevant, beyond the juridical borders of South Africa.	**Yes**	**No**
I (of my own free will) declare myself prepared to participate in the study.	**Yes**	**No**

POPIA Compliance

In accordance with the provisions of the **Protection of Personal Information Act 4 of 2013** (as amended), I hereby consent:

f) To my personal information (hereinafter 'data') being collected, processed, shared and stored in accordance with the research protocol as approved by the WITS Human Research Ethics Committee (Medical);

g) To my anonymised data being shared, processed and transferred by third parties and between third parties, and where relevant beyond the jurisdictional borders of South Africa;

h) To all findings and results flowing from my anonymised data being broadly shared and published on the conclusion of the research

INFORMATION SHEET FOR HEALTH CARE WORKERS – Time-motion Study Component

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Sponsor: European Union
Principal Investigator: Dr Gloria Maimela
Institution: Wits RHI
Email: gmaimela@wrhi.ac.za
Contact number: <insert>

Hello, my name and surname is _____ (insert name). I am a_____ (insert designation) at the Wits RHI Climate and Health Directorate. Together with colleagues at Wits RHI, we are conducting a research study to investigate the effect of indoor heat on the physical health and mental wellbeing of health care workers (HCWs) and on productivity and the quality of care provided. We would like to invite you to participate in our study.

What you should know about this research study:

- Before agreeing to participate, we are giving you this participant information sheet and consent form so that you may read about the purpose, risks, and benefits of this research study.
- You have the right to refuse to take part, and you have the right to agree to take part now and change your mind later.
- Whatever you decide, it will not affect your regular work.
- Please review this consent form carefully. Ask any questions before you make a decision.
- Your participation is voluntary.
- Thank you for reading this information. If you decide to take part in the study, you will be asked to complete a consent form.
- If you have any questions, please do not hesitate to ask me.

PURPOSE OF STUDY

You are being invited to participate in a study that seeks to understand the impact of ambient heat on HCWs' working environments, their physical and mental wellbeing, their productivity, and on the quality of care provided. This study focuses only on HCWs working in maternity and newborn care. The results from this study will help to design a program that can improve health facilities' adaptation to heat and thereby improve working conditions and health outcomes. The study is being conducted in Zimbabwe, South Africa and Sweden.

Why am I being asked to participate in this research study?
You are being asked to participate in this study because you are a HCW:

- Aged 18 years and above
- Working full-time at Stanza Bopape Community healthcare Centre (CHC) or Mamelodi Hospital
- Working in antenatal, maternal, labour or neonatal ward/clinic
- Able and willing to consent to provide data for the study

PROCEDURES AND DURATION
The specific component of the study for which we are seeking your consent today is the **Time-motion assessment** component. Time-motion assessment is a method of collecting data on clinical work patterns through observation of activities that HCWs do as they go about their work or engage in other daily activities.

In this study component, we wish to observe you and other HCWs in your work environment, focusing on how heat affects your workflow. We will assess your work task activities, people involved in the task, the time taken to complete tasks, and the methods of the task performance, as well as interruptions to your work and multitasking. We will also ask you to wear two non-invasive sensors; one that will be attached to your wrist to measure the number of steps that you take in your shift and your heart rate and one that will be put around your chest to measure your core body temperature. You will be able to view your heart rate and other results of the sensors if you wish. We will give you the sensors before the start of the observations, so that you can get used to them. You will return the sensors at the end of the study period. Finally, we will record the type of clothing that you are wearing while participating in the assessment, as this may also affect your body temperature.

We will perform these observations over a period of 3-5 weeks, and for two time periods – once when the temperature is cool and once when it is hot. Observations will be carried out at different times of the day so that we may capture activity patterns across the shift.

Researchers trained to carry out these assessments will be stationed in the antenatal, maternal, labour, and neonatal wards/clinics at different times of the day and on different days of the week. They will move around these spaces but remain unobtrusive, and as far as possible, their observations will not interfere with the duties you carry out as a HCW. The researchers will take notes on a tablet or other electronic device about what they are observing.

It is important to be clear that our observations are **not** intended to monitor staff performance or to identify errors in the care you provide. Information gathered during the observations will not

be shared with your supervisors, but anonymous information may be shared with relevant stakeholders in government and with our research partners in Sweden, Zimbabwe, and the UK. The primary purpose of collecting this observation data is to inform our development of an intervention that will be tested in another component of the study.

Your privacy and confidentiality will be protected throughout, and no personal identifying information will be collected on any individuals who are observed in this activity. No names will be collected or published in our reports or academic articles. No photographs or videos will be taken of any individuals who are observed.

RISKS AND DISCOMFORTS

The most important risk is breach of confidentiality, but this risk is low as we will use security measures to protect your personal data. An additional risk of participating in this study is that you may be anxious that you are being evaluated, which may make you feel uncomfortable. Our researchers have been trained in creating a supportive environment, without interfering with your regular work. Informal conversations will only be held when it is conducive for you with limited interruption of the work schedule. It is important to know that you can stop your participation in this study at any time, without any consequences.

BENEFITS AND/OR COMPENSATION

There are no direct benefits or reimbursement from participating in these observations. It is expected that the results will inform the development of an intervention intended to improve working conditions at health facilities. You will not need to pay anything to take part in the study. At the end of the observation period, you will be reimbursed R400 for your time and inconvenience.

CONFIDENTIALITY

Your data will be collected, processed, and stored according to the South African Protection of Personal Information (POPI) Act of 2013. To protect your confidentiality, no personal identifiers will appear in any verbal presentations, reports and publications that make use of this observation data. All electronic data will be protected by security access codes. We will use a unique participant identification (ID) number instead of your name when storing and analyzing your data. Any written information will be kept under lock and key in a cabinet and separately from any information that identifies you (such as this consent form). After study completion, files/information will be kept securely at the project office for a period of 6 years after all analysis and publications are complete for this study and then will be destroyed. Your de-identified data may be stored electronically for a longer than 6 years for use in other studies if you agree. No identifiable information will be shared with your colleagues or facility managers.

Who may see, use or share the information collected during this study about you?

The researchers that are involved in this study have access to this information. Organizations that may look at and/or copy your research records for ethical, research, quality assurance, and data analysis include:

- Wits Human Research Ethics Committee
- London School of Hygiene and Tropical Medicine Ethics Committee

Additionally, we may share your de-identified information with researchers for use in other research studies if you agree to this. The information will be labelled with a unique code, and we will not share your name.

VOLUNTARY PARTICIPATION
It is your decision to take part in this study or not. Taking part in this study is completely voluntary. You may stop your participation in the study at any time without penalty. No matter what decision you make, there will be no negative consequences to you in any way.

ETHICAL APPROVAL
This study has been submitted to the University of Witwatersrand, Human Research Ethics Committee, and this committee has granted written approval.

If you have study questions, or a study related problem?
If you have any questions about your participation in this study, please contact:

Dr Gloria Maimela
Wits RHI
22 Esselen Street, Hillbrow, Johannesburg 2100
gmaimela@wrhi.ac.za
<insert telephone number>

If you have any questions concerning this study or consent form beyond those answered by the investigator, including questions about the research, your rights as a research participant or research-related injuries; or if you feel that you have been treated unfairly and would like to talk to someone other than a member of the research team, please feel free to contact the University of Witwatersrand Human Research Ethics Committee, via email to Prof. Clement Penny at clement.penny@wits.ac.za or by calling during office hours: 011 717 2301.

YOU WILL HAVE A COPY OF THIS INFORMATION SHEET TO KEEP

Thank you for taking the time to consider partaking in this study.

Health Care Worker Informed Consent Form for Time-motion Assessment

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Principal Investigator: Dr Gloria Maimela

OFFER TO ANSWER QUESTIONS
Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

For Researcher:
Did the participant raise any questions? YES/NO

If Yes, what where they?

Statement of Consent:

Please indicate your response by **ticking or circling** the corresponding response to the statement

Statement		
I confirm that I have read and understood the information sheet. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily.	**Yes**	**No**
I understand that the researchers will always wear clothes/badges that make it clear that they are not a member of staff at the facility.	**Yes**	**No**
I agree to be observed as part of the **time-motion assessment** for this study.	**Yes**	**No**
I understand that all the information collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes.	**Yes**	**No**
I understand that I may, at any stage, without prejudice, withdraw my consent and participation in the study.	**Yes**	**No**
I agree for my contact details to be stored so that the research team may contact me to participate in future research activities related to this study.	**Yes**	**No**
I agree for my information to be shared, processed and transferred anonymously with other researchers, and in trusted data repositories and, where relevant, beyond the juridical borders of South Africa.	**Yes**	**No**
I (of my own free will) declare myself prepared to participate in the study.	**Yes**	**No**

POPIA Compliance

In accordance with the provisions of the **Protection of Personal Information Act 4 of 2013** (as amended), I hereby consent:

a) To my personal information (hereinafter 'data') being collected, processed, shared and stored in accordance with the research protocol as approved by the WITS Human Research Ethics Committee (Medical);
b) To my anonymised data being shared, processed and transferred by third parties and between third parties, and where relevant beyond the jurisdictional borders of South Africa;

To all findings and results flowing from my anonymised data being broadly shared and published on the conclusion of the research

Appendix 12: Participant information sheet and informed consent form for survey component

INFORMATION SHEET FOR HEALTH CARE WORKERS – Survey Component

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Sponsor: European Union
Principal Investigator: Dr Gloria Maimela
Institution: Wits RHI
Email: gmaimela@wrhi.ac.za
Contact number: <insert>

Hello, my name and surname is _____ (insert name). I am a (insert designation) at the Wits RHI Climate and Health Directorate. Together with colleagues at Wits RHI, we are conducting a research study to investigate the effect of indoor heat on the physical health and mental wellbeing of health care workers (HCWs) and on the productivity and the quality of care provided. We would like to invite you to participate in our study.

What you should know about this research study:

- Before agreeing to participate, we are giving you this participant information sheet and consent form so that you may read about the purpose, risks, and benefits of this research study.
- You have the right to refuse to take part, and you have the right to agree to take part now and change your mind later.
- Whatever you decide, it will not affect your regular work.
- Please review this consent form carefully. Ask any questions before you make a decision.
- Your participation is voluntary.
- Thank you for reading this information. If you decide to take part in the study, you will be asked to complete a consent form.
- If you have any questions, please do not hesitate to ask me.

PURPOSE OF STUDY

You are being invited to participate in a study that seeks to understand the impact of ambient heat on HCWs' working environments, their physical and mental well-being, their productivity, and the quality of care provided. This study focuses on HCW working in maternity and newborn care and will be carried out twice – once during a hotter period and once during a cooler period. The results from this study will help to design a program that can improve health facilities adaptation to heat and thereby improve working conditions and health outcomes. The study is being

conducted in Zimbabwe, South Africa and Sweden. In South Africa, a minimum of 80 HCWs will participate in the study.

Why am I being asked to participate in this research study?
You are being asked to participate in this study because you are a HCW:

- Aged 18 years and above
- Working full-time at Stanza Bopape Community Healthcare Centre (CHC) or Mamelodi Hospital
- Working in antenatal, maternal, labour, or neonatal ward/clinic
- Able and willing to consent to provide data for the study

PROCEDURES AND DURATION
If you agree to take part in this study, you will be expected to participate in an anonymous survey and urine collection.

1) You will be requested to participate in an anonymous survey asking about your wellbeing in relation to your work at the facility which will last approximately thirty to forty-five minutes. If you are still at the same healthcare facility, you will be invited to complete the same survey twice, once in the hot season and once in the cold season. We will store your contact details to be able to contact you to participate in future surveys.
2) You will be requested to provide a urine sample to check for urine osmolarity, a commonly used biomarker for hydration status. This will be done at the end of a shift, on the day that you complete the survey.

RISKS AND DISCOMFORTS
The most important risk is breach of confidentiality, but this risk is low as we will use security measures to protect your personal data. An additional risk of participating in this study is that you may be anxious that you are being evaluated, which may make you feel uncomfortable. Our researchers have been trained in creating a supportive environment, without interfering with your regular work. It is important to know that you can stop your participation in this study at any time, without any consequences. You can also choose to skip a question if you do not feel at ease. There are no risks to urine collection. If we find any abnormalities in your urine, or results from the survey, we will notify and refer you for further care if required.

BENEFITS AND/OR COMPENSATION
There are no direct benefits to participating in this study. It is expected that the results will inform the development of an intervention intended to improve heat-related working conditions at health facilities. You will not need to pay anything to take part in the study. You will be reimbursed R400 for your refreshment costs, time, and inconvenience.

CONFIDENTIALITY
Your data will be collected, processed and stored according to the South African Protection of Personal Information (POPI) Act of 2013. To protect your confidentiality, no personal identifiers will appear on the surveys, urine specimens or in any verbal presentations, reports and

publications. All your data will be protected by security access codes. We will use a unique participant identification (ID) number instead of your name when storing and analysing your data. Any written information will be kept under lock and key in a cabinet and separately from any information that identifies you (such as this consent form). After study completion, files/information will be kept securely at the project office for a period of 6 years after all analysis and publications are complete for this study and then will be destroyed. Your de-identified data may be stored electronically for a longer than 6 years for use in other studies if you agree. No identifiable information will be shared with your colleagues or facility managers.

Who may see, use or share the information collected during this study about you?
The researchers that are involved in this study have access to this information. Organizations that may look at and/or copy your research records for ethical, research, quality assurance, and data analysis include:

- Wits Human Research Ethics Committee
- South African National Health Research Ethics Council (NHREC)
- London School of Hygiene and Tropical Medicine Ethics Committee

Additionally, we may share your de-identified information with researchers for use in other research studies if you agree to this. The information will be labelled with a unique code and we will not share your name. You will mark your decision at the end of this form.

VOLUNTARY PARTICIPATION
It is your decision to take part in this study or not. Taking part in this study is completely voluntary. You may stop your participation in the study at any time without penalty. No matter what decision you make, there will be no negative consequences to you in any way.

ETHICAL APPROVAL
This study has been submitted to the University of Witwatersrand, Human Research Ethics Committee, and this committee has granted written approval.

If you have study questions, or a study related problem?
If you have any questions about your participation in this study, please contact:

Dr Gloria Maimela
Wits RHI
22 Esselen Street, Hillbrow, Johannesburg 2100
gmaimela@wrhi.ac.za
<insert telephone number>

If you have any questions concerning this study or consent form beyond those answered by the investigator, including questions about the research, your rights as a research participant or research-related injuries; or if you feel that you have been treated unfairly and would like to talk to someone other than a member of the research team, please feel free to contact the University of

Witwatersrand Human Research Ethics Committee, via email to Prof. Clement Penny at clement.penny@wits.ac.za or by calling during office hours: 011 717 2301.

YOU WILL HAVE A COPY OF THIS INFORMATION SHEET TO KEEP.

Thank you for taking the time to consider partaking in this study.

Health Care Worker Informed Consent Form for Survey

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Principal Investigator: Dr Gloria Maimela

OFFER TO ANSWER QUESTIONS
Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

For Researcher:
Did the participant raise any questions? YES/NO

If Yes, what where they?

Statement of Consent:

Please indicate your response by **ticking or circling** the corresponding response to the statement

Statement		
I confirm that I have read and understood the information sheet. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily.	**Yes**	**No**
I understand that the researchers will always wear clothes/badges that make it clear that they are not a member of staff at the facility	**Yes**	**No**
I agree to participate in a **confidential survey.**	**Yes**	**No**
I agree to submit a **urine sample** and provide the result to the study team.	**Yes**	**No**
I understand that all the information collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes.	**Yes**	**No**
I understand that I may, at any stage, without prejudice, withdraw my consent and participation in the study.	**Yes**	**No**
I agree for my contact details to be stored so that the research team may contact me to participate in future research activities related to this study.	**Yes**	**No**
I agree for my information to be shared, processed and transferred anonymously with other researchers, and in trusted data repositories, and where relevant beyond the juridical borders of South Africa.	**Yes**	**No**
I (of my own free will) declare myself prepared to participate in the study.	**Yes**	**No**

POPIA Compliance

In accordance with the provisions of the **Protection of Personal Information Act 4 of 2013** (as amended), I hereby consent:

c) To my personal information (hereinafter 'data') being collected, processed, shared and stored in accordance with the research protocol as approved by the WITS Human Research Ethics Committee (Medical);

d) To my anonymised data being shared, processed and transferred by third parties and between third parties, and where relevant beyond the jurisdictional borders of South Africa;

To all findings and results flowing from my anonymised data being broadly shared and published on the conclusion of the research.

INFORMATION SHEET FOR PATIENTS – Participant Observation Component

Title of the research study: HIGH Horizons Health Care Worker Study in South Africa, Sweden, and Zimbabwe

Sponsor: European Union
Principal Investigator: Dr Gloria Maimela
Institution: Wits RHI
Email: gmaimela@wrhi.ac.za
Contact number: <insert>

Hello, my name is Dr Gloria Maimela, I am a Researcher at the Wits RHI Climate and Health Directorate. Together with colleagues at Wits RHI, we are conducting a research study about how heat affects the physical health and mental wellbeing of health care workers in maternity and newborn care, as well as their productivity and the quality of care provided. Results from this study will help us to design a program to help make health facilities cooler in the hot season, and thereby improve working conditions for health care workers and health outcomes for patients. The study is being conducted in Zimbabwe, South Africa and Sweden.

As part of the study, we will be carrying out **Participant Observation.** This is a method of collecting research information through observing a set of activities or group of people as they go about their work or engage in other daily activities.

Researchers trained to carry out such observations (and wearing easily identifiable badges) will be present in the antenatal, maternal, labour and neonatal wards/clinics at different times of the day and on different days of the week. They will move around these spaces and try to stay out of the way as much as possible. Occasionally, the researchers will take written notes about what they are observing.

These researchers will be observing the health care workers as they administer care in these wards/clinics, rather than the patients. In the process, however, some aspects of health care worker-patient interaction may be observed. Researchers will not observe sensitive procedures (e.g. a patient undergoing a vaginal examination).

Your privacy and confidentiality will be protected throughout, and no personal identifying information will be collected on any individuals who are observed in this activity. No names will be collected or published in our reports or academic articles. No photographs or videos will be taken of any individuals who are observed. Information gathered during the observations will only be shared with relevant stakeholders in government and with our research partners in Sweden, Zimbabwe and the UK.

If you do not wish to be observed, you have the right to 'opt out' of these observations, and it will not affect the care you receive in this facility.

To opt out, simply tell the researchers and they will respect your decision. No one except the researcher will know that you have opted out of the observations.

ETHICAL APPROVAL
This study has been approved by the University of Witwatersrand, Human Research Ethics Committee. If you have study questions, or a study related problem, please contact:

Dr Gloria Maimela
Wits RHI
22 Esselen Street, Hillbrow, Johannesburg 2100
gmaimela@wrhi.ac.za
<insert telephone number>

If you have any questions concerning this study or consent form beyond those answered by the investigator, including questions about the research, your rights as a research participant or research-related injuries; or if you feel that you have been treated unfairly and would like to talk to someone other than a member of the research team, please feel free to contact the University of Witwatersrand Human Research Ethics Committee, via email to Prof. Clement Penny at clement.penny@wits.ac.za or by calling during office hours: 011 717 2301.

YOU WILL HAVE A COPY OF THIS INFORMATION SHEET TO KEEP

Thank you for considering participation in this study.