RESEARCH PAPER

June 2024

Utilization of Heat Early Warning Resources Within Slum Communities in Nigeria

Authors

Olumuyiwa Bayode Adegun[1],
Tobi Eniolu Morakinyo[2] and
Peter Elias[3]

1. Federal University of Technology, Akure, Nigeria <muyiwaadegun@yahoo.co.uk>
2. University College Dublin, Dublin. Ireland <tobi.morakinyo@ucd.ie>
3. University of Lagos, Lagos, Nigeria pelias@unilag.edu.ng

Global Disaster Preparedness Center

Table of Contents

ABSTRACT

Slums face critical risks from exposure to extreme temperatures. The report present results of a study on the utilization of early warning resources in selected slum communities in Akure and Lagos, Nigeria. Through community surveys (n=637) and focus group discussions, the study examined awareness of heat warnings, barriers to access, preferences for receiving information, and actions taken. The findings revealed low awareness of available heat warnings, which impacted anticipatory actions taken. Barriers included the infrequency, language, and delivery methods of the information. Most residents preferred receiving heat warnings via radio, in-person communication, SMS, and printed materials. A Community Heat Early Warning System was developed and tested over 38 days (January–February 2024) in the two communities. Feedback through focus groups and interviews indicated a positive reception, with recommendations for improvement and scalability. The study highlights the potential of a bottom-up and hybrid top-down-bottom-up approach for heat risk communication, aiming to empower vulnerable urban settlements by improving their preparedness for extreme heat events and enhancing climate resilience.

Research funded by the Global Disaster Preparedness Center of the American Red Cross.

Global Disaster Preparedness Center | American Red Cross

1.0 INTRODUCTION

Globally, natural and man-induced disasters have been on the increase. For instance, between 2015 and 2018, Africa was impacted by over 700 disaster events (from flooding to drought, hurricanes, heat waves, and so on) which affected around 80 million individuals and resulted in over 66,000 mortalities (African Union Commission, 2022). In Nigeria, more than 6000 deaths and 500,000 people were displaced and made homeless between 2010 and 2018, due to various types of disasters (National Emergency Management Authority, 2018). Urban settlements are hotspots of these disasters. For instance, large cities that are exposed to cyclones are projected to increase from 310 to 680 million between year 2000 and 2050 (Baker, 2012). The global assessment report on disaster risk reduction published by the United Nations International Strategy for Disaster Reduction (2009) shows that "both disaster occurrence and loss are associated with processes that increase the hazard exposure of the poor – for example, the expansion of informal settlements". These statistics show the imperative of improved disaster preparedness to reduce negative impacts, especially in the unravelling context of climate change.

Extreme weather events and high levels of vulnerability associated with climate change show the importance of early warning. The World Meteorological Organisation (WMO) believes that Early Warning Systems can provide over ten times return on investment. The WMO (2023) explains that, for example, providing a 24-hour notification of an impending hazardous event can cut the ensuing damage by 30% or more. Estimates also show that countries with substantial to comprehensive early warning systems have one-eighth of the disaster mortality compared with those with limited or no form of early warning systems (WMO, 2023). According to the United Nations Office for Disaster Risk Reduction, Nigeria is among the many African countries that do not have or report having multi-hazard early warning systems. In many countries, when early warning systems are available, they operate at a national level and often fail to effectively reach last-mile communities. Even when early warning information is disseminated to at-risk communities, it is often not properly understood or appropriate action taken.

Parts of cities categorised as slums and informal settlements are communities with disadvantaged and at-risk people located at the 'last mile'. At times, being excluded from the formal economy, these communities are the last to benefit from municipal services and interventions. Available estimate indicates that 13.8% of the world's urban population lives in slums or slum-like conditions in cities and 51.3% of this number (approximately 218 million) are in sub-Saharan Africa alone (UN-Habitat, 2020).

In Nigeria, the situation is particularly dire as nearly 50% of the urban population resides in vulnerable slums and informal communities (UN-Habitat, 2012). High densities, poorly constructed dwellings, and more importantly lack of awareness and adaptive capacities characterize these areas (Elias, 2018). These communities face critical risks from extreme temperatures and dangerous heat wave events in the context of climate change.

This report captures the process and outcomes of a study that evaluates the utilization of early warning resources for extreme heat in selected slum communities in Akure, Ondo State and Lagos, Lagos State, Nigeria. The study sought to assess the utilization of early warning resources available and identify actions taken, access barriers and preferences for improvements towards developing a Community Heat Early Warning System tailored to slum communities. In line with the research objectives, this study involves three chronological work packages as follows:

1. evaluating utilization of heat-related weather information by the slum residents
2. developing and testing a Community Heat Early Warning System (CHEWS) in the selected communities
3. qualitative assessment of the Community Heat Early Warning System deployed in the communities.

Ultimately, the research seeks to empower vulnerable urban settlements by enhancing their preparedness for extreme heat events, strengthening their resilience, and fostering the adoption of community-based early warning systems in the face of climate change.

2.0 LITERATURE REVIEW

2.1 THE CONCEPTS OF EARLY WARNING EARLY ACTION

The United Nations International Strategy for Disaster Reduction defines an Early Warning System as a “set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare, act appropriately, and in sufficient time to reduce the possibility of harm or loss” (UNIDR, 2009).

Beyond early warning, early action is important. Early is also referred to as “anticipatory action” or “forecast-based action”. It involves practical steps taken, based on forecast information, to protect people before a disaster happens. Early warning-early action therefore refers to actions taken based on a forecast in advance of a hazardous event that are meant to avert or minimize negative impacts (REAP, 2022).

According to The UN Global Survey of Early Warning Systems, a complete and effective early warning system comprises four interrelated elements: ‘risk knowledge’, ‘monitoring and warning service’, ‘dissemination and communication’ and ‘response capability’. To be effective, early warning must meaningfully engage with at-risk communities hence the concept of Community or People-centred Early Warning Systems. These refer to "effort by or with a community to systematically collect, compile and/or analyse information that enables the dissemination of early warning messages that can help the community take action to reduce harm or loss from a hazard" (IFRC, 2022). It recognizes that engaging the at-risk communities in developing early warning systems can help ensure people heed warnings and take appropriate actions. Usually, emergency alerts from national early warning systems often do not reach everyone at risk, but community early warning can ensure information reaches and are actionable by those who are vulnerable. Where and when national early warning systems are available, Community early warning systems can complement the usually national governmental mandates to eliminate and reduce the impact of disaster through better preparation (ibid).

Early warnings and early action that reach last mile at-risk communities are an institutional priority for the global network of the International Federation of Red Cross. In line with Sufri et al. (2020), this means at-risk last mile communities should be involved in identifying and analysing the indicators for impending threats so that they can adequately prepare themselves. Community early warning requires that the community is engaged with the design and operation of the warning systems, and not only responding to warning messages. Based on a study which involved workshops with local stakeholders, Vandermolen et al. (2022) explained that increasing the effectiveness of heat risk warning messages would demand utilizing locally defined metrics to enable people to understand areas that are most vulnerable and why. They also recommended information about clear actions for mitigating health impacts at different levels and in diverse languages and formats, especially through story-telling and short videos that facilitate information equity.

2.2 EXTREME HEAT AS A DISASTER

Heatwaves, connected with exposure to extreme heat, are described by World Weather Attribution as one of the most fatal natural disasters. It is a silent killer. According to Sailor et al. (2019), heat is the number one weather-related killer in the United States. Ballester et al (2023) estimated that there were over 61,000 heat-related deaths across European countries during the hot summer between 30th May and 4th September of 2022. Available studies also indicate that “extreme temperatures are associated with high mortality and morbidity, especially amongst vulnerable populations” in African countries (Manyuchi et al., 2022). When it doesn't immediately lead to death, heat causes health problems. Exposure to heat results in increased blood pressure and heart rate, affecting the circulatory, nervous, respiratory, and renal systems (Khosla et. al., 2021). A critical review on heat stress and public health shows that exposure to extreme temperatures can have significant impacts on health and present a challenge for public health (Kovats et al., 2008). Most heat-related morbidity, mortality and non-health problems can be prevented or reduced with improved preparedness especially those which are based on proper utilization of early warning resources.

The duration and frequency of days with extremely high temperatures are increasing due to climate change (Adelekan et al., 2022). The ongoing rapid urbanization is exacerbating the health risk association with heat exposure. The unfolding scenario is especially a concern for countries where the living conditions are poor. It is estimated that over 2 billion people might face dangerous extreme heat in the coming decades. Of this, over 600 million are expected to be in India and over 300 million in Nigeria (Lenton et al., 2023). Literature shows that a notable proportion of urban residents in Nigeria experience exposure to extreme. In Lagos, average monthly temperature has increased by over 0.5°C since 1980 (Opperman et al., 2021) while Urban Heat Island (UHI) intensity has increased by over five times since 1984 (Bassett et al., 2020). In Adegoke and Dombo’s (2019:40) analysis of three decades of temperature data, they found that over 50% of Akure’s population has experienced some form of thermal discomfort.

Heat is a major challenge in slums and informal settlements which are typically at the last mile in rapidly growing cities in developing countries. Informal and unplanned urban areas significantly experience higher heat exposure, and they have lower capacities to adapt. For example, experimental studies within slums in Nairobi, Kenya (Scott et al., 2017), Makassar, Indonesia (Ramsay et al., 2021) and Pretoria, South Africa (Hugo and Sonnendecker, 2023) have confirmed higher vulnerability to extreme temperatures. Geo-spatial

assessments in Mumbai, India (Mehorotra et al., 2018) and Lagos, Nigeria (Obe et al., 2023) also affirm that poorer households are disproportionately exposed to extreme heat.

2.3 HEAT-RELATED WEATHER INFORMATION DISSEMINATION

The frequency of extreme heat events and the associated impacts on human health are expected to increase in a warming world. This expectation necessitates the design and implementation of early warning. While only 54% of 104 National Meteorological and Hydrological Services offer heat warning services, as at 2023, the WMO (2023) hopes that extreme heat services should rapidly increase globally by 2027. This means that all countries would need to develop and enhance their weather information dissemination services.

The United States of America pioneered the Hot Weather-Health Watch/Warning System during the 1990s (Kalkstein et al., 1995). It considered high-temperature forecasts alongside mortality risks. In Europe, heat early warning systems began to receive a lot of attention after the deadly 2003 summer heat waves. Almost every European country now has a heat-health early warning system which is usually the weather-based alert component of a wider heat-health action plan (Casanueva et al., 2019). In most of the European countries, the daily threshold of daily maximum temperature is region-specific and involves epidemiological studies linking heat to mortality data. The European Heat-Health warning systems “provide plenty of information through their websites, mobile apps, and social media (e.g., Twitter). Also, brochures, flyers and newsletters are sent to hospitals, nursing facilities and general practitioners”. Information is issued in the local language of each country. A few countries - Sweden, Hungary and Switzerland provide information in both local language and English (ibid).

Drawing insights from the German experience, Jones et al. (2015) explored the development and interests in Climate Information Systems for Heat-Health Early Warning. They found that 75% of users showed interest in weather-scale heat information, while 63% were interested in climate-scale data. Conversely, only 25% expressed interest in seasonal information, with little to no interest in decadal data, emphasizing the importance of timely and current information. This information guides heat action plans that should include phases focusing on forecasting, monitoring, warning, and alerting (Lowe et al., 2011).

Countries outside Europe also have their heat-health warning systems.

Ahmedabad (India) developed a heat action plan in 2013 after a deadly heat wave in 2010. The Heat Action Plan was updated in 2018 (Ahmedabad Municipal Cooperation, 2019). China also developed a heat-health warning system where health risk information was disseminated to community health centres and residents, especially vulnerable populations with underlying health conditions such as cardiovascular disease, respiratory disease, and diabetes. The heat-health information and their use were "communicated through fixed electronic display screens in the community, mobile text, instant messaging groups, and television through the daily weather forecast [as well as] posters, fliers, internet, newspapers, and a painting contest among students" (Li et al., 2018).

A clear lesson from the existing heat-health warning systems globally is the need for multi-sectoral cross-hierarchical cooperation. This kind of cooperation is an indispensable element for the smooth co-design and effective implementation. According to Casanueva et al. (2019: 2657), "joint collaboration of institutional agencies and multidisciplinary approaches are essential for successful development of heat-health warning systems and action plans". In the same vein, Elias (2018:129) argues that, to be successful, climate change communication in local urban communities "must involve coordination and cooperation at multiple levels of governance structure".

2.4 BARRIERS TO AND ENABLERS IN HEAT EARLY WARNING INFORMATION AND EARLY ACTION

In discussing strategies to enhance the reach and effectiveness of heat early warning systems, it is necessary to consider possible or real barriers. There is scant literature directly focussed on barriers in heat risk communication. The few available and accessed provide useful lessons. In their analysis of the heatwave early warning system in Ahmedabad, India, Trahan et al. (2023) identified some barriers. They noted that gender and literacy level limited access to and the effectiveness of early warning systems within the City's Heat Action Plan, which was the first plan in Southeast Asia. They noted that women face greater barriers to early warning information due to lower literacy levels, compared with males. Also, phone ownership was a major barrier. Over 60% of participants in their study did not own or have access to a mobile phone, which hindered them from receiving heat warnings disseminated through text or WhatsApp. Gender, age, and homeownership were also predictive factors found among residents in three German cities (Heidenreich and Thieken, 2024).

In VanderMolen et al.'s (2022) study, some barriers to heat risk communication were identified within heat-vulnerable communities in San Diego, California. These barriers include lack of comprehensive details in the information disseminated, problems with geographic specificity (not adequately fine-scaled) in the warning content, non-diversity in language and messaging format, as well as poor lead time in information dissemination. Some other hinderances are unfamiliarity or difficulty with communication technologies (e.g., emergency preparedness apps), lack of access to the internet and cell phones, and poor cellular networks. Also, socio-economic situations often hinder proper anticipatory actions even when heat warning messages are received. For example, when the right messages are well received, poor residents who cannot hold necessary insurance coverage nor can afford medical care can only do little in terms of anticipatory actions. Moreover, scepticism about the reliability of weather information disseminated might also hinder relevant anticipatory action.

Another barrier is the inability to meet the peculiar communication needs (in terms of channel or content) of special groups. In Slovenia, Pogacar et al (2020) noted that "very little information is available for older people on television and radio, and much more on the web and social media, which they do not use to this extent". Sihvonen (2023) aligned with this because he found that in Finland there were "plenty of elderly who are struggling with using or owning technical equipment like smartphones or computers". As a result, heat risk information and early warning channelled through these technologies might be missed.

Many of the challenges with early warning systems relate to a breakdown in communication of available weather information to the public and poor response capacities. In Perez et al's (2022) analysis of the big disasters of this century, they explain that "the lack of EWS protection is not a lack of forecasts or warnings, but rather a lack of adequate communication and lack of response capability". Through their survey in three medium-sized German cities, Heidenreich and Thieken (2024) found that response costs and efficacy were among the predictors of outcome variables in individual heat adaptation. All these barriers also highlight areas of possible interventions to enhance (enablers) the effectiveness and reach of early warning and early action, especially to the vulnerable in last mile communities.

Regarding the need to increase reach and effectiveness of heat education and warning systems, Lowe et al.'s (2011) study revealed that participants recommended channels such as television, radio, printed material with visual and textual information, other news, and social media. It was also proposed that communications can be made via individuals or institutions who relate more directly with the people. These organizations/individuals can directly

integrate heat risk education and warning messages into established communication programs. Jalonne et al. (2014) assessed strategies to reduce the harmful effects of extreme heat events in four American cities which had some versions of the heat-health warning system. Workshops held in the cities reflected concerns with coordination of communication since there tend to be several messages from different sources.

2.5 AFRICAN CONTEXT OF HEAT/GENERAL EARLY WARNING SYSTEMS

Early warning is not new across African countries, though it is not widespread across all sectors and spaces. According to the WMO Secretary General, “only 40% of the African population has access to early warning systems”, which is the lowest proportion of any region of the world (WMO, 2023). For example, based on the UN's Office for Disaster Risk Reduction, Nigeria is one of the countries that do not have or report having multi-hazard early warning systems. Available weather or natural hazard information, when available, often does not effectively reach last mile communities, especially slums. This is not appropriate, given that Africa is particularly vulnerable to extreme weather events and natural hazards – from floods to severe storms, extreme heat, and wildfires. These disaster events affect the socio-economically weak people living in low-income urban and rural areas.

Based on a survey of the literature landscape, we found that in African countries where early warning systems are available, these are used mostly in the agriculture sector (warning about drought, locust invasion and so on), health sector (warning about outbreak-prone diseases such as malaria, yellow fever, and dengue) and climate hydro-meteorological hazards such as flooding or storms. While some of the early warning systems involves weather information and at times corresponding actions, the “early warning early action” conceptual combination has not gained sufficient traction in the African context. Furthermore, there is little or no attention to early warning for extreme heat, or a multi-hazard approach that involves heat-related disasters.

There is only one study accessed showing a recent attempt at a heat-health early warning system in the African context. The work of Thiaw et al (2021) in Senegal proposed an “end-to-end heat-health early warning” approach leveraging on the Sahel situation. After preparing heat forecasts and mapping associated health risks for the period 29 April–5 May 2020 (during the peak heatwave season), they held a stakeholder engagement session which led to the production of a prototype 3-page heat–health bulletin. The bulletin

contained a health impact risk map on the first page, potential health impacts on the second page, and heat hazards outlooks on the third page. Their study highlighted the need for capacity building across all sectors to enable the Heat-Health Early Warning Systems.

An Early Warnings for All Action Plan for Africa was recently launched (WMO, 2023). This plan dwells on the four fundamental pillars of 'Disaster risk knowledge and management', 'Observations, monitoring, and forecasting', 'Dissemination and communication', 'Preparedness and Response Capabilities', and 'Governance and Coordination'. It seeks to save the lives and livelihoods of those who are regularly exposed to extreme weather and bear a disproportionate socio-economic cost of climate change. The pillar on Preparedness and Response Capabilities is led by International Federation of Red Cross (IFRC) and it is essentially based on community early warning actions. It seeks “active participation of local communities in early warning systems. This includes educating communities about the risks they face, training them on response and evacuation procedures, and integrating their indigenous knowledge into the systems” (IFRC, 2022).

The existing body of knowledge lacks substantial coverage of activities in the Nigerian context and generally most African countries. The specific challenges faced by last mile communities deserve attention. Therefore, there is a pressing need for research to address heat-health issues among slum dwellers, a notable part of last mile communities in cities, especially preparedness measures, mitigation strategies, and policy directions. Additionally, while various studies have explored the effectiveness of heat warning systems for flooding and agricultural situations, there remains a notable gap in heat-related health challenges on special socio-demographic groups or socio-economic classes. Further research is needed to understand the unique vulnerabilities of special groups and to identify barriers to accessing available early warning resources, preventative actions taken or not taken, and what influences these actions or inactions. It is also useful if targeted interventions and communication strategies on heat risk early warning systems are co-designed, tested and assessed to improve disaster reduction among the heat vulnerable urban residents. These are some of the gaps that this study aims to fill.

3.0 RESEARCH METHODOLOGY

3.1 STUDY AREA DESCRIPTION AND CLIMATIC CONDITIONS

This research focused on slum communities in Lagos and Akure, two cities situated in Nigeria. Lagos stands as Nigeria's largest city, while Akure, although medium-sized, serves as an example of secondary cities where rapid urban growth is taking place. Akure is the capital city of Ondo State in Nigeria (See figure 1). Challenges of urbanization and climate change are conspicuous in both cities.

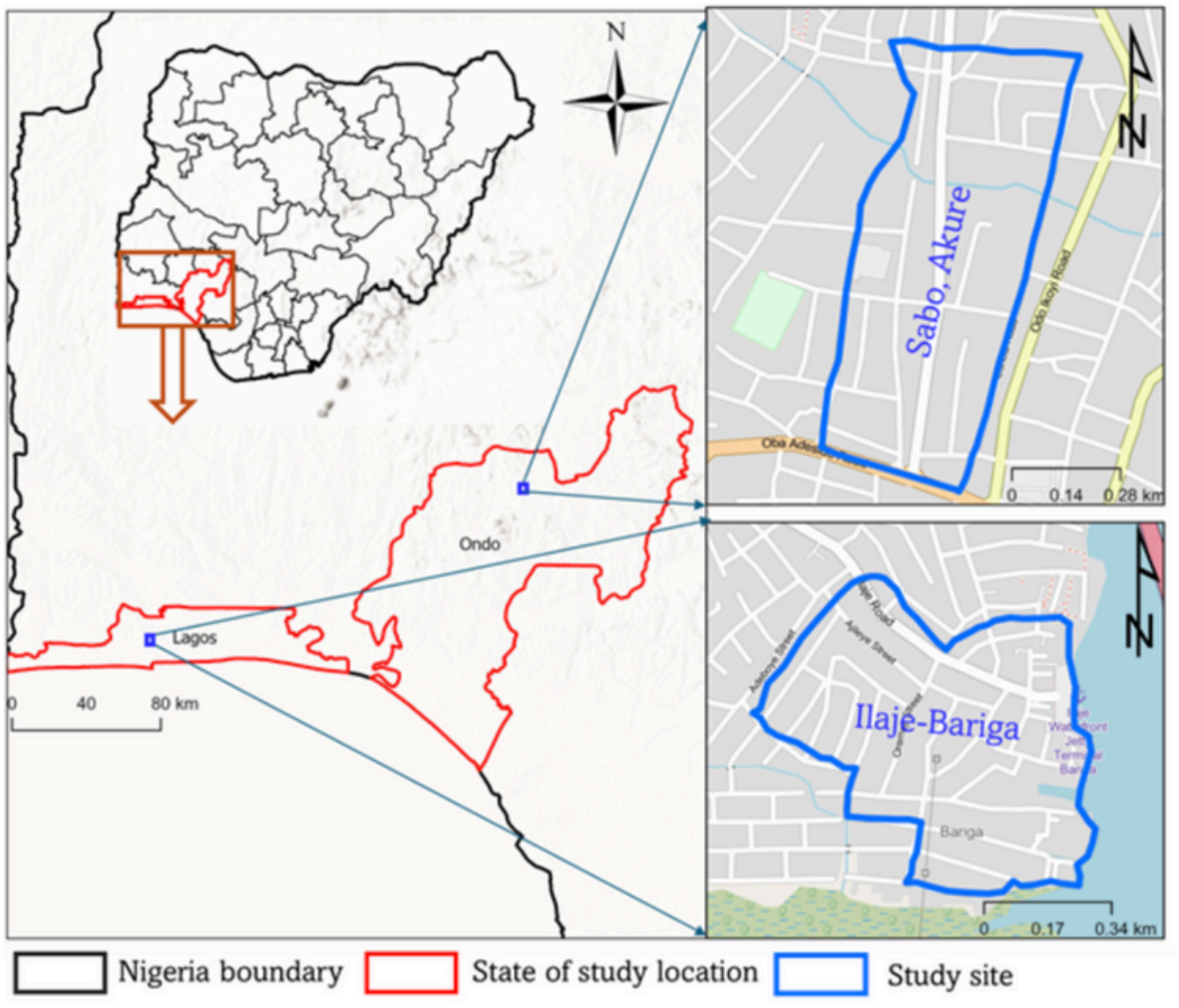


Figure 1. Location map of the two study communities

The annual temperature in Lagos typically ranges between 25°C and 33°C, accompanied by notably high humidity levels, particularly during the summer season. In Akure, average temperatures range from approximately 22°C to 31°C annually, with humidity levels slightly lower compared to Lagos due to its inland location (see Figure 2). This suggests that Lagos often experiences year-round and round-the-clock uncomfortable thermal conditions (also shown in Figure 2). Regional climate models indicate significant exposure to extreme heat for the millions of residents in both Lagos (Guo et al., 2022) and Akure (Ayeni and Oloukoi, 2022). Approximately half of the population in both cities reside in poorly planned, under-serviced neighbourhoods where environmental conditions are adverse. These areas are regarded as slum communities where the residents are daily exposed to negative externalities from the environment.

The specific case study areas are Ebute-Ilaje also called Ilaje-Bariga (located in Bariga Local Council Development Area) in Lagos and the inner-city Sabo community in Akure. The two communities were selected based on the research team's connection and previous academic engagements in the areas. The case communities are not presented as representative of all slums across the two cities even though they embody most characteristics of slums and shelter poverty.

Ebute Ilaje is a typical sand barrier-lagoon ecosystem which lies on the Lagos lagoon, and it is located about 5km away from the city's Central Business District (Adejumo et al., 2011). It accommodates residents over 20,000 residents many of whom work in the local informal fishing, sand mining business on the lagoon and other precarious means of livelihoods. The unplanned area is characterized by inadequate basic infrastructure. There is electricity connection in most homes (though supply is erratic), but no potable water connection. Roads are not paved, and municipal waste collection is available. Residents reply of water vendors, a few boreholes, and shallow wells. Most dwellings are stilts houses or those made from weak sandcrete blocks. The inner-city Sabo community in Akure is a densely populated area, with approximately 200 individuals per hectare in the neighbourhood. The houses, usually the row housing (called face-me-face-you) type, are overcrowded. There is electricity connection in most homes (though supply is erratic), some roads are paved, but there is no potable water connection. Residents reply of water vendors, a few boreholes, and shallow wells. The community is dominated by Hausa economic migrants from the Northern parts of Nigeria. The socio-economic demographic character of economic migrants makes the Akure community different from Ebute-Ilaje in Lagos where most residents, though have a history of migration are more settled and they hail from Ondo State in the South-Western part of Nigeria where Lagos is also located.

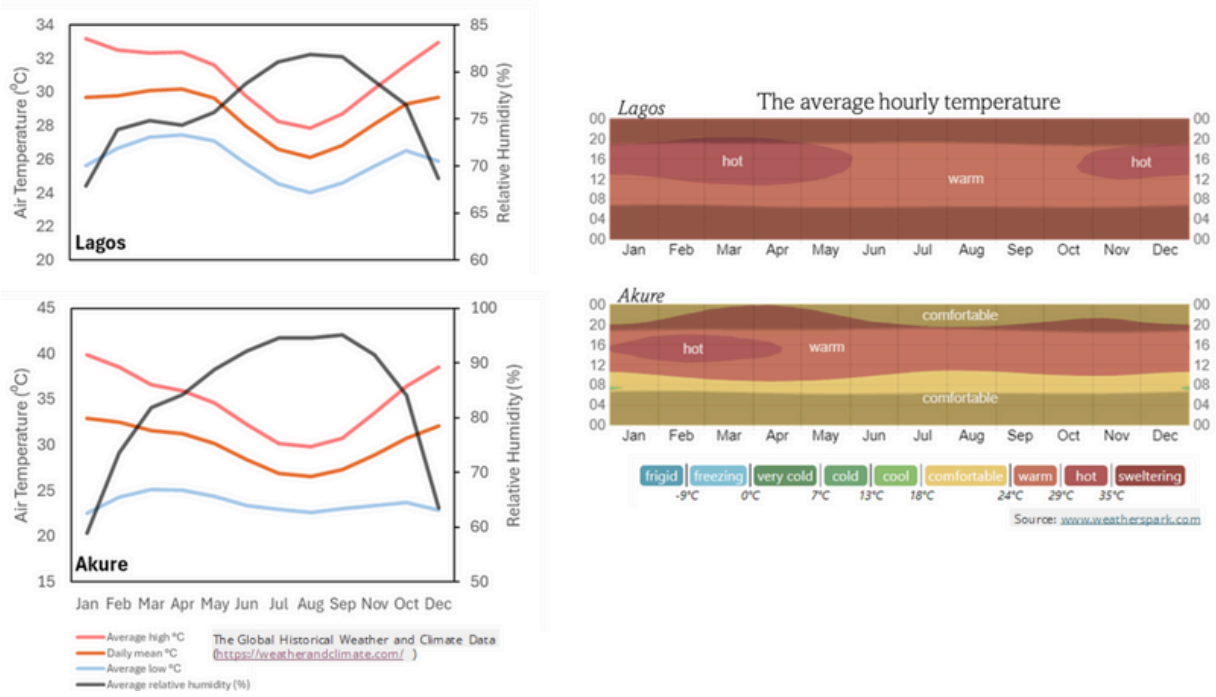


Figure 2. Left (Annual air temperature and humidity in Lagos and Akure, Nigeria) and right (Hourly and monthly air temperature and thermal perception in Akure and Lagos, Nigeria)

3.2 STUDY DESIGN AND FRAMEWORK

The study attempted a transdisciplinary approach, integrating insights from diverse stakeholders including residents, community leaders, and civil society organizations to collectively generate knowledge and solutions. For instance, in Akure, there was a collaboration with the local leadership in the slums community while engaging Nigerian Red Cross members in the neighbourhood was very useful. In Lagos, partnering with the Shantytown Empowerment Foundation (SHEF), a grassroots NGO, Nigerian Slum/Informal Settlements Federation (NSISF), an affiliate organisation of the Slum Dwellers International, facilitated local-level cooperation. This approach prioritizes participation to capture localized perspectives, expertise, and experiences. The research focus was discussed and disseminated to the community for their benefit. This strategy aligns with advocacy for promoting community empowerment and ownership in early warning systems.

Data collection tools (community surveys and focus group discussions) that helped to generate primary data - both qualitative and quantitative - were deployed in both communities. Additionally, secondary data was derived from forecasted meteorological variables - air temperature and relative humidity. The weather information was used to estimate heat stress levels. Figure 3

illustrates our study framework. The research activities were processed in line with the three chronological work packages in the project, earlier presented in Section 1. Each data collection activity is explained in the subsequent following sub-sections.

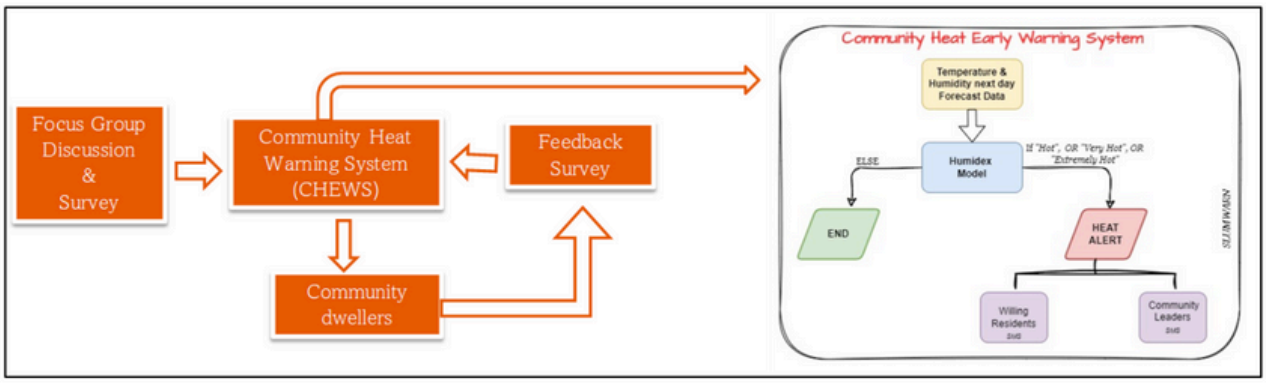


Figure 3. Study methodological framework

3.3 WORK PACKAGE I - EVALUATING HEAT-RELATED WEATHER INFORMATION

This first work package involves assessing, from the perspectives of marginalised slum dwellers, existing heat-related weather warning information in terms of awareness, accessibility, understanding, accuracy, dissemination preferences, appropriation, actioning, etc. The following methods were used in this regard:

3.3.1 FOCUS GROUP DISCUSSIONS

In each selected community, focus group discussions (FGDs) were conducted. The project commenced by establishing collaborations and networking with community leaders and interest groups which helped in recruiting participants for the FGDs. Through our field assistants, the community leader identified and invited residents who are interested in and available to voluntarily discuss the research topic. The intention to have a representation of a diverse mix of genders, age groups, outdoor workers, and other vulnerable individuals informed the identification and invitation of the volunteer residents. Each FGD had between 4 and 10 participants. In line with the

objective, questions posed during the sessions sought to qualitatively assess awareness, access, comprehension, accuracy, dissemination preferences, appropriation, actionability or otherwise of the existing information and resources. An discussion schedule which contains the relevant questions was developed and used as a guide in all the FGDs. The discussions were conducted in the local languages (Hausa in Akure and Yoruba in Lagos), translated where necessary, audio-recorded with permission of the participants, and subsequently transcribed for content analysis.

In Lagos, five FGDs were conducted. Each group in Lagos represented a mix of diverse residents – from outdoor workers (for example, fishermen, and sand dredgers) to those working indoors (for example, traders, and hair stylists) and those without stable employment. Five FGDs were also conducted in Akure. One of the groups was a wholly female group while two were specifically for outdoor workers. Commercial bike riders and wheelbarrow pushers were the two groups of outdoor workers represented in the discussions. Figure 4 includes pictures of FGD sessions held in both communities.

Figure 4. Ongoing focus group discussions in Akure (left, November 2023) and Lagos (right)

3.3.2 COMMUNITY SURVEYS

After the focus group discussions, we proceeded to conduct community surveys. This involve administering questionnaire to elicit information that quantitatively assess, from the perspectives of slum dwellers the utilization of existing heat-related weather forecast information. The assessment encompassed aspects of awareness, access, comprehension, accuracy,

dissemination preferences, appropriation, and actionability of the information and resources. To study instrument, (questionnaire) whose content is shown in Appendix 1, includes 26 questions across sections dealing with socio-demographics characteristics of the residents, awareness, accessibility, utilization and assessment of existing heat warning resources, as well as interest in, preferences and suggestions for the Community Heat Early Warning System to be designed and deployed in the community.

The survey respondents were selected through random sampling within each of the community. Since the exact population of each slum is not available, a calculated sample size could not be generated. But a minimum of 250 randomly sampled respondents per community was targeted. The questionnaire was administered using the KoBoToolbox software, which is efficient in recording all information electronically. The questionnaire was loaded on the software and a training session was conducted for the enumerators/field assistants. The enumerators surveyed by asking each respondent the questions and then entering the answers on the survey link opened on their smartphone. It took an average of 20 minutes to complete each survey. After completion, all the entries were screened and cleaned on the KoBoToolbox platform. A total of 364 (57.1%) and 273 (42.9%) responses (total = 637) in Akure and Lagos respectively were used for analysis after cleaning. The survey also helped to develop a phone number contact database of volunteer residents for eventual information dissemination through the heat early warning system to be deployed in the communities.

3.4 WORK PACKAGE II - DEVELOPING AND TESTING A COMMUNITY HEAT EARLY WARNING SYSTEM (CHEWS)

The CHEWS implementation involves two main stages, first is data pre-processing and then the designing and dissemination of the relevant messages. Information from the earlier activities also informed this stage of the research project.

3.4.1 WEATHER DATA PROCESSING

This stage first involved the collection of next-day Maximum Temperature and Relative Humidity data for the two study locations. We initially proposed to access weather data from daily forecasts by the Nigeria Meteorological Agency

(NIMET), usually made available on their website and mobile app. After accessing what was available, we found that they didn't provide relative humidity data which is a critical parameter for heat stress evaluation. Also, the heat index information made available was not updated daily. We eventually got the daily Maximum Temperature and Relative Humidity data from the UK Met App (https://www.metoffice.gov.uk/) and the Accuweather site (https://www.accuweather.com/).

The data accessed is inputted into the Humidex model, a widely adopted index for objectively classifying heat conditions and their effects on individuals. The Humidex model was built in an Excel template, facilitating the insertion of next-day temperature and humidity values to derive the corresponding Heat Index (HI) value.

Heat Stress Index – Humidex estimation

The Humidex is a measure of the combined effect of temperature and humidity on the human body. It was originally designed by Canadian meteorologists to describe the perceived temperature in hot and humid weather conditions. It is widely used in heat stress assessment, particularly in coastal cities. Although unitless, the Humidex is sometimes estimated in degrees Celsius as it reflects a person's perceived temperature. As air temperature and humidity increase, the body's ability to transport metabolic heat through evaporative cooling diminishes. The Humidex (HI) is calculated using the following formula:

$$HI_{(T,\,RH)} = T + \frac{5}{9}\,\mathrm{T}\,[6.112\,\frac{RH}{100}\;10^{\frac{7.5T}{237.7+T}} - 10]$$

HI = Humidex (perceived temperature)
T = Air temperature (in degrees Celsius)
RH = Relative humidity (in percentage)

This formula provides an index value that indicates the level of heat stress experienced by individuals. Higher Humidex values signify increased levels of heat stress, with values exceeding 39 associated with serious health risks, particularly for vulnerable populations (See Table 1).

Table 1. Classification of Humidex and heat risk conditions

Classification of heat condition	Humidex (HI oC)	General effect on people
No Risk	≤ 29	No risk to population groups

Very warm	30- 38	Fatigue is possible with prolonged exposure and/or physical activity
Hot	39- 41	Sunstroke, heat cramps, or heat exhaustion is likely and heat stroke is possible with prolonged exposure and/or physical activity
Very hot	42-44	Sunstroke, heat cramps, or heat exhaustion is possible with prolonged exposure and/or physical activity
Extremely hot	≥ 45	Heat/Sunstroke highly likely with continued exposure

Adapted from Masterton and Richardson, 1979; Kotharkar et al., 2021)

3.4.2 DESIGNING AND DISSEMINATION OF HEAT INDEX INFORMATION.

Utilizing a phone contact database derived from community surveys, we sent SMS alerts advising on the respective daily predicted heat index and applicable preventative actions for each of the two locations. The heat index is based on weather forecast information accessed, the calculation and relevant classification based on Table 1. We used a bulk SMS system to send the messages for 39 days (considered as the pilot period), from 9th January to 16th February 2024, including the first day of test running. These days fall within the hottest months of the year. Temperature and humidity information, daily heat index classification, risk level, the number of persons who received them, and other relevant data during the 38 days for the two locations are shown in Appendix 2.

Based on the most popular preferences in the community surveys (further shown in Section 4.1.5), the SMS was sent in English and Yoruba in the Lagos slum community, as well as English and Hausa in the Akure slum neighbourhood. Figure 5 shows the sample screenshot of two of the various message versions sent and received for two heat indexes across the two cities. As shown in Appendix 2, at least 175 residents who signed up received the SMS in Lagos for the pilot period while at least 151 residents who signed up also

received it in Akure during the pilot period. Disparity between the number of SMS sent and the total number delivered/received is attributed to the phone numbers enrolled with 'do not disturb' (DND) status. Although they are interested in the heat warning information, such residents with DND status on their phones will not receive any form of promotional messages, including the ones on heat warning that was disseminated.

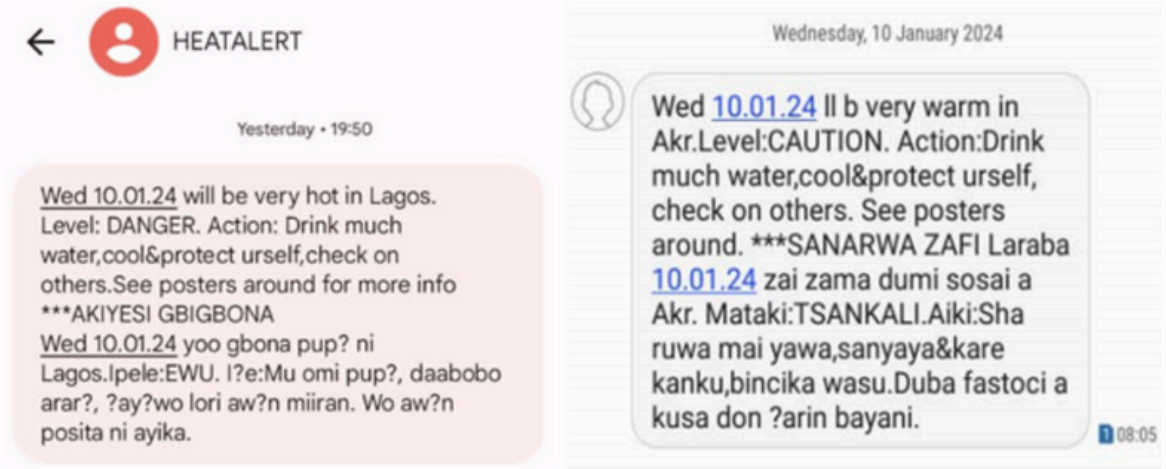


Figure 5. Sample screenshots of HEATALERT messages sent and received in Akure and Lagos.

Information about the heat index and appropriate preventative actions were also disseminated through posters. The community survey had shown a high preference for information reception through hard copy graphic materials. About two dozen A2-sized colour posters were pasted across strategic places within each of the two communities. The sample posters are shown in Appendix 3. Based on the most popular preferences in the community surveys, the posters included messages in English and Yoruba for the Lagos slum, as well as English and Hausa for the Akure slum neighbourhood. Figure 6 shows some residents viewing posters placed within their communities.

Figure 6. Residents viewing posters in Ilaje-Bariga (left) and Sabo-Akure (right).

3.5 WORK PACKAGE III – ASSESSMENT OF THE HEAT WARNING DISSEMINATION

After the 38-day dissemination of heat index and precautionary information through SMS and posters, we assessed the pilot system. The aim is to evaluate access, understanding and actioning based on the messages, and the respective channels. This involved five focus group discussions within the Lagos community. The discussants were drawn from residents who received or engaged with either of the heat warning communication products. In Akure, focus group discussions could not be held because the period coincided with a religious season where gathering residents for research purposes was more difficult. Instead, five selected residents who received the heat warning messages were interviewed. The semi-structured interviews were conducted in the language preferred by the interviewee. To complement the interviewees, the researchers participated in a community meeting and were given time to harvest feedback from residents who received messages during the 38-day dissemination period. Generally, the interviews and focus group discussions allowed the residents to share their experiences, perspectives, and insights on the heat warnings. It revealed their understanding of the messages received, and any actions taken as well as any barriers encountered.

3.6 ETHICAL CONSIDERATIONS

Due consideration was given to being ethical during this study. Before commencing field work, the team applied for ethical review with the Institutional Research Ethics Committee at the Federal University of Technology, Akure. After the review, an ethics clearance (FUTA/ETH/23/128) was issued for the study. As part of the principles followed, obtaining informed consent from research participants was ensured. During interviews, focus group discussions and surveys, we generally begin by introducing the study and then invite them to voluntarily participate. Assurances about confidentiality, non-traceability, anonymity etc on their participation and information supplied were given. Also, before starting the focus group discussions and interviews, we generally inform them that it is voluntary. So, they can withhold their consent or withdraw at any time during the interview, if they so wished. Also, we asked for permission to audio-tape either the interview session or the focus group discussion.

In accessing and processing data from open-source platforms, we ensured compliance with relevant data ethics principles. Nigeria's Data Protection

regulations were complied with in managing the phone contact database and any other data acquired through the survey and other research activities. We'll ensure that after the study, there is security, legitimate purpose, fairness and transparency in the use of the data collected.

4.0 RESULTS AND FINDINGS

4.1 STATUS QUO ON THE UTILIZATION OF HEAT EARLY WARNING SYSTEMS

The first part of the study deals with evaluating the utilization of heat early warning resources. As earlier indicated, it involved community survey and focus group discussions. There are five objectives in this Work Package I, whose findings are presented in this sub-section.

4.1.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF SURVEY RESPONDENTS

The total number of responses collected in the community survey and used for analysis is 637, with 364 (57.1%) and 273 (42.9%) for the Akure and Lagos slum communities respectively (see Figure 7). The data are analysed and presented together in this section. Socio-economic and demographic characteristics considered in the study include age of respondents, marital, gender and level of education.

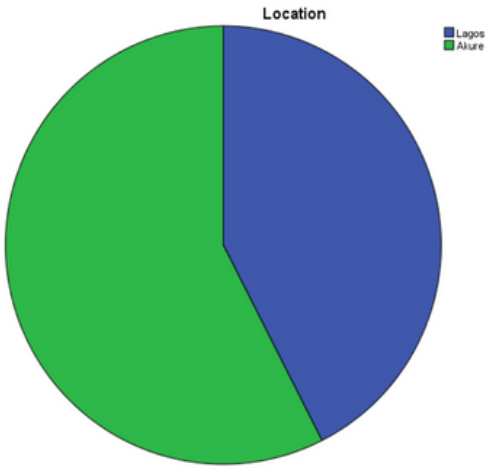


Figure 7. Distribution of Respondent across the two locations

More than half of the respondents were male (53.0%) while female respondents were 47.0% (See Table 2). A larger proportion 258 (40.2%) of the respondents were in the age category 18-30, followed by the age group 31-40, 209 (32.6%). It was also observed that the more population in the 18-30 range were residents at Akure (32.4%) and lesser population within 31-40 in Lagos (12.1%). This indicates most respondents are still in their active and productive years. Age differences within the respondents' structure could influence their heat perception and individualized adaptation approaches.

Over 57.5% of respondents across the two locations are married while the least are widowed (2.7%). The greatest percentage (42.5%) of respondents had at least secondary level of education and a relatively low percentage (18.3%) had no form of formal education. This indicates that most respondents are literate and can process basic information. Concerning employment, those self-employed had the largest percentage (61.9%) with those retired as the least (1.1%). It is common to find that residents of slum communities are mostly self-employed within the informal sector.

Table 2. Socio-demographic characteristics of the respondents

Characteristic	Variable	Akure	Lagos
Gender	Male	232 (62.53%)	109 (60.44%)
	Female	137 (36.93%)	165 (39.93%)
Age	18-30	209 (56.33%)	51 (18.68%)
	31-40	80 (21.56%)	131 (47.99%)
	41-50	50 (13.48%)	74 (27.11%)
	51-60	15 (4.04%)	18 (6.59%)
	Over 60	20 (5.39%)	3 (1.1%)
Marital Status	Single	177 (47.71%)	56 (20.51%)
	Married	170 (45.82%)	200 (73.26%)
	Divorced /Separated	13 (3.5%)	13 (4.76%)
	Widowed	12 (3.23%)	5 (1.83%)
Education	None	71 (19.14%)	46 (16.85%)
	Primary	47 (12.67%)	85 (31.14%)
	Secondary	147 (39.62%)	125 (45.79%)
	Tertiary	103 (27.76%)	17 (6.23%)
Occupation	Unemployed	77 (20.75%)	52 (19.05%)
	Self-employed	213 (57.41%)	187 (68.5%)
	Private	45 (12.13%)	30 (10.99%)
	Civil servant	31 (8.36%)	1 (0.37%)
	Retired	12 (3.23%)	3 (1.1%)

4.1.2 OBJECTIVE 1: ASSESSMENT OF AWARENESS OF HEAT EARLY WARNING RESOURCES

Early warning resources cover a variety of warning information, communication systems and anticipatory practices, including everything in between them. The Nigerian Meteorological Agency (NIMET) is a notable source of information for weather forecasts aired on local or national TV as well as some radio stations. The forecast usually covers rainfall and temperature information for the following day(s). Weather forecast information is also available from sources other than NIMET, especially delivered through mobile applications.

The first objective is part of Work Package 1, earlier mentioned in Section 1. It assesses the level of awareness on heat early warning resources in the selected communities. Overall - across the two locations - respondents with no knowledge of heat early warning systems had the highest percentage (38.1%) followed closely by those who are knowledgeable at about 36.4% of the respondents. Those who are unsure whether they have such knowledge represents a quarter (25.4%) of the total respondents. Access to heat warning information in the two communities had been through radio (36.6% of respondents), followed by word of mouth (24.5%), TV (24.2%), and then social media (22.1%). A closer look at the result (shown in figure 8) shows there is a variation in the level of awareness of current heat warning information across the two areas. Akure has more residents (53% of the respondents) who are knowledgeable about heat warning information, compared with Lagos where only 27.47% of the respondents reported such. This translate to the situation that 64.47% of Lagos respondents do not know about heat warning systems, which is well over 27.22% reported in Akure. This variation can be attributed to various reasons, including age and educational level. That the Akure community has more youthful population (56.3% are 18-30 years old, compared with 18.18% for same group in the Lagos community) and more educated (27.7% have tertiary education compared with 6.23% in the Lagos community) could account for the higher awareness.

The finding about little or no awareness of heat early warning information also emanated from the focus group discussions. Statements made by the discussants attest to this. A female Akure resident explained, "We have never heard it [weather forecast] before" (personal communication, Women FGD Akure, November 2023). Although she believes it is possible to predict events, but she is not familiar with forecasting weather events. Another statement was that “we don’t know it [heat forecast] because no one has educated us. If not

for this conversation, who is thinking about it?" (personal communication, General FGD participant, Akure, October 2023). In Lagos, a resident noted that:

> "Unlike the COVID-19 pandemic when announcements were made throughout the nation, we haven't heard anything similar regarding heat either through the Radio, Television, Newspaper or SMS. There hasn't been any such awareness... There was no announcement as to when to experience heat. But I know that our parents were able to identify the different seasons within specific periods of the year" (personal communication, Lagos FGD06 participant, November 2023).

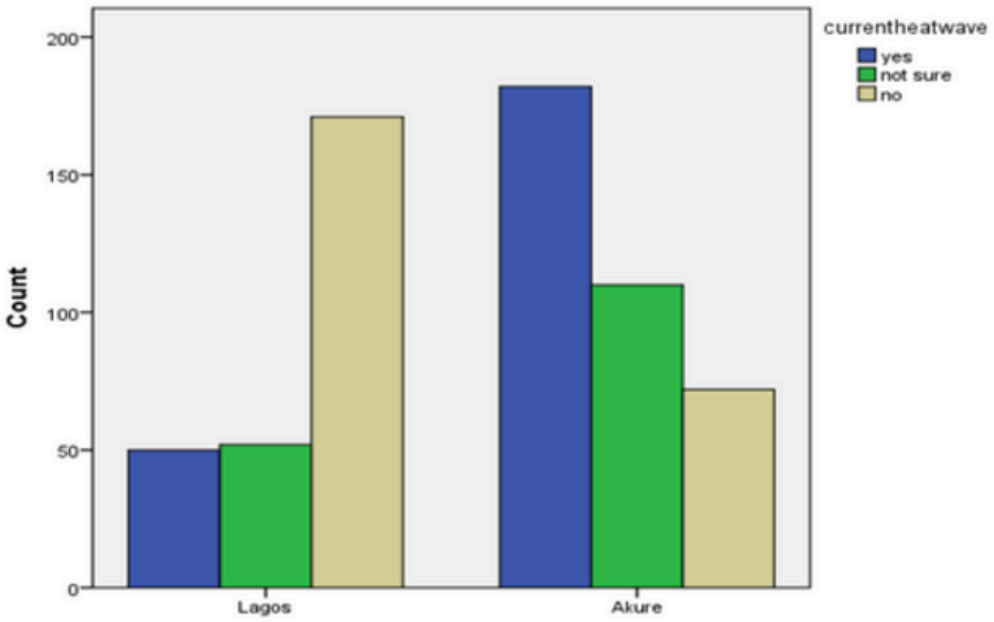


Figure 8. Status of Knowledge of Heat Warning Resources

From the analysis, the mean score shows the ranking of factors that influenced awareness about heat warning information and related resources in the two locations. Table 3 shows that "understanding heat warning information" (M= 2.91) ranked first. Language had the second ranking while "availability of information" on heat ranked third (M=2.39). The "mode of technology" and the "frequency of information" both had a mean score of 2.22 as factors influencing awareness about the heat warning information.

Table 3: Factors affecting awareness of current Heat Warning(HW) information

	N	Minimum	Maximum	Mean	Std. Deviation
Understanding_HW	622	.00	5.00	2.9084	1.17665
HW_Language	618	1.00	5.00	2.4951	1.65231
HW_Avaliability	619	1.00	5.00	2.3877	1.68802
HW_Technology	622	1.00	5.00	2.2235	1.68250
HW_Frequency	615	1.00	5.00	2.2228	1.60845
Valid N (listwise)	590				

4.1.3 OBJECTIVE 2: ACTIONS TAKEN BASED ON CONTACT WITH HEAT WARNING INFORMATION

This second objective is part of Work Package 1, which was earlier mentioned in Section 1. The survey and focus group discussions investigated actions that people took based on information received or resources accessed. The level of actions taken based on heat early warning accessed differs across the two locations. A higher percentage (37.74%) in Akure, compared with Lagos (23.81%) have taken actions based on heat early warning encountered. Over 70% of the Lagos respondents have not taken any relevant action based on a heat warning (See Figure 9). This might be linked to age level and education status. From the survey responses, the Akure population are younger and more educated than Lagos. Also, from the survey, bathing is the most mentioned heat-coping action taken by respondents across the two areas. Other top coping actions in descending order of their popularity among the residents are dressing (wearing light clothing), drinking more water (hydration), altering diet (eating healthy food), and opening windows and doors.

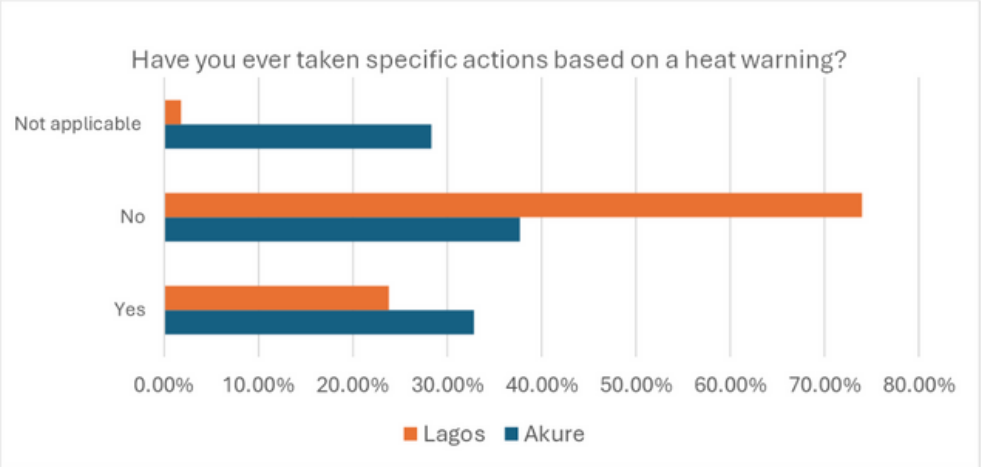


Figure 9. Taking actions based on heat warning information

During the focus group discussions, the residents acknowledged actions they usually take in response to heat. These are usually reactive and not pre-emptive. These are not usually based on specific formal or informal heat early warning information. For example, the commercial bike riders noted that based on the outdoor nature of their work "*if you notice it [heat] is extremely hot, you can park somewhere for some time before continuing …Or if you want to have lunch you park and rest before continuing with work*" (personal communication. Okada FGD Akure, November 2023). Echoing the view of his colleagues, a wheelbarrow pusher explained that you "*pull off your clothes and look for a hand fan to fan yourself…, you can look for a place to sit (you may also be feeling headache at that moment)…and allow the sun to go down before continuing the work*" (personal communication, Barrow pushers FGD Akure, November 2023).

Some of the residents who receive or encounter heat warning information refuse to take any meaningful action. It appears they prefer to react rather than prepare. Some will even do nothing. These inactions and ill-actions, also captured in the survey, might be partially explained by uncertainty about the accuracy of weather forecasts. Regarding this, one of the wheelbarrow pushers noted that "*we are not working with it [heat information]. God decides everything. Everything they are forecasting [about the weather] is not certain because it's not man that decides but God*" (personal communication, barrow pusher FGD, Akure, November 2023).

Moreover, informal workers (often living within slums) who work outdoors, have the pressure of making ends meet. These tend to trump concerns and compliance with precautionary actions prescribed. They noted that "if the heat is out [as predicted] people don't put their mind to it… There is nothing we can do" (personal communication, barrow pusher FGD, Akure, November 2023). They believe that "*what to eat is very important. the heat of the pocket [financial lack]is more than that of the weather… People don't wait to listen to it, not to even talk of understanding what they are talking about*" (personal communication, General FGD Participant, Akure, October 2023). Another participant remarked that "*it is only people that believe [the forecasts] that listens … you are thinking of what to eat tomorrow, how will you think of the heat of the weather*". (personal communication, general FGD, Akure, October 2023). While many noted that the "*heat period is associated with different types of diseases and many effects, some people think of it while others aren't concerned*" (personal communication, general FGD, Akure, October 2023).

4.1.4 OBJECTIVE 3: BARRIERS TO THE EFFECTIVENESS OF AVAILABLE HEAT EARLY WARNING INFORMATION

The survey and discussions elicited information about barriers towards access, understanding and effective utilization of heat warning information in the communities. This third objective is part of Work Package 1 of the study. On questions related to these aspects, the respondents were asked to rank using a score from 1 to 5. From the analysis (See Table 4), the most critical barrier relates to the frequency of heat early warning information. This was largely evident in the two cities as infrequency was ranked top in both settings. Also, the lack of awareness ranked second, followed by inaccessible technology and then, the language barriers. The U test analysis shows that there is a significant difference in the level of these barriers in the two cities, thus indicating that other factors might be associated with the barriers apart from the locational issues. These factors could include socio-economic disparities, varying levels of community engagement, or differences in infrastructure and resources. From the analysis, the mean is always higher in Lagos than in Akure which implies that the barriers have stronger effects in Lagos than in Akure. Understanding these contextual issues is crucial for tailoring dissemination strategies to the specific needs and challenges of each community.

Table 4. Barriers to accessing Heat Warning information

	Pool				Lagos			Akure			U-Test	
	N	Mean	Std. Dev	Rank	Mean	Std. D	Rank	Mean	Std. D	Rank		
Infrequency	604	3.67	1.70	1st	4.39	1.35	1st	3.09	1.73	1st	-10.178	.000
Awareness_barrier	608	3.61	1.77	2nd	4.35	1.39	2nd	3.01	1.83	2nd	-9.447	.000
Technology_barrier	642	3.39	1.91	3rd	4.34	1.45	3rd	2.69	1.91	3rd	-11.162	.000
Language_barrier	642	3.13	1.81	4th	3.95	1.44	4th	2.52	1.81	4th	-9.879	.000
Valid N (listwise)	602											

Statements from the participants further showed the barriers to understanding and effective utilization of heat warning resources. In the women's group discussion, the participants identified the problems of technology and language barriers in accessing heat early warning information from the news. Capturing the minds of other Hausa women, she said "*We have a television but no power: so, it's because of power that we are not listening to news as we ought to... It is only Yoruba and not everybody understands it. The Hausa news is only on Fridays*" (personal communication, Women FGD Participant Akure, November 2023).

4.1.5 OBJECTIVE 4: DISSEMINATION PREFERENCES ON HEAT EARLY WARNING INFORMATION

The study also appraised the residents' preferences regarding means through which heat early warning information should be disseminated within the communities. This fourth objective is part of Work Package 1 in the study. The result presented in Table 5 shows that the most preferred Heat Warning information media are 'radio', "in-person", "SMS", "printed visual materials", and "phone" in order of preference. The least preferred are 'website', "Email" and "Newspaper". The identification of 'radio', "in-person", and "SMS" as preferred media suggests that residents value direct, immediate, and accessible forms of communication. These offer timely alerts and may reach a broad audience, particularly those who may not have access to digital technologies or internet connectivity. Furthermore, the preference for "printed visual" and "phone" underscores the importance of traditional communication channels, which remain relevant for segments of the population, especially older adults.

A further analysis shows the level of variation in preferences between the two locations. The result is shown in appendix 4. The significant level from the U-test analysis indicates that only three mediums are insignificantly different namely email, leaflet and, media release, thus, eight are significantly different. This level of variation indicates that other factors such as socio-demographic factors might influence respondents' preferences, thus categorical regression analysis was undertaken.

Table 5. Mean Score and Ranking for Mediums of Information Dissemination

		N	Minimum	Maximum	Mean	Std. Deviation	Ranking
1	Radio	548	1.00	5.00	4.3285	1.28333	1st
2	In_person	590	1.00	5.00	4.0407	1.55435	2nd
3	SMS	596	1.00	5.00	3.8742	1.62830	3rd
4	Printed_Visual	538	1.00	5.00	3.6283	1.70750	4th
5	Telephone	599	1.00	5.00	3.4591	1.81813	5th
6	Media_release	642	.00	5.00	2.9174	2.05563	6th
7	Leaflet	529	1.00	5.00	2.7656	1.65313	7th
8	Social_Media	642	.00	5.00	2.3769	1.95055	8th
9	Newspaper	642	.00	5.00	2.2508	1.90025	9th
10	Email	510	1.00	5.00	1.9804	1.46324	10th
11	Website	642	.00	5.00	1.8302	1.70000	11th
	Valid N (listwise)	486					

In the regression analysis, age and education were used as predictors for preference thus forming the dependent variable. The result (Table 6) shows that age significantly predicted the preference for printed visual, SMS, Email, telephone, and radio. Specifically, it was observed that older respondents prefer printed visual (β=.134, f=3.523), telephone (β=.324, f=19.770), radio (β=.187, f=6.787) whereas younger respondents have preference for SMS (β=-.169, f-=9.491) and Email (β=-.175, f=2.943). This suggests that when deciding on the medium of dissemination, age of the targeted population must be well considered. Older adults tend to prefer traditional media reflecting potential ease with familiar technologies and communication methods. Conversely, younger respondents show a preference for digital media, SMS and Email, indicating a reliance on mobile devices and new online platforms for information access.

Similarly, the regression analysis (Table 7) shows that the education level of respondents influenced the respondents' preferences as there is a significant difference based on the educational status. Respondents with a higher level of education prefer SMS (β=.208, f=13.257), Email (β=.283, f=20.373) whereas respondents with a lower level of education prefer telephone (β=-.219, f=8.916), in-person (β=-.210, f=12.858), and media release (β=-.217, f=11.960). The result suggests that the level of education must be considered when making decisions on the medium of transmitting early warning information. Respondents with higher levels of education exhibit preferences for digital communication channels, suggesting their familiarity with new technologies and online information sources. In contrast, those with lower levels of education tend to prefer more interpersonal forms of communication, such as in-person interactions and telephone calls, which may align with their literacy levels.

Table 6. Categorical Regression of Media Preferences by AGE

	Coefficients				
	Standardized Coefficients		Df	F	Sig.
	Beta	Bootstrap (1000) Estimate of Std. Error			
Printed_Visual	.134	.071	2	3.523	**.030**
SMS	-.169	.055	1	9.491	**.002**
Email	-.175	.102	3	2.943	**.033**
Telephone	.324	.073	3	19.770	**.000**
Social_Media	-.096	.072	3	1.772	.152
In_person	.032	.075	1	.182	.670
Media_release	-.125	.096	1	1.683	.195
Leaflet	.070	.076	1	.831	.363
Website	-.110	.085	1	1.688	.195
Radio	.187	.072	1	6.787	**.009**
Newspaper	-.069	.079	2	.766	.465
Dependent Variable: Age					

Table 7. Categorical Regression by EDUCATION

	Coefficients				
	Standardized Coefficients		Df	F	Sig.
	Beta	Bootstrap (1000) Estimate of Std. Error			
Printed_Visual	.095	.077	2	1.520	.220
SMS	.208	.057	1	13.257	**.000**
Email	.283	.063	2	20.373	**.000**
Telephone	-.219	.073	2	8.916	**.000**
Social_Media	.100	.088	1	1.309	.253
In_person	-.210	.059	2	12.858	**.000**
Media_release	-.217	.063	3	11.960	**.000**
Leaflet	-.074	.076	2	.949	.388
Website	.123	.105	2	1.390	.250
Radio	-.004	.084	1	.002	.967
Newspaper	.071	.086	2	.683	.505
Dependent Variable: Education					

The study also investigated language preferences for the heat early warning information. The survey had a question checking "Which language would you prefer the warming be delivered". In Lagos, Yoruba is most preferred, by 85.71% of the residents (See figure 10). This is followed by English (26.37%) and Pidgin (20.88%). Lagos, Nigeria is dominated by the Yorubas, although almost every national tribe is represented there. In Akure, English is most preferred by 52.56% of the residents. Hausa, Yoruba, and pidgin were also notably preferred by 28.3%, 25.61% and 20.49% of the residents respectively. The Akure community is dominated by Hausa migrants hence the high preference for Hausa Language. These numbers informed the languages used for the heat messages/information dissemination in the piloting of the heat early warning system across the two communities.

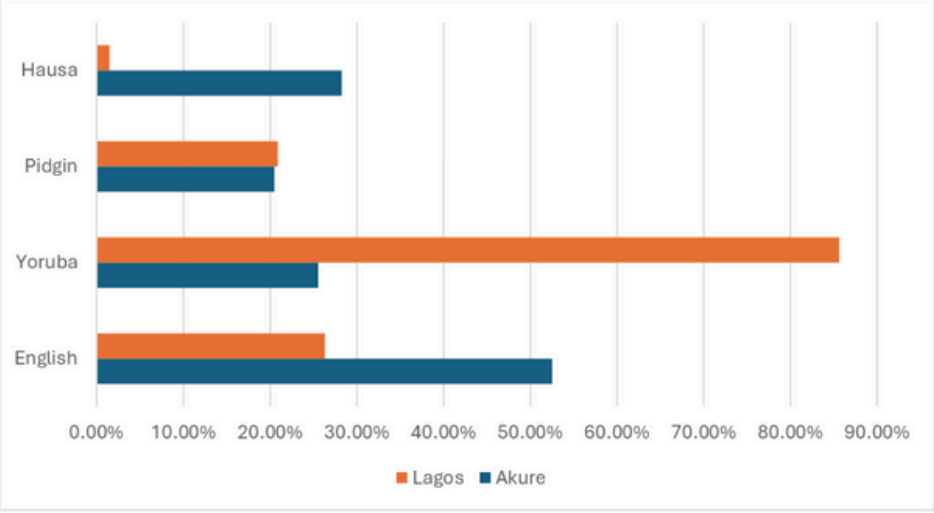


Figure 10. Language preference for heat warming information to be delivered

The focus group discussion also captured the residents' suggestions and preferences for heat warning information dissemination. Using diverse locally understood languages and media also came out strongly in the discussions. They recognised the need for "announcements over Radio, Television, Handbills and Posters communicated in the three major languages - Yoruba, Hausa, Ibo including English. This is to ensure that the messages are passed across to all in their languages as was done for HIV and COVID-19" (personal communication, FGD 4 participant Lagos, Nov 2023). They also suggested the need to reach out "*to the Local Government, Community Development Associations and Local Community Heads (Baálè) or Monarchs in the local languages. Once the information reaches them, it can be passed down to religious institutions (Churches, Mosques) who will disseminate it to their congregation*" (personal communication, FGD 7 participant Lagos, Nov 2023).

4.1.6 OBJECTIVE 5: CONTENT AND TARGET OF HEAT EARLY WARNING INFORMATION

As part of work package 1, this fifth objective investigated what the residents feel might be a useful addition to the heat level forecast to be captured in the early warning alert. Table 8 gives the result of choices from a list of suitable additional content supplied in the survey. There is overwhelming support for all the content across the communities. The least supported across the two areas was including "a link to further information on what to do". More proportion of the residents in Akure compared with Lagos are unsure whether those contents should be included. For example, 17.52% in Akure are unsure whether "a countdown timer towards heat occurrence" should be included. Notably, this same option of countdown had the highest level of uncertainty in Lagos.

Table 8. Additional information that should be included in the CHEWS alert

Additional content	Akure	Lagos
Guidance on what action to take, e.g. 'drinking water, seeking medication attention'	Yes = 77.36% Maybe =10.24% No = 7.55%	Yes = 96.34% Maybe = 2.56% No = 0.37%
A message that provides reassurance e.g. 'stay calm'	Yes = 71.16% Maybe = 10.51% No = 10.51%	Yes = 95.6% Maybe = 3.3% No = 0.37%
A countdown timer towards heat occurrence	Yes = 60.38% Maybe = 17.52% No = 13.21%	Yes = 93.41% Maybe = 5.49% No = 0%
Potential impacts and risks (e.g. heat stroke, higher risk of meningitis)	Yes = 69% Maybe = 12.94% No = 9.43%	Yes = 97.07% Maybe = 2.56% No = 0%

Information on additional hazards about the same time e.g. flooding,	Yes = 69.27% Maybe = 12.94% No = 8.09%	Yes = 97.07% Maybe = 2.2% No = 0%
Further information about heat forecasting	Yes = 68.46% Maybe = 12.13% No = 9.97%	Yes = 96.7% Maybe = 2.2% No = 0.37%
A link to further information on what to do	Yes = 58.76% Maybe = 14.56% No = 16.44%	Yes = 76.56% Maybe = 12.09% No = 6.96%

The survey investigated which groups should be specially targeted in the dissemination of the heat early warning information. From the list provided within the survey instrument, the highest support (with 574 votes at 92.58%) across the two areas to parents of infants and children, followed by adults over 65 years old with 522 votes at 83.92% (See figure 11). Targeting outdoor workers received the least votes (frequency = 417), though there is still overwhelming support of about 80%. Suggestions were made for the other categories not included in the least. Those prominently mentioned are persons who are obese/fat and young people, especially pupils and students.

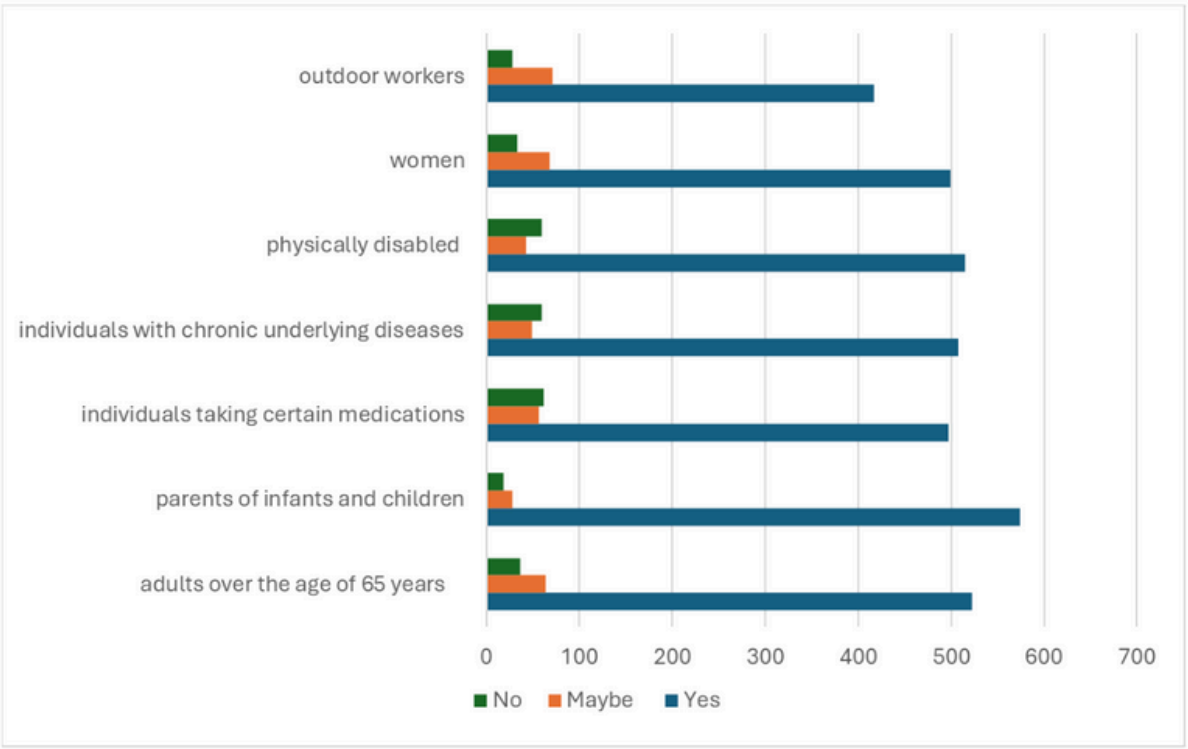


Figure 11. Groups to be targeted in the dissemination of the heat early warning information.

4.2 FEEDBACK ON THE CHEWS DEPLOYED IN THE COMMUNITIES.

After deploying the health warning messaging - Work Package 2 (earlier explained in section 3.4), we undertook an assessment of the exercise. This is the 3rd Work Package. It involved interviews and focus group discussions as also earlier explained in section 3. Results from the feedback sessions and their respective themes are presented in this sub-section.

4.2.1 CONFIRMING RECEIPT OF HEAT WARNING INFORMATION

Statements by the participants showed that they received the HEATALERT SMS (shown in figure 4) with the correct content. In Akure, the participants responded that "*Yes, I received some messages... At least one message per day*" (personal communication, Destiny, Akure, 17 March 2024); "*I got the message so many times... And I checked and read it. I saw the good advice contained in them*" (personal communication, Mr H, Akure, March 2024). Among those who got the messages, someone did not initially like them. He said "*I got the messages... at a point, I was thinking of blocking the messages but later thought through on what was sent because it was helpful. I thought it was too much and didn't want to receive the notification again*" (personal communication, Mr M, Akure, 17 March 2024). These comments confirming receipt of the messages also signal possibility of alert fatigue - a situation whereby people receive the same message in excess or continuously receives unhelpful messages through the alert system. These tend to desensitize receivers to content of the messages.

The posters pasted also were seen by a good number of the residents. The Akure residents remarked "*Yes, I saw a lot of the posters. I checked one, I even wanted to start reading. I now said, "Yoruba eh" I can't read it. I saw another one in English and I went through it*" (personal communication, Mr M, Akure, 17 March 2024); "*Anytime I'm walking on the street, I always see posters around*" (personal communication, Mr O, Akure, 17 March 2024); "*Truly, we got the messages ... One day, I was walking on the street. I just saw posters everywhere. The message was advising us on what to do in terms of heat*" (personal communication, Mr J, Akure, 17 March 2024); The residents acknowledged that the posters contained information that can help improve and protect their health especially those exposed to heat, but noted that when seen "*some persons read it [posters] while some others did not read it*" (Community leader at Akure meeting, 17 March 2024).

All those who participated in the focus group discussion and interviews received the SMS and most of them saw the posters. For example, in one of the discussions in Lagos, only 8 out of the 10 discussants saw the posters. One of them said "*I didn't see them. But I know some of my neighbours saw them*" (discussant 6, Lagos FGD 12, March 2024). The problem may be incognisance. A discussant remarked that "*some people are just nonchalant about things. They may just look at the photo and disregard the information on the poster … [so] they may not understand what it means or meant for*" (discussant 1, Lagos FGD 12, March 2024). Nonetheless, they generally believe that "*adhering to the recommendations on the posters has helped a lot in the past 2 months*". (Lagos FGD 9, March 2024).

4.2.2 EARLY ACTIONING BASED ON THE HEAT INFORMATION

One of the goals of early warning is to activate early action in preparation for emergencies. The consensus is that the information and messages were helpful. Many of the residents took note of the information and recommended actions from the heat forecast and precautions circulated. Comments along this line include: "*The message was very useful because it informs me on what will be happening tomorrow*" (Mr D, Akure, 17 March 2024); "*The message is very good. It has given people different advice about heat*" (Mr H, Akure, March 2024). Another resident noted that "*we were informed of what to do when the heat is high and how to prevent the heat by taking water and wearing light cloths to reduce hotness… The fact is that it is really helpful*" (Mr O, Akure, 17 March 2024).

i) tangible impacts and testimonials of change through the heat warning information

It became apparent that many altered their daily routine and lifestyle due to their contact with heat warning information through the SMS and posters. The changes relate to personal things such as hydration, dressing, bathing, diet, and activity patterns, especially among those who are often exposed to heat. Hydration is the most popular action reported by the residents, essentially because "*drinking water is not expensive*" (personal communication, Mr D, Akure, 17 March 2024).

Some noted improvements in their health due to the changes made. A female resident noted that "*before the message, I usually feel nauseous when the heat is at its peak. I have however seen a drastic change since the precautionary measures have been adhered to*" (personal communication, discussant 3, Lagos FGD 11, March 2024). A male Lagos resident noted that "*my*

work is quite strenuous, and it makes me stay under the sun for long hours... but since I started using guidelines provided through the messages, like taking shower and drinking plenty water, I realized there have been tremendous changes" in my health (personal communication, discussant 5, Lagos FGD 11, March 2024).

Other comments also show how useful the messages were. A female Lagos resident and mother noted that "*before this time, I could get back from work and decide not to shower and this gets uncomfortable most times, but since I started using one of the preventive measures, I realized it was helpful*" (personal communication, discussant 1, Lagos FGD 12, March 2024); while another said that "*before now, I can go out anytime particularly when the sun is at its peak but I have recently adjusted my movements and now understand the disadvantages of heat to the body. I also understand that drinking water helps to hydrate the body*" (personal communication, discussant 3, Lagos FGD 10, March 2024). Two other discussants testified that "*after I received the SMS, I made few changes. I endeavoured to shower at night, and this provided some relief... I don't go out when the heat is at its peak. I sit under the shade to calm my body down*" (personal communication, Lagos FGD 9, March 2024).

The accounts by Akure residents of the positive impacts are similar to those given by Lagos residents. A male Akure resident noted that "at night, I mind the clothes I put on and drink water. I also ensure a bottle of water is by my side in case of anything. The fact is that it is really helpful" (personal communication, Mr O, Akure, March 2024) while another male resident and father confessed that

> "*It helped with our family. I tried my best to inform them. If I leave home, I try my best to get fruits ... there was a day I had completely forgotten, and I just got the message and remembered that I had not taken fruits. I now said that from today no day will pass without taking any fruit... I told my family to stop sleeping with clothes or reduce what they put on and to bath before sleeping and finally to ensure they take fruits...[also] we are taking water*" (personal communication, Mr J, Akure, March 2024).

ii) further dissemination of the heat information by the residents

Based on the experience and perceived benefits, many who received the messages shared it with others – their children, relatives, neighbours, etc. The comment from Lagos in this regard is that "*I understand it very well and took time to explain the details to my children so they can utilize them*" (personal communication, discussant 4, Lagos FGD 11, March 2024). In Akure, a resident acknowledged that "*when I check the SMS and notice it's on heat I will just go to the last line to check action to be taken...I didn't share [the message] with anybody but if I see anybody in that situation, I would tell them what you can do*" (personal communication, Mr M, Akure, 17 March 2024).

4.2.3 EVALUATION OF THE COMMUNICATION MEDIA AND CONTENT

Most of the residents had little or no problem understanding the content of the heat warning messages. Many felt that "the SMS is useful" (personal communication, Mr J, Akure, March 2024), and that "*everything about the information is okay. I'm not sure there is anything to remove except you wish to add anything*" (personal communication, Mr D, Akure, March 2024). In situations where the residents do not understand any part of the message, they seek clarification from family members and community members. "*If I don't understand, I have people I can share with to put me through. Some of our community leaders were approached to explain the areas we found difficult, and they explained*" was another enlightening remark (personal communication, discussant 3, Lagos FGD 9, March 2024). Another comment was that "*I received the SMS, and it was beneficial. I was unable to read [understand] myself. My child interpreted the content*" (personal communication, discussant 3, Lagos FGD 10, March 2024).

All those who received appreciated the messages and want it to continue. This might be because, to them, the "*content of the SMS was accurate. The heat was at its peak during the days as noted in the messages*" (personal communication, discussant 1, Lagos FGD 11, March 2024). The appreciative comments include "*You should continue please. You, are helping humanity, please continue*" (personal communication, Mr D, Akure, March 2024); "*You are to continue advising people again because it is important... you should continue because God of heaven will bless you*" (personal communication, Mr H, Akure, March 2024).

4.2.4 PREFERENCES/SUGGESTIONS FOR IMPROVEMENT

As part of the feedback, we solicited suggestions that can improve and scale-up the impact of the heat early warning system being developed. The suggestions and preferences expressed fall into the following categories:

i) Using other channels

While many received the SMS and posters, they largely feel other mass communication media should be explored. Radio and television were severally mentioned. An Akure resident asked, "*Can you try if we can be hearing it on radio?* (Mr J, Akure, March 2024); Other participants commented that "*broadcasting it on radio will help a lot because not everyone accesses their*

phones to check their messages. But people listen to radio, they listen to news" (Mr M, Akure, March 2024). Another person noted that "*It will also be good if it is presented on the radio in English, Hausa, and Yoruba to enable radio listeners access to the information*" (Mr O, Akure, 17 March 2024). Similar comments were made by participants in Lagos. A resident noted that "*there are many people who don't know that this type of sensitization is ongoing. I will suggest the inclusion of radio and television announcements*" (discussant 4, Lagos FGD 13, March 2024).

An in-person community sensitization awareness event was also mentioned. Someone suggested that "*you can organize a sensitization exercise for the community members. The sensitization exercise should be geared towards educating the neighbourhood on the disadvantages of heat and the precautions to take*" (discussant 4, Lagos FGD 10, March 2024).

ii) Expanding languages and clarity of the messages

Heat information (forecast and precautions) in the SMS and posters were communicated in English and a vernacular language based on the highest preferences indicated in the survey (explained in Section 4.1.5). In Akure, the English messages included a Hausa translation while in Lagos, the English messages included a Yoruba translation. Notwithstanding, the feedback shows residents want the inclusion of more languages. The Lagos residents suggested that languages apart from English and Yoruba should be included. On the SMS they remarked, "*I want to implore you to consider sending the SMS in the Hausa language so that they can also benefit from it*" (personal communication, discussant 5, Lagos FGD 11, March 2024). They also noted that *"the posters were seen by many but not all could understand the content. For instance, the one pasted at my house, it was my sibling that took time to explain the content to two people looking at it"* (personally communication, discussant 3, Lagos FGD 13, March 2024).

iii) Greater reach (scaling up) of the messages

The messages were received by many within each community. However, it became clear that the heat information is useful to a greater population beyond those who got the SMS and saw the posters. To reach more people, "*there is a need for the information to get to some other communities*" (personal communication, discussant 1, Lagos FGD 13, March 2024) - to scale up the impact. The residents requested that "*the frequency and reach is increased as many didn't receive the messages. The number of people who didn't receive the message is more than those who received it... so that it can be beneficial to all*". (personal communication, discussant 3, Lagos FGD 9, March 2024). They would like to "*keep having the SMS because there are people who haven't received them. It may be that they only heard from some of us. It will be best if the messages can be sent directly to their phones like all of us*" (personal communication, discussant 4, Lagos FGD 11, March 2024).

The Lagos residents feel the posters weren't adequate. They believe not every member of the community saw them. So, they recommend that more posters should be used. According to a discussant, "*I think the posters weren't enough because there were some areas that didn't see them at all. Unfortunately, these areas would have also benefitted as they also face similar challenges*". (personal communication, discussant 3, Lagos FGD 13, March 2024). It was also advised that "*the posters should be continued because not all community members own phones*" (personal communication, discussant 1, Lagos FGD 11, March 2024).

iv) Cogent concerns raised about implications of the message
Another notable aspect of the feedback highlights implication of the messages, especially on a vital service like water. Some of the residents think *"What is missing is water which has been highlighted by most people here. If water is installed in this area, it will ease a lot of things"* (personal communication, discussant 5, Lagos FGD 9, March 2024). The residents believe that beyond awareness, they need improved services especially water and electricity which are crucial to most of the precautionary measures to heat exposure.

5.0 DISCUSSION AND IMPLICATIONS

Appraising the utilisation of heat early warning resources in selected slum communities in Akure, a secondary city and Lagos, a megacity is timely and responsive given the growing pervasive impacts of the interactions between climate change and human health. It aligns with the need to reach last mile communities. Heat exposure in densely populated cities comes with a heavy burden, especially among the disadvantaged and vulnerable groups. This study's findings echo the significance of heat stress challenges faced by large populations in informal and disadvantaged communities, not only in the case study areas but across sub-Saharan Africa. It also underscores the critical role of comprehension and awareness in effectively responding to heat early warning systems. With nearly 50% of Nigeria's population, approximately 100 million people, living in informal settlements (UN-HABITAT), there is a significant need to educate these communities about the harmful effects of heat exposure.

During the piloting period of our Community Heat Early Warning System, SMS alerts for "Hot," "Very Hot," or "Extremely Hot" conditions were sent out on 74% of the days in Lagos, whereas Akure participants received "Very Warm" or "Hot"

warnings on 71% of the days. This indicates that Lagos residents experienced more uncomfortable conditions compared to Akure residents. Despite Akure generally having higher temperatures than Lagos, its significantly lower humidity levels contribute to the difference in heat stress perception. Nevertheless, participants in both cities reported severe thermal conditions during these periods. These findings corroborate previous studies that have quantitatively confirmed heat stress issues in both Lagos and Akure, Nigeria (Balogun et al., 2010; Obe et al., 2023; Ojeh et al., 2016).

The heat intensity in slums as one of the last mile communities is dire due to their physical environment characteristics, such as densely packed housing, substandard building materials, a lack of public cooling spaces (e.g., parks, shaded areas, air-conditioned public facilities), and poor access to essential public services and amenities like affordable healthcare. These factors significantly reduce the adaptive capacity of the residents. The combination of low adaptive capacity and high exposure to heat hazards makes residents of informal settlements extremely vulnerable to heat, leading to health issues such as headaches, malaria, skin rashes, heat stroke, high blood pressure, sleep disturbances, and increased aggression (Ncongwane et al., 2021; Pasquini et al., 2020, Di Napoli et al., 2018).

Although not directly assessed in this study, the health and economic consequences of extreme heat and heat stress are substantial, particularly for residents of last-mile communities. The co-developed and piloted heat warning system has shown widespread acceptance and value in the selected communities as a bottom-up innovation for heat warning forecasting and dissemination. Beyond education and information dissemination to the target population, it is also important to provide basic services and infrastructure in vulnerable slum communities as mitigation measures to build community resilience. In this regard, water and electricity are basic services government should be prioritised for vulnerable communities and populations. Earlier studies show that the most popular adaptation measures within slum communities are linked to water (hydration, bathing) and electricity (cooling devices) (Adegun, 2023).

To achieve early warning for all, leveraging technology is essential to enhance the impacts and reach of heat warning information and foster early action. It is crucial to scale up what this study piloted. For instance, digitalizing the Community Heat Early Warning Systems by integrating Internet of Things (IoT)1 sensors for local heat monitoring with large-scale weather data can feed machine learning models for heat early warnings, enabling faster and broader dissemination across various parts of the country. Masselot et al. (2021) propose that machine learning and data-driven approaches are useful for improvement in the efficacy and automation of early warning systems.

Our study also identified limitations in the current top-down heat warning/forecast dissemination approach used in Nigeria. The impact-based Heat Index forecast by the Nigerian Meteorological Agency (NIMET) is disseminated through websites, social media, and national TV. However, these channels are not accessible to many due to infrequency, technical jargon, and technological, power failure, and language barriers. NIMET should improve the contents of the heat warning messages and the medium of dissemination without leaving anyone behind. It should be regular and consistent to ensure that communities receive timely alerts. However, less helpful frequently disseminated content and monotonous formatting that can diminish the receivers' interest with time, should be avoided to prevent alert fatigue,

The language factor is essential for improved disaster preparedness using proper communication to the diverse populations that need heat early warning information. Heat alerts, jingles and sensitization information can be translated into the four commonly spoken languages nationally – English, Yoruba, Hausa, Ibo, and pidgin. Other local languages and their dialects should be considered. All segments of society - older people, women, people with disabilities, those with underlying ailments, children, etc should be adequately covered using all the traditional and modern means of communication. The factors of socioeconomic characteristics including age, education, and ownership/access to telephone are also critical for receiving and utilising heat early warning messages.

We propose a hybrid top-down-bottom-up approach for communication and dissemination. In this model, national heat impact-based forecasts by NIMET would be relayed to the National Broadcasting Corporation, which would disseminate them to all radio stations and then to end-users. Relevant government agencies, such as the Ministry of Health and the Ministry of Environment, would use these forecasts for disaster reduction and risk management. Meanwhile, the Community Heat Early Warning System would disseminate heat warnings at the community level through SMS alerts and posters and offer sensitization and awareness programs. Collaborating with relevant stakeholders such as the media, relevant institutions (religious, educational and health), and NGOs is essential to the hybrid approach. This aligns with the earlier call for multi-sectoral cross-hierarchical collaboration by scholars such as Elias (2018) and Casanueva et al. (2019).

Whereas this study has focused on poor communities and at-risk populations in densely populated urban slums, it is by no means exhaustive. Limitations of this work include the lack of analysis of risk management infrastructure (e.g., primary healthcare) availability and accessibility, and the validation of model/forecast data to ensure accuracy at the local scale. Further studies can target other groups in the last mile for example people living with disabilities.

The study can also be extended to non-slum urban communities in densely populated areas of Nigeria.

6.0 CONCLUSION

The study has shown the utilization of early warning resources in selected slum communities in Akure, Ondo State and Lagos, Lagos State, Nigeria. It delved into awareness on heat warning information, access barriers, preferences, actions taken on heat warning information. The study shows low awareness on available heat warning information, which consequently affected actions taken. The kinds of action taken based on heat early warning accessed differ across the two locations. Access barriers include infrequency, technology devices, and language of the information. Most residents mostly preferred receiving Heat Warning information through 'radio', "in-person", "SMS", and "printed visual materials". As part of the study a Community Heat Early Warning System was designed, piloted for 40-days, and its impacts assessed in the two slum communities. This was well received, and the feedback include suggestions for improvements and scaling up.

Ultimately, the research seeks to empower vulnerable urban settlements by enhancing their preparedness for extreme heat events, strengthening their resilience, and fostering the adoption of community-based early warning systems in the face of climate change. Using the lived experiences of the last-mile communities to tell their stories can contribute data to monitor global aspirations such as the UN Sustainable Development Goal 3, Goal 11 and beyond. It indicates progressive steps towards achieving goals within the Sendai Framework for Disaster Risk Reduction 2015-2030.

7.0 REFERENCES

Adegun, O. B., 2023. Strategies for addressing exposure to extreme heat in a slum community. In Proceedings of the Institution of Civil Engineers-Municipal Engineer. https://doi.org/10.1680/jmuen.23.00022.

Adejumo, T., Olajide, O. and Bishi, H. 2011, Eco-City: An Alternative Concept for Sustainable Urban Renewal in Metropolitan Lagos. Ecocity World Summit, Montreal, Canada.

Adelekan, I., Cartwright, A., Chow, W., Colenbrander, S., Dawson, R., Garschagen, M., Haasnoot, M., Hashizume, M., Klaus, I., Krishnaswamy, J., Lemos, M.F., Ley, D., McPhearson, T., Pelling, M., Kodira, P. P., Revi, A., Sara, L. M., Simpson, N. P., Singh, C., Solecki, W., Thomas, A., Trisos, C. 2022. What the latest science on impacts, adaptation and vulnerability means for cities and urban areas. Indian Institute for Human Settlements. https://doi.org/10.24943/ SUPSV209.2022.

African Union Commission, 2022. Institutional and Operational framework for Multi-hazard early warning and early action system for Africa. Policy Brief. Ahmedabad Municipal Corporation., 2013. Ahmedabad Heat Action Plan: Guide to Extreme Heat Planning in Ahmedabad. Available online: https://www.nrdc.org/sites/default/files/ahmedabad-heat-action-plan-2018.pdf.

Ayeni, O.D. and Oloukoi, G., 2022. Analysis of temperature trend as an indicator of climate change using land surface temperature (LST) and meteorological data in Akure, southwest Nigeria. Journal of Research in Forestry, Wildlife and Environment, 14(3), pp.84-100.

Baker, J., 2012. Climate change, disaster risk, and the urban poor: Cities building resilience for a changing World. The International Bank for Reconstruction and Development. Washington, USA.

Ballester, J., Quijal-Zamorano, M., Méndez Turrubiates, R.F., Pegenaute, F., Herrmann, F.R., Robine, J.M., Basagaña, X., Tonne, C., Antó, J.M. and Achebak, H., 2023. Heat-related mortality in Europe during the summer of 2022. Nature Medicine, 29(7), pp.1857-1866.

Balogun, A. A., Balogun, I. A., & Adeyewa, Z. D., 2010. Comparisons of urban and rural heat stress conditions in a hot–humid tropical city. Global Health Action, 3(1), 5614.

Casanueva, A., Burgstall, A., Kotlarski, S., Messeri, A., Morabito, M., Flouris, A.D., Nybo, L., Spirig, C. and Schwierz, C., 2019. Overview of existing heat-health warning systems in Europe. International journal of environmental research and public health, 16(15), p.2657.

De Perez, E.C., Berse, K.B., Depante, L.A.C., Easton-Calabria, E., Evidente, E.P.R., Ezike, T., Heinrich, D., Jack, C., Lagmay, A.M.F.A., Lendelvo, S. and Marunye, J., 2022. Learning from the past in moving to the future: Invest in communication and response to weather early warnings to reduce death and damage. Climate Risk Management, 38, p.100461.

Di Napoli, C., Pappenberger, F., & Cloke, H. L., 2018. Assessing heat-related health risk in Europe via the Universal Thermal Climate Index (UTCI). International Journal of Biometeorology, 62(7), 1155–1165. https://doi.org/10.1007/s00484-018-1518-2

Early Warnings For All Action Plan for Africa is launched. WMO Press release. Available: https://wmo.int/news/media-centre/early-warnings-all-action-plan-africa-launched. Accessed 15 May 2024.

Elias, P., 2018. The challenges of climate change communication for Lagos coastal communities. in: W. Leal Filho et al. (eds): Handbook of Climate Change Communication: vol. 2: Climate Change Management. Pp. 129-145. Available online at https://doi.org/10.1007/978-3-319-70066-3-10.

Guo, L., Di, L., Zhang, C., Lin, L., Chen, F. and Molla, A., 2022. Evaluating contributions of urbanization and global climate change to urban land surface temperature change: a case study in Lagos, Nigeria. *Scientific Reports*, *12*(1), p.14168.

Heidenreich, A. and Thieken, A.H., 2024. Individual heat adaptation: Analyzing risk communication, warnings, heat risk perception, and protective behavior in three German cities. *Risk analysis*. doi: 10.1111/risa.14278.

Hugo J., M., 2023. Heat stress: adaptation measures in South African informal settlements. Buildings and Cities, 4(1):55–73. doi:10.5334/bc.269.

International Federation of Red Cross, 2022. https://www.ifrc.org/sites/default/files/2022-11/220921_EWEA%20brief_Global%20Climate%20Resilience%20Platform_IFRC.pdf

Jalonne L. White-Newsome, S., McCormick, S., Sampson, N., Buxton, M. A., O'Neill, M. S., Gronlund, C. J., Catalano, L., Conlon, K. C., & Parker, E. A., 2014. Strategies to Reduce the Harmful Effects of Extreme Heat Events: A Four-City Study. International Journal of Environmental Research and Public Health, 11, 1960-1988. https://doi.org/10.3390/ijerph110201960.

Jones, H. M., Glitz, S., Shumake-Guillemot, J., & West, M., 2015. Developing Climate Information Systems for Heat Health Early Warning: Workshop Report, Action Plan, and Requirements.

Kalkstein LS, Jamason PF, Greene JS, Libby J, Robinson L., 1995. The Philadelphia hot weather–health watch/warning system: development and application, summer. Bulletin of American Meteorology Society. 1996;77(7):1519–28. doi: 10.1175/1520-0477(1996)077<1519:TPHWHW>2.0.CO;2.

Kotharkar, R., Ghosh, A. and Kotharkar, V., 2021. Estimating summertime heat stress in a tropical Indian city using Local Climate Zone (LCZ) framework. Urban Climate, 36, p.100784.

Kovats RS, Hajat S., 2008. Heat stress and public health: a critical review. *Annu Rev Public Health*. 29:41-55. doi: 10.1146/annurev.publhealth.29.020907.090843. PMID: 18031221.

Lenton TM, Xu C, Abrams JF, Ghadiali A, Loriani S, Sakschewski B, Zimm C, Ebi KL, Dunn RR, Svenning JC and Scheffer M., 2023. Quantifying the human cost of global warming. *Nature Sustainability* 6(10): 1237-1247.

Li, Y. Y. Jin, Y. Cheng, C. Li, Z. Wu; C. Peng, S. Yu and D. Fang; Y. Xu, X. Chen and Q. Wang; G. Cui, C. Yang and L. Lan; S. Luo and Y. Wang; M. Jin. 2018. Heatwave and health risk early warning systems in China. Climate Services for Health: Improving public health decision-making in a new climate. Eds. J. Shumake-Guillemot and L.Fernandez-Montoya. Geneva.

Lowe, D., Ebi, K. L., & Forsberg, B., 2011. Heatwave Early Warning Systems and Adaptation Advice to Reduce Human Health Consequences of Heatwaves. International Journal of Environmental Research and Public Health, 8(12), 4623-4648. https://doi.org/10.3390/ijerph8124623

Manyuchi, A.E., Chersich, M., Vogel, C., Wright, C.Y., Matsika, R. and Erasmus, B., 2022. Extreme heat events, high ambient temperatures and human morbidity and mortality in Africa: A systematic review. South African Journal of Science, 118(11-12), pp.1-8.

Masselot, P., Chebana, F., Campagna, C., Lavigne, É., Ouarda, T.B. and Gosselin, P., 2021. Machine learning approaches to identify thresholds in a heat-health warning system context. Journal of the Royal Statistical Society Series A: Statistics in Society, 184(4), pp.1326-1346.

Masterton, J. M., & Richardson, F. A., 1981. Humidex: a method of quantifying human discomfort due to excessive heat and humidity.

Mehrotra S, Bardhan R, and Ramamritham K., 2018. Urban informal housing and surface urban heat island intensity: exploring spatial association in the City of Mumbai. Environment and Urbanization ASIA, 9(2):158-177.

Ncongwane, K. P., Botai, J. O., Sivakumar, V., & Botai, C. M., 2021. A literature review of the impacts of heat stress on human health across Africa. Sustainability, 13(9). https://doi.org/10.3390/su13095312

National Emergency Management Agency (NEMA), 2018. 2017 Annual Report, National Emergency Management Agency, Abuja. Nigeria.

Obe, O.B., Morakinyo, T.E. and Mills, G., 2023. Assessing heat risk in a sub-Saharan African humid city, Lagos, Nigeria, using numerical modelling and open-source geospatial socio-demographic datasets. City and Environment Interactions, 20, p.100128.

Ojeh, V. N., Balogun, A. A., & Okhimamhe, A. A., 2016. Urban-rural temperature differences in Lagos. *Climate*, 4(2), 29.

Oppermann E, Kjellstrom T, Lemke B, Otto M and Lee JKW, 2021. Establishing intensifying chronic exposure to extreme heat as a slow onset event with implications for health, wellbeing, productivity, society and economy. Current Opinion in Environmental Sustainability, 50:225-235.

Pasquini, L., van Aardenne, L., Godsmark, C. N., Lee, J., & Jack, C., 2020. Emerging climate change-related public health challenges in Africa: A case study of the heat-health vulnerability of informal settlement residents in Dar es Salaam, Tanzania. Science of the Total Environment, 747. https://doi.org/10.1016/j.scitotenv.2020.141355

Pogačar, T., Žnidaršič, Z., Kajfež Bogataj, L. and Črepinšek, Z., 2020. Steps towards comprehensive heat communication in the frame of a heat health warning system in Slovenia. International journal of environmental research and public health, 17(16), p.5829.

Ramsay EE, Fleming GM, Faber PA, Barker SF, Sweeney R, Taruc RR, Chown SL and Duffy GA, 2021. Chronic heat stress in tropical urban informal settlements. iScience 24(11), p.103248.

REAP, 2022. Glossary of early action terms: 2022 edition. Risk-informed Early Action Partnership. https://www.early-action-reap.org/glossary-early-action-terms-2022-edition

Sailor, D.J., Baniassadi, A., O'Lenick, C.R. and Wilhelmi, O.V., 2019. The growing threat of heat disasters. Environmental Research Letters, 14(5), p.054006.
Scott AA, Misiani H, Okoth J, Jordan A, Gohlke J, Ouma G, Arrighi J, Zaitchik BF, Jjemba E, Verjee S and Waugh DW (2017). Temperature and heat in informal settlements in Nairobi. PloS one, 12(11): p.e0187300.

Sihvonen, I., 2023. Assessing the Heat Wave Adaptation and Risk Perception Among the Elderly: The Role of Early Warning Systems (EWS). MSc Thesis Environmental Change. University of Helsinki.

Sufri, S., Dwirahmadi, F., Phung, D. and Rutherford, S., 2020. A systematic review of community engagement (CE) in disaster early warning systems (EWSs). Progress in Disaster Science, 5, p.100058.

Thiaw, W.M., Bekele, E., Diouf, S.N., Dewitt, D.G., Ndiaye, O., Ngom Ndiaye, M.K., Ndiaye, P.N., Diene, N., Diouf, M., Diaw, A. and Diop, S., 2022. Toward experimental heat–health early warning in Africa. Bulletin of the American Meteorological Society, 103(8), pp.E1843-E1860.

Trahan, A., Walshe, R. and Mehta, V., 2023. Extreme heat, gender, and access to preparedness measures: An analysis of the heatwave early warning system in Ahmedabad, India. International Journal of Disaster Risk Reduction, 99, p.104080.

UN-Habitat, 2012. State of the World's Cities 2008/9: Harmonious Cities. Routledge. London.
United Nations International Strategy for Disaster Reduction, 2009. UNISDR terminology on disaster risk reduction. Retrieved from http://www.unisdr.org/we/inform/publications/7817.

United Nations International Strategy for Disaster Reduction. 2009. Global Assessment Report on Disaster Risk Reduction.

VanderMolen, K., Kimutis, N. and Hatchett, B.J., 2022. Recommendations for increasing the reach and effectiveness of heat risk education and warning messaging. *International Journal of Disaster Risk Reduction*, *82*, p.103288.

World Meteorological Organisation, 2023. 2023 State of Climate Services – Health. World Meteorological Organization, Geneva, Switzerland.

APPENDICES

APPENDIX 1: SAMPLE QUESTIONNAIRE

SLUMWARN: Heat Warning Information and Resources Accessibility Survey

Introduction:

This survey is a component of the SLUMWARN project, which seeks to investigate how residents in slum areas (as last mile communities) utilize heat early warning resources in Nigeria. The study aims to identify barriers to accessing early warning messages, understand the preventative actions taken based on these messages, and explore the factors influencing actions or inactions within slums.

Participation is voluntary. Your participation as a member of this community will significantly contribute to the development of an easy-to-use inclusive tools for developing and disseminating heat-related early warning, early actions information effectively within the community.

The questionnaire does not include any identifier (anonymous) and the findings will be kept confidential, used for academic purposes.

Are you willing to participate in this survey? Yes [ ] or No [ ]

Project Contact: Dr Olumuyiwa Adegun +2349099664705; obadegun@futa.edu.ng

1. Age:
   - 18-24
   - 25-34
   - 35-44
   - 45-54
   - 55-64
   - 65 or older

2. Gender:
   - Male
   - Female
   - Prefer not to say

3. Marital Status
   - Single
   - married
   - separated/divorced
   - widow/widower

4. Education level
   - Primary
   - Secondary
   - Tertiary
   - None

5. Occupation:
   - Govt sector employment [ ],
   - private sector employment [ ],
   - unemployed [ ],
   - retired [ ],
   - self-employed (informal sector) [ ],
   - specify the self-employment ____

6. Average daily income:
7. What languages do you

   Speak_____
   Understand _____
   Write _____

8. Do you own/have access to a mobile phone? Yes [ ] No [ ] 9. It's been hot recently, do you intentionally seek for heat warning (forecast)

information to support you decision making?

- Yes
- No
- I really don't care

10. If yes, How do you usually access the heat warning information? (Select all that apply)

- Television
- Radio
- Social media
- SMS Phone alerts
- Community bulletin boards
- Words of mouth
- Town crier
- Other (please specify)

11. If yes, from which sources if you know e.g. NIMET, local weather station, international forecast?

12. If yes (to 4), how often do you access or receive them

- Anytime I want
- Hourly
- Daily
- Weekly
- Other specify

13. Do you feel that the current heat warning information is easily accessible to you?

Yes [ ] No [ ] Not sure [ ]

14. Do you feel that the current heat warning information is useful or valuable to you?

- Yes
- No
- Not sure

15. On a scale of 1 to 5, how well do you understand the heat warning information provided?

1: Very poor
2: Poor
3: Average
4: Good
5: Very well

16. What are the barriers to your access and understanding of the heat warning information?

- Literacy - I don't understand the language used.
- I don't own phone or device with which to access
- I am not interested

17. Have you ever taken specific actions based on a heat warning?

Yes [ ] No [ ] Not applicable [ ]

18. If yes, please describe the actions you took.

19. Please rate the following statements on a scale of 1 to 5, where 1 is "Strongly Disagree" and 5 is "Strongly Agree."

- I am aware of the availability of early warning messages in my community.
- The language used in early warning messages is easy to understand.
- The frequency of early warning messages is sufficient.
- The technology used to deliver early warning messages is accessible to me.
- I face challenges in accessing early warning messages due to:
  - o Lack of awareness
  - o Language barriers
  - o Infrequent messages
  - o Inaccessible technology
  - o Other (please specify)

20. What mode of early warning information would be most helpful for you? (Select all that apply

- Printed visual information
- SMS
- Email
- Phone call
- Telegram/WhatsApp messaging
- In person/ house-to-house announcements
- Media release
- Leaflet
- Website
- Radio
- Newspaper
- Others, please mention

21. A new COMMUNITY HEAT EARLY WARNING SYSTEM (CHEWS)is being developed, are you willing to receive heat warning from us?

Yes [ ] No [ ]

If yes, please indicate your phone number _____, your WhatsApp number _____

22. In which language would you prefer the warming be delivered

- Yoruba
- English
- Pidgin
- Hausa
- Other (specify)

23. Is there anything else you would like to share about your experiences with heat warnings or suggestions for improvement?

24. What additional information should be included in the CHEW alert?
    - Guidance on what action to do, e.g. ‘drinking water, seeking meeication attentions
    - A message that provides reassurance e.g. ‘stay calm'
    - A countdown timer towards heat occurrence
    - Potential impacts and risks (e.g. heat stroke, higher risk of meningitis)
    - Information on additional hazards about the same time e.g. flooding,
    - Further information about heat forecasting
    - A link to further information on what to do
    - Other (please specify)

25. To you, what are benefits of heat early warning

    - I would be able to mentally prepare myself for what is coming
    - I would be able to take physical actions to protect myself
    - I would be able to help or save other people nearby
    - Others

26. Which groups should be targeted for CHEW? Yes [ ] No [ ] Maybe [ ]
    - adults over the age of 65 years
    - parents of infants and children
    - individuals taking certain medications
    - individuals with chronic underlying diseases
    - physically disabled
    - women
    - outdoor workers
    - others, specify

APPENDIX 2: DAILY HEAT INDEX DISSEMINATION DETAILS FOR THE TWO LOCATIONS

Lagos

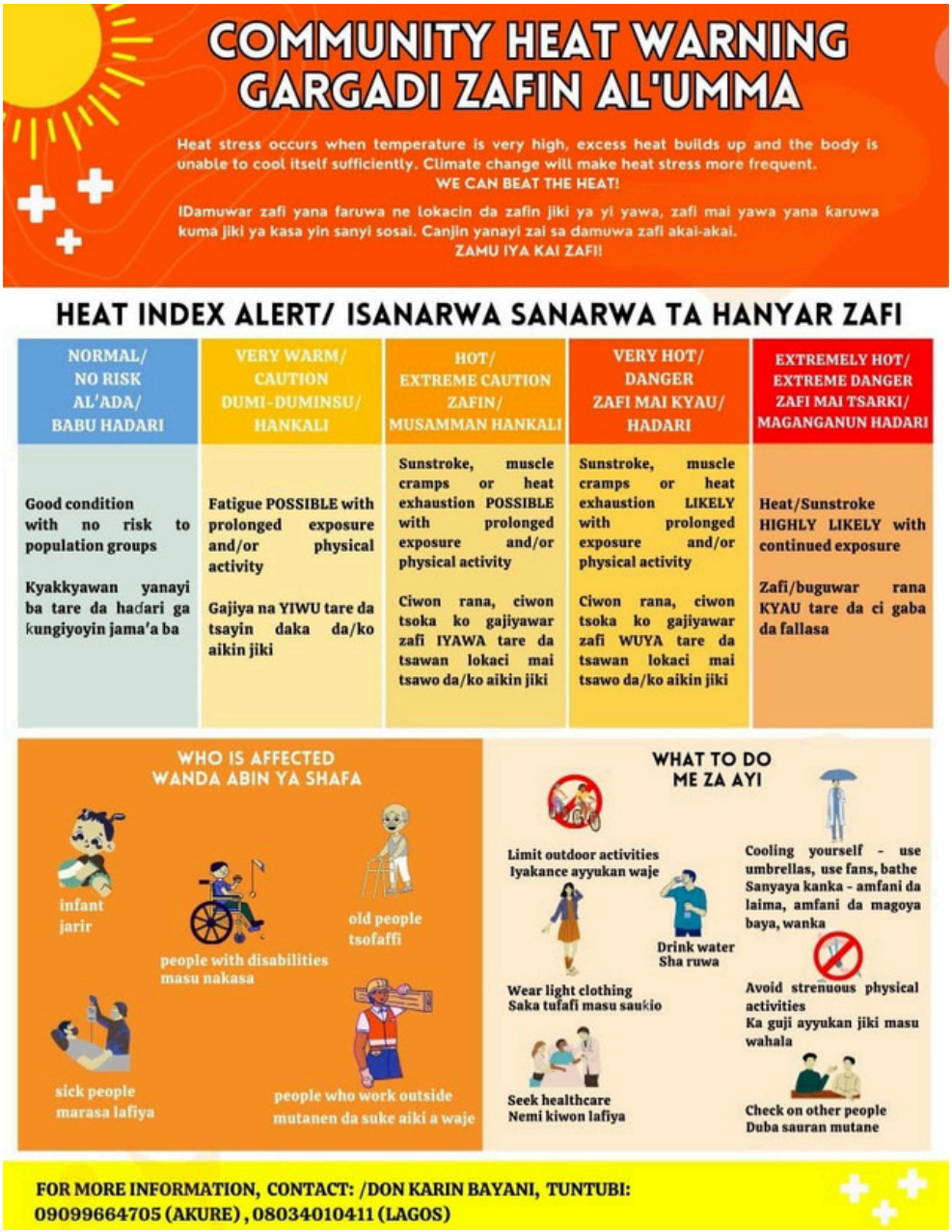
S/N	DAY	DATE	TEMPERATURE/ HUMIDITY	HEAT LEVEL	RISK LEVEL	No of SMSSENT	No DELIVERED	TIME SENT	DAY	DATE SENT	REMARKS
1	Wed	10- Jan	32C/57%	Very Hot	Danger	7	5	1950HRS			Test Run
2	Thurs	11- Jan	33C/62%	Very Hot	Danger	255	187	1900HRS	Wed	10- Jan	
3	Fri	12-Jan	32C/63%	Very Hot	Danger	258	188	1900HRS	Thurs	11- Jan	
4	Sat	13- Jan	32C/66%	Very Hot	Danger	258	188	1900HRS	Fri	12-Jan	
5	Sun	Jan	32C/63%	Very Hot	Danger	258	175	1929HRS	Sat	13- Jan	
6	Mon	15- Jan	33C/59%	Very Hot	Danger	258	189	1927HRS	Sun	14-Jan	
7	Tue	16- Jan	34C/62%	Very Hot	Danger	258	195	1901HRS	Mon	15- Jan	
8	Wed	17- Jan	34C/49%	Very Hot	Danger	258	191	1903HRS	Tue	16- Jan	
9	Thurs	18- Jan	34C/53%	Very Hot	Danger	258	175	1900HRS	Wed	17- Jan	
10	Fri	19- Jan	33C/46%	Very Hot	Danger	258	189	1900HRS	Thurs	18- Jan	
11	Sat	20- Jan	33C/60%	Very Hot	Danger	258	189	1900HRS	Fri	19- Jan	
12	Sun	21- Jan	34C/61%	Extremely Ho	Extreme Dan	258	190	1900HRS	Sat	20- Jan	
13	Mon	22- Jan	33C/60%	Extremely Ho	Extreme Dan	258	191	1902HRS	Sun	21- Jan	
14	Tue	23 Jan	32C/61%	Extremely Ho	Extreme Dan	258	190	1900HRS	Mon	22- Jan	
15	Wed	24 Jan	32C/65%	Very Hot	Danger	258	188	1900HRS	Tue	23- Jan	
16	Thurs	25 Jan	33C/59%	Very Hot	Danger	258	194	1903HRS	Wed	24- Jan	
17	Fri	26 Jan	33C/58%	Very Hot	Danger	258	189	0646HRS	Thurs	25- Jan	
18	Sat	27 Jan	34C/29%	Very Warm	Caution	258	187	1900HRS	Fri	26- Jan	
19	Sun	28 Jan	33C/34%	Very Warm	Caution	258	189	1859HRS	Sat	27- Jan	
20	Mon	29 Jan	33C/49%	Hot	Extreme Caut	258	187	1900HRS	Sun	28- Jan	
21	Tue	30 Jan	32C/58%	Hot	Extreme Caut	258	183	1900HRS	Mon	29- Jan	
22	Wed	31 Jan	32C/57%	Hot	Extreme Caut	258	182	1901HRS	Tue	30- Jan	
23	Thur	01- Feb	33C/56%	Very Hot	Danger	258	186	1939HRS	Wed	31- Jan	
24	Fri	02- Feb	34C/52%	Very Hot	Danger	258	195	1900HRS	Thur	01- Feb	
25	Sat	03- Feb	33C/57%	Very Hot	Danger	258	195	1841HRS	Fri	02- Feb	
26	Sun	04- Feb	33C/39%	Very Warm	Caution	258	189	1810HRS	Sat	03- Feb	
27	Mon	05- Feb	33C/38%	Very Warm	Caution	258	195	1807HRS	Sun	04- Feb	
28	Tue	06- Feb	34C/31%	Very Warm	Caution	258	190	2035HRS	Mon	05- Feb	
29	Wed	2/7/2024	34C/30%	Very Warm	Caution	258	189	1752HRS	Tue	06- Feb	
30	Thurs	8 Feb	32C/44%	Very Warm	Caution	258	187	1850HRS	Wed	2/7/2024	
31	Fri	9 Feb	32C/53%	Hot	Extreme Caut	258	186	1846HRS	Thurs	8 Feb	
32	Sat	10 Feb	34C/30%	Very Hot	Danger	258	190	1817HRS	Fri	9 Feb	
33	Sun	11 Feb	32C/61%	Very Hot	Danger	258	195	1827HRS	Sat	10 Feb	
34	Mon	12 Feb	33C/65%	Extreme Hot	Extreme Dan	258	195	1841HRS	Sun	11 Feb	
35	Tue	13 Feb	32C/67%	Very Hot	Danger	258	194	0623HRS	Tue	12 Feb	
36	Wed	14 Feb	32C/68%	Very Hot	Danger	258	192	1759HRS	Tue	13 Feb	
37	Thurs	15 Feb	33C/64%	Extreme Hot	Extreme Dan	258	190	1827HRS	Wed	14 Feb	
38	Fri	16 Feb	33C/64%	Extreme Hot	Extreme Dan	258	195	1824HRS	Thurs	15 Feb	
39	Sat	17 Feb	32C/66%	Very Hot	Danger	258	191	0441HRS	Sat	16 Feb	

APPENDIX 2: DAILY HEAT INDEX DISSEMINATION DETAILS FOR THE TWO LOCATIONS (CONTINUED)

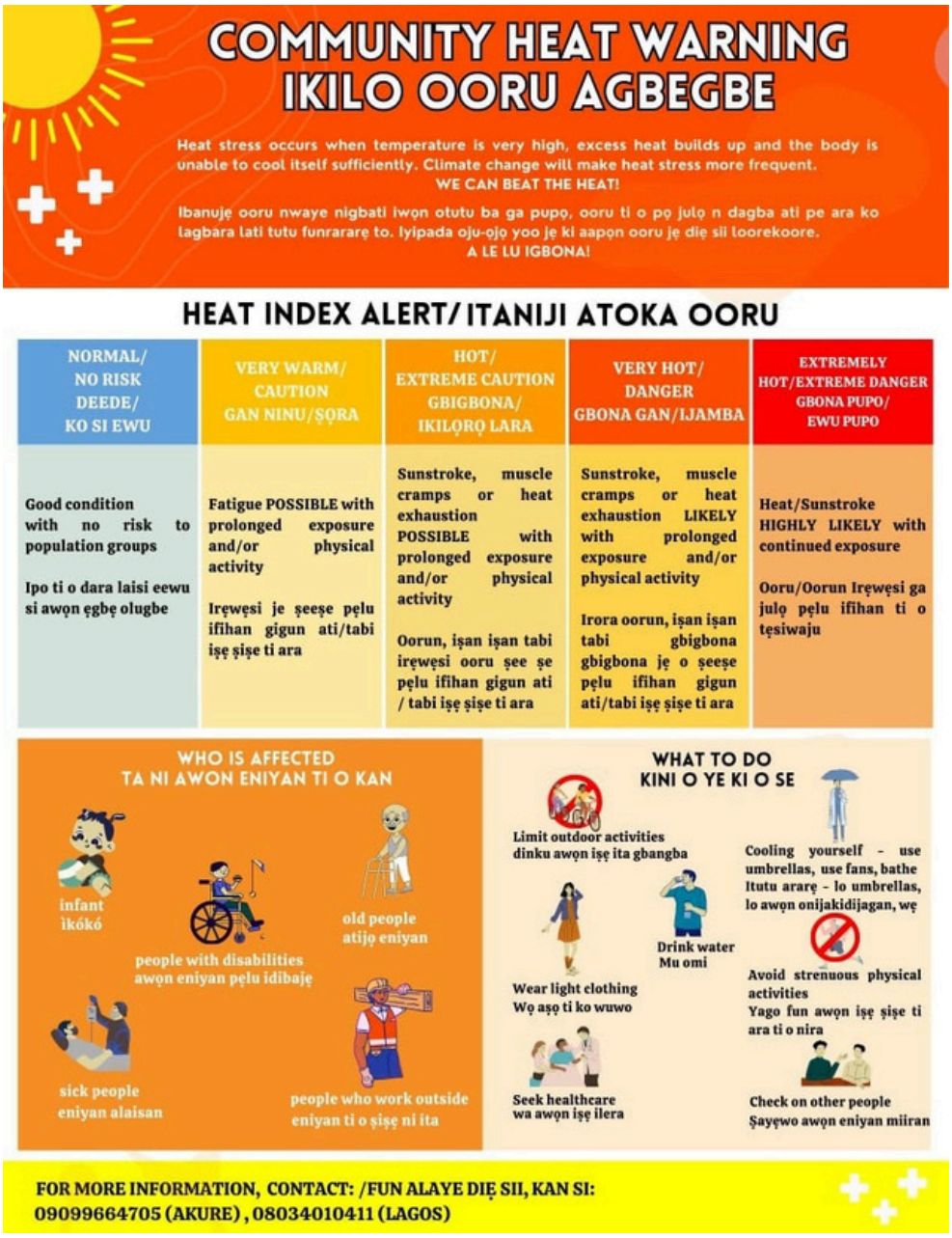
Akure

S/N	DAY	DATE	TEMPERAT	HEAT LEV	RISK LEVE	No of SMS S	No DELIVE	TIME SENT	DAY	DATE SENT	REMARK
1	Wed	10- Jan	34C/30%	Very Warm	Caution	7	5	1950HRS			Test Run
2	Thurs	11- Jan	35C/30%	Very Warm	Caution	185	162	1900HRS	Wed	10- Jan	
3	Fri	12-Jan	35C/33%	Very Warm	Caution	189	163	1900HRS	Thurs	11- Jan	
4	Sat	13- Jan	35C/32%	Very Warm	Caution	191	162	1900HRS	Fri	12-Jan	
5	Sun	14-Jan	33C/33%	Very Warm	Caution	190	158	1929HRS	Sat	13- Jan	
6	Mon	15- Jan	34C/31%	Very Warm	Caution	188	148	1927HRS	Sun	14-Jan	
7	Tue	16- Jan	35C/19%	Very Warm	Caution	189	157	1901HRS	Mon	15- Jan	
8	Wed	17- Jan	35C/17%	Very Warm	Caution	189	158	1903HRS	Tue	16- Jan	
9	Thurs	18- Jan	35C/19%	Very Warm	Caution	189	155	1900HRS	Wed	17- Jan	
10	Fri	19- Jan	35C/27%	Very Warm	Caution	189	158	1900HRS	Thurs	18- Jan	
11	Sat	20- Jan	36C/24%	Very Warm	Caution	189	156	1900HRS	Fri	19- Jan	
12	Sun	21- Jan	36C/24%	Very Warm	Caution	189	159	1900HRS	Sat	20- Jan	
13	Mon	22- Jan	35C/29%	Very Warm	Caution	190	170	1902HRS	Sun	21- Jan	
14	Tue	23- Jan	33C/35%	Very Warm	Caution	190	158	1900HRS	Mon	22- Jan	
15	Wed	24- Jan	33C/28%	Very Warm	Caution	190	156	1900HRS	Tue	23- Jan	
16	Thurs	25- Jan	34C/21%	Very Warm	Caution	190	161	1903HRS	Wed	24- Jan	
17	Fri	26- Jan	35C/29%	Very Warm	Caution	190	159	0645HRS	Thurs	25- Jan	
18	Sat	27- Jan	35C/18%	Very Warm	Caution	190	160	1900HRS	Fri	26- Jan	
19	Sun	28- Jan	35C/18%	Very Warm	Caution	190	156	1857HRS	Sat	27- Jan	
20	Mon	29- Jan	34C/23%	Very Warm	Caution	190	156	1900HRS	Sun	28- Jan	
21	Tue	30- Jan	34C/30%	Very Warm	Caution	190	151	1900HRS	Mon	29- Jan	
22	Wed	31- Jan	34C/36%	Hot	Extreme Caut	190	162	1859HRS	Tue	30- Jan	
23	Thur	01- Feb	34C/32%	Very Warm	Caution	190	163	1938HRS	Wed	31- Jan	
24	Fri	02- Feb	35C/24%	Very Warm	Caution	190	158	1900HRS	Thur	01- Feb	
25	Sat	03- Feb	35C/19%	Very Warm	Caution	190	163	1900HRS	Fri	02- Feb	
26	Sun	04- Feb	35C/17%	Very Warm	Caution	190	170	1907HRS	Sat	03- Feb	
27	Mon	05- Feb	35C/15%	Very Warm	Caution	190	158	2035HRS	Sun	04- Feb	
28	Tue	06- Feb	34C/31%	Very Warm	Caution	190	165	1852HRS	Mon	05- Feb	
29	Wed	2/7/2024	36C/13%	Very Warm	Caution	190	170	1850HRS	Tue	06- Feb	
30	Thurs	8 Feb	34C/21%	Very Warm	Caution	190	172	1846HRS	Wed	2/7/2024	
31	Fri	9 Feb	34C/32%	Very Warm	Caution	190	165	1817HRS	Thurs	8 Feb	
32	Sat	10 Feb	35C/35%	Hot	Extreme Caut	190	170	1827HRS	Fri	9 Feb	
33	Sun	11 Feb	35C/43%	Very Hot	Danger	190	168	1841HRS	Sat	10 Feb	
34	Mon	12 Feb	36C/35%	Hot	Extreme Caut	190	163	0623HRS	Sun	11 Feb	
35	Tue	13 Feb	36C/35%	Hot	Extreme Caut	190	167		Mon	12 Feb	
36	Wed	14 Feb	36C/34%	Hot	Extreme Caut	190	170	1900HRS	Tue	13 Feb	
37	Thurs	15 Feb	36C/27%	Hot	Extreme Caut	190	170	1900HRS	Wed	14 Feb	
38	Fri	16 Feb	35C/33%	Hot	Extreme Caut	190	168	1900HRS	Thurs	15 Feb	
39	Sat	17 Feb	35C/39%	Hot	Extreme Caut	190	169	0441HRS	Sat	16 Feb	

APPENDIX 3: SAMPLE OF POSTERS IN THE VARIOUS LANGUAGES



APPENDIX 3: SAMPLE OF POSTERS IN THE VARIOUS LANGUAGES (CONTINUED)



APPENDIX 4: APPRAISAL OF HW INFORMATION PREFERENCES IN THE COMMUNITIES

	Location	N	Mean Rank	Sum of Ranks				
Printed_Visual	Lagos	206	319.39	65795.00	23918.000	79196.000	-6.523	**.000**
	Akure	332	238.54	79196.00				
	Total	538						
SMS	Lagos	244	375.15	91537.50	24240.500	86368.500	-10.500	**.000**
	Akure	352	245.37	86368.50				
	Total	596						
Email	Lagos	182	265.37	48297.00	28052.000	82008.000	-1.307	.191
	Akure	328	250.02	82008.00				
	Total	510						
Telephone	Lagos	250	414.34	103586.00	15039.000	76114.000	-15.265	**.000**
	Akure	349	218.09	76114.00				
	Total	599						
Social_Media	Lagos	273	350.21	95607.50	42530.500	110795.500	-3.502	**.000**
	Akure	369	300.26	110795.50				
	Total	642						
In_person	Lagos	253	368.73	93288.50	24103.500	81056.500	-11.130	**.000**
	Akure	337	240.52	81056.50				
	Total	590						
Media_release	Lagos	273	328.83	89770.50	48367.500	116632.500	-.904	.366
	Akure	369	316.08	116632.50				
	Total	642						
Leaflet	Lagos	190	249.95	47491.00	29346.000	47491.000	-1.768	.077
	Akure	339	273.43	92694.00				
	Total	529						
Website	Lagos	273	288.84	78853.00	41452.000	78853.000	-3.996	**.000**
	Akure	369	345.66	127550.00				
	Total	642						
Radio	Lagos	212	323.26	68531.00	25279.000	81895.000	-7.302	**.000**
	Akure	336	243.74	81895.00				
	Total	548						
Newspaper	Lagos	273	254.24	69408.00	32007.000	69408.000	-8.087	**.000**
	Akure	369	371.26	136995.00				
	Total	642						