

Review Article

The Effects of Heat Wave on Human Health and Adaptive Strategies in Sub-Saharan Africa

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Received: 28/Jul/2024; **Accepted:** 30/Aug/2024; **Published:** 30/Sept/2024

Abstract— This review examined studies that analyzed the effects of heat wave on human health in Sub-Saharan Africa. Research articles on the effects of extreme heat, humidity, heat waves, and heat-related morbidity and mortality were identified. Temperatures of up to 50 °C have been reported in the region and that severe heat has numerous effects on human health. The detrimental effects of heat wave on the health of humans in the region include declining mental health of adults in low-income areas, an increase in the risks of miscarriage and renal diseases, and a decrease in productivity and social comfort. Other effects include meningitis, heatstroke, heat exhaustion, malaria, and deaths. These impacts are exacerbated by the population's low socio-economic status and the environmental quality. Some of the adaptive measures highlighted are incorporating tree planting and greening urban buildings, designs, and materials to improve ventilation and comfort, which will reduce health risks associated with extreme temperatures, the need to always stay hydrated, and developing protected green areas where people can find shelter during heat waves. Other measures include improving health infrastructure, health action plans development, improving the surveillance and response systems, enhancing education on health risks associated with climate change to boost community awareness, and preparedness.

Keywords— Temperature, Health, Climate Change, Heat, Health risks, Africa

1. Introduction

A heat wave is characterized as a period of two to three days or more during which there is an accumulation of local excess heat across a series of exceptionally hot days and nights. Heat waves are a normal occurrence of the weather caused by warm air being trapped in the atmosphere. Because greenhouse gas emissions trap heat, they are occurring more frequently and with greater intensity as a result of climate change. Several risks are raised by extreme heat, including the ones connected to peoples' health or the economy, such as higher mortality rates, water shortages and quality issues, forest fires, power outages, and losses in agriculture [1].

Numerous studies on human health and heat-related risks have focused on developed regions, but few have been conducted in Africa [2,3,4]. Elevated body temperature due to high temperatures can cause heat stress and stroke, and, in severe cases, even death. Heat stress is more likely to affect those who are obese, have heart disease, or have respiratory issues [5,6]. Dehydration, respiratory problems, heat fatigue, cardiovascular tension, skin conditions, problems of mental health, and imbalances of electrolyte are a few of the negative impacts of extreme temperatures on human health [7,8,9]. According to studies by [10], high temperatures have been

linked to an increase in violent crimes, the exacerbation of pre-existing heat-related health disorders, which can result in organ failure and mortality, and an increase in fatal traffic accidents. The need for water and power is also increased by rising temperatures [11], which has an effect on infrastructure, open spaces, and the general liveability of metropolitan areas [12].

A number of factors, including socioeconomic, demographic, environmental, physiological, and behavioural ones, exacerbate the effects of heat on human health. According to [13,14], high population density areas especially in urban centres with little to no green space, and large amounts of manmade impermeable surfaces warm up faster than surrounding areas. Access to proper cooling systems, healthcare services, and hydration might also be impeded by financial constraints. This is due to the fact that inadequate access to air conditioning frequently makes people more vulnerable during periods of intense heat. Furthermore, living in a home with inadequate ventilation might make the negative consequences of excessive heat worse [15]. The detrimental impacts of extreme heat are exacerbated by ineffective public health initiatives and heat wave warning systems [16,17]. High temperatures are a common hazard for workers in the mining, construction, and agricultural

industries [18]. Additionally, due to less efficient thermoregulation, older adults and small children are more susceptible to heat [19]. Insufficient preventive measures may result from a lack of awareness of the dangers posed by heat [20].

Due to the growth in the emission of greenhouse gas (GHG), which continue to modify the region's temperatures, the frequency of hot days in Sub-Saharan Africa has increased during the 1980s [21,22]. In Sub-Saharan Africa, temperatures frequently approach the threshold of discomfort for humans [23]. In Bilma, Niger Republic, for example, a severe temperature incident of 48.2 °C was recorded in 2010 [24]. Moreover, tropical Africa saw over 50 heat waves a year between 1989 and 2009 [25]. Extreme heat waves of 50 °C have been reported by [26] in Nigeria northeast. Heat waves are the worst kind of extreme weather event, according to [27], and the deaths are mostly underreported and unknown until months after the event. In Bamako, Mali, a hospital named Gabriel Touré reported a spike in hospitalization and deaths between April 1 and April 4, 2024. Over the course of the four days, the hospital recorded 102 deaths, which is more than the 130 deaths recorded for the entire month of April 2023.

In countries regarded as low and middle income, the effects of excessive heat on humans are exacerbated by demographic and socio-economic factors like poverty, literacy rates, and societal stratification. Additionally, because of their socio-cultural norms and weak political institutions, they are not as well able to adapt to extreme heat [28]. However, further research on the impact of high temperatures on human health in Sub-Saharan Africa is needed to determine the need for strengthening the region's resilience to events exacerbated by climate change [29,30,31]. According to recent research, certain High Income Countries have seen a decrease in the severity of health consequences from high heat, which suggests that their ability for adaptation has increased [32,33]. On the other hand, because of their low ability to adapt to intense heat and increased susceptibility, Low and Middle Income Countries are becoming more vulnerable to it [2,34,13].

This attempts to compile opinions from the literature regarding the relationship between intense heat and health in Sub-Saharan Africa. It also lists the adaptable steps taken to lessen these effects.

2. Socio-economic variables that raise population susceptibility to heat

The bioclimatic urban discomfort index in Calabar city, Nigeria, was investigated by [35], utilizing socioeconomic and demographic indicators, including age sensitivity, urban planning, urban heat island effect, socio-cultural and biophysical data, and health. According to the study, a population's ability to adapt is influenced by a number of characteristics, including age, chronic illness or disability, urban heat island effect, low income, population density, informal settlements, and locations with less vegetation. It

suggested that while calculating a person's susceptibility to heat stress in cities, age and urban environmental elements should be considered.

Studies on the relationship between heat and human health must take socioeconomic and demographic aspects into account because heat sensitivity is influenced by age groups, socio-economic class, and health state. High population density urban regions amplify the health concerns associated with the urban heat island effect. Socioeconomic position affects the availability of cooling supplies, medical care, and awareness about high heat, all of which are critical for reducing the health hazards associated with heat. Gaining an understanding of these variables can aid in the development of focused plans to shield the most susceptible groups from health problems brought on by the heat.

2.1. Studies according to informal, rural, and urban settlements

Studies evaluated the susceptibility of urban and rural populations to high temperatures [36,37]. Nonetheless, only a small number of studies were conducted in rural areas, with West African rural areas having a higher number of studies than other regions. These studies demonstrated the negative effects of heat on health, human behavior, and productivity in rural communities among laborers, mining employees, and farmers [37]. However, communities' coping strategies and reactions to heat exposure are ineffective in reducing the risk of heat-related illness and death in both homes and farms [38]. Due to their tendency to produce heat islands, urban areas are well known for the detrimental effects of heat on human health. The negative effects of heat on humans are exacerbated by the urban heat island, which occurs when temperatures in urban areas are higher than in the nearby rural areas [39].

In many African cities, low-income inhabitants are now housed in informal settlements that have grown as a result of urban sprawl. Many African cities are unplanned and densely inhabited, with informal settlements being a crucial component [40]. Due to their limited ability to adapt, residents of these haphazard settlements are specifically vulnerable to the effects of intense heat. For example, [41] found that persons living in shanty towns have higher rates of non-communicable diseases, mental health issues, and occupational hazards due to their poor income and harsh weather. The residents of these shanty settlements are especially vulnerable to the heat because of their cramped living quarters, subpar construction materials, and lack of access to basic services and public facilities [42]. Variations in urban planning, development, vegetation, and building materials can have a significant impact on the morbidity and death associated with heat. This is because [43] discovered that the intense heat felt in the vicinity of the informal settlements was several degrees Celsius higher than the local weather station's recorded ambient temperature. Poor groups were found to be more vulnerable to intense heat than wealthy ones [42,43], underscoring the social disparities in heat exposure and unfavorable health outcomes. However, there aren't enough empirical studies on how vulnerable

human health is to heat in sub-Saharan Africa's informal settlements [44]. Despite the fact that excessive heat is predicted to be a hazard to the African continent [45], research conducted in Zimbabwe has revealed that urban outdoor workers and informal settlements are more sensitive to it [46]. However, there is still more to learn about sub-Saharan Africa's susceptibility to heat.

3. Heat-related morbidity

Increased temperatures and heat stress exacerbate health hazards, according to the following studies [47,48,49,50]. According to a study by [51], densely populated areas are linked to outdoor thermal discomfort. However, [52] discovered that heat stress and discomfort are among the primary health problems during the hot season, leading to exhaustion, and general discomfort that interfere with people's activities. [53] Found a strong correlation between heat waves, precipitation, and extreme temperatures.

According to a number of studies [54,55,56], heat waves and severe temperatures are linked to an increase in the cases of respiratory illnesses, physiological stress, and malaria. High temperatures, relative humidity, and general air quality have been linked to an increase in the occurrence of malaria, typhoid fever, and meningitis, according to [57,58]. High temperatures can aggravate stress from heat, heat cramps, exhaustion, and dehydration. They can also lead to productivity loss, anxiety, acute meningitis, heatstroke, and kidney failures and negatively impact outdoor workers' social wellbeing, according to [37,38].

Children's health outcomes have also been found. For example, [59] discovered a rise in childhood acute malnutrition, dehydration, heat exhaustion, and possible effects of excessive heat exposure on fetal health. [28] found that prolonged exposure to heat stress is linked to a higher risk of stillbirths. As [60] highlighted, heat waves lasting more than four days increase the risk of mortality in females and the population of people over 55 years. Once again, it has been established that intense heat affects the female and senior population disproportionately. According to [61] there is an association between exposure to heat and unfavorable outcomes in pregnancy in Accra, Ghana. For every degree increase in wet bulk globe temperature, there is a 42% increase in the probability of miscarriage. The population that spends extended periods of time in the heat is impacted when summertime temperatures rise to above 40°C [46].

On the other hand, [36] confirmed that elevated temperatures were associated with a rise in diarrheal cases in Botswana. Farmers in Bawku East, Northern Ghana were shown to be susceptible to malaria and heat cramps as a result of heat exposure [38]. The hot and rainy season is associated with an increase in morbidity or mortality [62,63,42].

4. Adaptive strategies for reducing the health impacts of extreme heat

To counteract these consequences, a thorough examination of Sub-Saharan Africa's seasonal mortality patterns is required [51,62,64,43,65].

A number of studies [55,48,47] emphasized the importance of incorporating urban greening and tree planting into buildings, designs, and materials to improve ventilation and thermal comfort, which will lessen the risks associated with high temperatures. This is especially important in areas where heat stress has a major impact on productivity and health. [50] stressed the need to always stay hydrated, develop climate-proof housing, and protect green areas where people can find shelter during heat waves, especially in rural areas. [66] recommended the adoption of urban planning and building designs to prevent heat stress and enhance comfort in urban centers.

Moreover, the need to put effective adaptation methods into practice has been emphasized by [43,56,52,54]. These include strengthening illness surveillance and response systems, creating health action plans, raising community knowledge and preparing people for the health hazards linked with climate change, and educating people about these risks. According to [54], enhancing regional climate modeling should be a top goal in order to improve heat wave prediction. [58] noted that, broadcasting weather reports and other means of communication should be used to raise people's awareness and educate them about climate change and its effects on health. [37] recommended that workplace heat stress policies be put into place and that outdoor workers should receive more education and knowledge regarding the health dangers associated with heat. In the future, creating efficient early warning systems for heat wave and public health initiatives catered to the requirements of the most vulnerable populations; children, women, and the elderly will be top priority for lowering health risks. These will lessen the impact of heat waves by improving their readiness and reaction [60]. In order to lessen the risk of stillbirth and maternal mortality, [28] emphasize the need for climate governance and public health policies to reduce exposure to heat stress, especially in rural regions. These tactics could include developing maternal healthcare facilities, installing heat stress alert systems, and raising public awareness and educating people about the dangers of exposure to heat while pregnant. In order to create successful solutions, [67] recommended that further study be done to examine the correlation between heat stress and pregnancy outcomes.

It has been determined that more research is required to fully analyze how intense heat affects socioeconomic activities. These will impact a more focused adaptation plan, which is essential for successful mitigation. Institutional initiatives are currently minimal. However, the strength of the heat wave management plan depends in its clear structure for risk assessment, public communication, and response [68].

5. Conclusion

Increased heat-related morbidity and death during the dry/hot season were reported in the majority of the research included here. Research showed that during hot weather or heat waves, there was an increase in discomfort, dehydration, and heat-related morbidity and fatalities. Extreme heat has a negative impact on people's health in Sub-Saharan Africa. It raises the

risk of miscarriage and kidney disease, lowers productivity, and negatively affects the social comfort and mental health of low-income individuals. Meningitis, heat exhaustion, heatstroke, malaria, and fatalities are further consequences. The sub-region's relatively low socioeconomic and demographic status of the populace, along with poor environmental quality, exacerbates the negative health effects of high heat. Green places are essential to human well-being. Studies show that people who live in areas with less vegetation are more vulnerable to heat-related diseases and fatalities. Additionally, there is a strong correlation between increased night time heat and insufficient sleep, with the latter effect being more common in the elderly and lower-class populations. Due to their high population and poor living conditions, informal settlements, where over half of Sub-Saharan Africa's population lives, are more susceptible to heat-related morbidity and mortality. In Sub-Saharan Africa, where anthropogenic activity and rising greenhouse gas levels are exacerbating climate change and severe heat stress, the health effects of heat are a cause for concern.

The need to always stay hydrated, creating protected green spaces where people can seek shelter during heat waves, and incorporating tree planting and urban greening into designs, materials, and building techniques are a few of the adaptive measures that are highlighted. These will improve ventilation and thermal comfort and lower the health risks associated with extreme temperatures. Additional steps include strengthening illness surveillance and response systems, creating health action plans, raising community knowledge and preparing people for the health hazards connected with climate change, and educating people about these risks. In general, there is a connection between the unfavourable consequences of excessive heat, the socioeconomic features, and the human living environment. Future research in this area should evaluate hospitalization and fatality rates brought on by heat waves in the sub region, as well as the steps institutional stakeholders are taking to reduce the risk.

Data Availability

Data supporting the conclusion can be found in the works of Nunfam, titled 'Mixed methods study into social impacts of work-related heat stress on Ghanaian mining workers: A pragmatic research approach' published in *Heliyon*, Vol. 7, No. 5, 2021. 'Urban extreme weather: a challenge for a healthy Living environment in Akure, Ondo State. By Daniel, published in *Niger Clim*, Vol. 3, No. 4, pp. 775–791, 2015. Other sources are; studies of Njoku and Daramola, on 'Human outdoor thermal comfort assessment in a tropical region' published in *Earth Syst Environ*, Vol. 3, pp. 29–42, 2019, and Adegebo, titled 'Urban thermal perception and self-reported health effects in Ibadan, southwest Nigeria, published in *Int J Biometeorol*, Vol. 66, No. 2, pp. 331–343, 2022.

Conflict of interest

We do not have any conflict of interest

Funding source

None

Author's contribution

The review was done as a group effort at all stages

Acknowledgement

We wish to thank Dr. Yusuf Hassan for helping with proofreading and corrections done by the reviewers on the manuscript. His effort is highly appreciated and acknowledged.

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