

# Heat Waves Research and Impacts on Human Health: The Need for Studies in Nigeria: A Review

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## Abstract

Heat waves comprise of hot and cold waves and hot waves are the number of days when normal daily temperature exceeds its normal limits for consecutive periods. This phenomenon is experienced globally and as such the temperate regions especially countries in Europe and Asia notably France, Germany, China, India etc. have and still doing extensive scholarly works on heat waves research while Nigeria is lagging behind on this vital research. The replacements of natural water channels and path for concrete surfaces have led to urban heat island effects ravaging the entire country. Heat waves are linked a number of issues that directly affect health. There is a need for more studies on the nexus between heat waves and health as it affects the generality of ambient population. This review has enunciated gaps especially in Nigeria for scholars and research students to take advantage of to broaden the frontiers of knowledge. This paper is guided by the introduction, tools and techniques, methodology, gaps and conclusion.

**Keywords:** Hot waves; Heat island effects; Health

## Introduction

### Heat waves

Heat waves refer to a run of hot days; precisely how many days, and how high the temperatures must rise [1]. Once the human body's physiological capacity to cope with increased heat stress is exceeded, the risks of functional failure, disease exacerbation and death rises rapidly. If the body temperature rises above 38°C, physical and cognitive functions are impaired; above 40.6°C, risks of organ damage, loss of consciousness, and death increase sharply. At high temperatures, displacement of blood to the surface of the body may lead to circulatory collapse [1,2]. Heat waves can cause mortality and hospitalizations due to hyperthermia and similar acute illness, and also by exacerbating pre-existing conditions such as cardiovascular and pulmonary illnesses [3]. Heat waves are exacerbated in urban environments by the urban heat island effect, caused by the concentration of concrete and asphalt surfaces, reduction of vegetation, and anthropogenic heat sources. Urban temperatures can be as much as 8°C higher than the surrounding countryside, though typically the increase is more in the order of 3°C to 4°C [3]. Increasing heat also contributes to smog formation and worsening air quality, both of which are evident problems in urban than rural environments. In urban environments, the effects of heat on air pollution may have a much larger effect on mortality and morbidity than the direct effects of heat stress [4]. Akanni [5] examined the upward trend in temperature in the United States of America (USA) and argued that the number of cases of squamous cell carcinoma was 5.5% higher for every 1°C increment in average temperatures, and basal cell carcinoma was 2.9% more common with every 1°C increase. These values correspond to an increase in the effective UV dose of 2% for each 1°C despite the beneficial effects of solar radiation on synthesis of vitamin D important for health [7] and [12] examined in retrospect the incidences of deaths from heat waves in Europe and observed that the severity of the 2003 event was so peculiar such that short-term mortality displacement contributed very little to the total heat wave mortality. These mortalities were at variance across Europe as France recorded more than 14,800 deaths, Belgium, Czech Republic, Germany, Italy, Portugal, Spain, Switzerland, the Netherlands and the UK all reported mortality within the range of 35,000 deaths [6] compared the impact of heat wave on mortality in France between 2003 and 2008 using the Poisson regression model relating the daily

fluctuations in summer temperature and mortality in France from 1975 to 2003. They discovered a reduction in the incidence of heat wave after the 2003 incidence due to increase awareness measures embarked upon by the government. What is shocking is the fact that heat waves could also exacerbate mental illness as Dholakia and Amit [7] investigated whether hospital admissions for mental disorders may be exacerbated by heat exposure and heat waves, in Hanoi, Vietnam and found a nexus between heat exposure and hospitalizations for mental illness in Northern Vietnam with relative risks increasing with the length of the heat waves. The groups of organic mental illness as well as those with mental retardation had the highest increase during these events. The study demonstrated relationships between admissions for mental disorders and heat waves, especially at a threshold temperature beyond 35°C as there were large differences between gender, urban, rural residents, and age groups. Men residents in rural regions and aged populations (over 60 years) appeared to face the largest relative risks of being admitted for mental disorders in periods of heat waves.

Similarly, Umoh et al. [8] investigated the impacts of both extreme heat and cold waves on human health in retrospect in five urban cities in India, namely: Ahmedabad, Bangalore, Hyderabad, Mumbai and Shimla spanning between 2005 – 2012. Their findings revealed a largely heterogeneous mortality risks across the urban areas as risks increase with intensity of heat (cold) waves.

In China, Mitchell et al. [9] reviewed studies on the variation in extreme heat events and their meteorological conditions, focusing on high temperatures during the summer season. The reviews indicated an upward trend in temperature over most parts of China even when

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variation existed (due to the periods and latitudes of the locations) between northwestern, southern and central china. Their frequencies and trends of extreme heats were decadal as large-scale circulation anomalies was the cause of the temperature rise in most parts of the cities. Anticyclone/cyclonic anomalies in the mid-upper troposphere were the cause of variation in northern china as the lower-tropospheric meridional wind anomalies affected temperature trends in central and southern china. Of relevance is the investigation of long-term trend of extreme temperatures, heat waves and cold spells (in terms of frequency, intensity and duration over 1951–2015 and their potential association with El-Niño Southern Oscillation (ENSO) events in Guangzhou China [10]. They observed an increase of 0.14°C per decade in the annual mean temperature, higher than both the national rate (0.09–0.15°C/decade) and the global rate (0.064°C/decade). Also annual extreme warm days increased by 6.26 days per decade while annual extreme cold days decreased by 1.77 days per decade. Others increases were observed in various aspects of heat waves including annual frequency, total duration, maximum duration, mean duration and intensity. No apparent association existed between the characteristics of heat waves and ENSO events. An inverse relationship existed between days and annual extreme cold days during the past 65 years in Guangzhou, China.

## Tools and Techniques

### Temperature warning systems

The heat watch is a system which helps to characterize conditions in a particular locale that are likely to produce dangerous heat stress and trigger an aggressive protective response from public health watchers [11]. Umoh and Mitchell [8,9] developed a Poisson regression model to study the main temperature effects and additional impacts from heat and cold waves in India and France and advised the use adaptation measures to minimize possible health impacts from heat and cold waves. Taiwo et al. [12] used a zero-inflated negative binomial time series regression models. Howden et al. [13] quantified the role of human activity on climate and heat-related mortality by analyzing both the Europe-wide temperature response in 2003 and localized responses over London and Paris using publicly-donated computing and perform thousands of climate simulations of a high-resolution regional climate models. Samet [14] investigated the impact of the 2013 heat wave on morbidity using the syndromic surveillance systems in England and discovered that daily peaks in heat illness amongst children and the elderly coincided with highest daily temperatures during summer of 2013.

### Research Methodology

This approach involves mapping the geographical distribution of the disease against the distribution of climate variables, and carrying out a regression analysis to characterize the climatic conditions that are associated with presence vs. absence of disease, or with different levels of disease transmission [15]. The main advantage of this approach is that it is entirely driven by a transparent statistical relationship between climate and disease distributions. It is also theoretically possible to include other, non-climatic, explanatory variables or confounders in the model, e.g. Ipeaiyeda et al. [15] assessed and investigated the spatiotemporal relationship between dengue fever cases and climatic conditions of temperature and precipitation using Negative binomial regression a subset of bivariate analysis to discover that high temperature and low precipitation were the favourable condition for the spread of dengue virus in South East Florida over a period of 34 years. Lugo [16] examined the long-term trend of extreme temperatures, heat

waves and cold spells in terms of frequency, intensity and duration over 1951–2015 and their potential association with El Niño Southern Oscillation (ENSO) events using Linear regression models. The association between heat waves and ENSO events was tested using the Oceanic Niño Index (ONI) in June-August (JJA) to identify the El Niño year, La Niña and Neutral years. A one-way ANOVA test was used to compare the frequency, duration and intensity of heat waves/cold spells among El Niño years, La Niña years and Neutral years [17] used Spearman's correlation to determine the association between dengue incidence and climatic factors (e.g. temperature, rainfall and humidity) at significant level of 0.01. They revealed an increase in rainfall with a positive correlation with high dengue incidence. However, there was no positive correlation between dengue incidence and temperature and humidity. Time series analysis was also employed to identify the serial correlations and trends over time, seasonal variations over time and the possibility of forecasting future dengue outbreaks. More importantly Trang et al. [18], developed an autoregressive integrated moving average (ARIMA) model to predict future dengue outbreaks in a cross sectional randomized cluster sample survey [19] of districts in Sri Lanka using GIS as a tool to identify dengue risk associated with population density, land pattern and climatic factors. GIS was employed to design a dashboard for health authorities to survey high-risk areas for control.

In Nigeria, several statistical methods have been employed for the elucidation and association between pollutants concentrations and the health of the inhabitants and ecosystem. Barata et al. [20] examined the concentration of pollutants at major road intersections in Ibadan city using the Duncan multiple range test and a biplot to illustrate the underlying relationship between pollutant concentrations and their sampling location features. Fouillet et al. [21] used receptor model which comprises of chemical mass balance (CMB), principal component analysis (PCA) and factor analysis (FA) to examine the level of particulate matter concentration in Nigeria. Horton et al. [22] used independent t test to determine the association between vehicle emission and incidences of asthma, cardiovascular and bronchitis in Jos plateau state Kalkstein and Valimont [23] went further to combine the used of independent t test and chi square test to test for strength of association between ventilator pattern and the presence of chronic bronchitis. Direct logistic regression model was also employed to assess the impact of age, gender, educational attainment, exposure to firewood smoke, and cigarette smoking on chronic bronchitis. Mc Michael [24] used ANOVA and step wise regression to test for a significant seasonal variation in air pollutants along traffic corridors in Lagos metropolis and the association between traffic density, air temperature and land-use.

### Research gaps

Studies have established the nexus between prolong exposure to heat waves and heat-related illnesses (e.g. heat cramps, heat syncope, heat exhaustion, heat stroke and possible death [25-27]. These studies all identified temperature extremes as a factor that can affect physiological functioning, mood behavior and workplace productivity, especially amongst outdoor workers. In China, efforts are being made to study the effects of heat waves on heaths and the environments. Barata and Fouillet [20,21] also examined the cause of melanoma and non-melanoma skin cancers from heat waves due to increase in emission of chlorofluorocarbons (CFCs) in North West England, Smith et al. [28] also examined the impacts of prolong extreme heat exposure and high hospital admissions for cardiovascular, respiratory and cerebrovascular diseases etc. There is paucity of information on these studies in Nigeria partly due to high cost of radiation measuring equipment as suggested

by Young et al. [29] and as such efforts have not been made in Nigeria to geographically examine the frequency, intensity, nature and areal extent of extreme heat waves and also to establish a cause effect relationship between prolonged exposure to heat waves and hospital admission for cardiovascular, respiratory, cerebrovascular diseases, heat stroke and possible deaths.

## Discussion

Urbanization is a continuous phenomenon and as such more people will continue to migrate and live in cities thus exposing them to urban heat island effects. There is a need for a better understanding of extreme heats and its impacts on human health which will provide a basis for heat awareness and implementation of a heat warning system in Nigeria.

There is paucity of data on incidences of extreme heats in Nigeria as compared to other climes Europe 2003; Russia in 2010, South Asia, the Middle East in 2015, and Southeast Asia in 2016. There is need for more studies on heat extremes in Nigeria especially under the current phenomenon of global warming for better understanding of the general circulation of the atmosphere and tropical sea surface temperature (SST) on temperature anomalies in Nigeria.

## Conclusion

The effects of hot waves to health is a function of prolonged exposure to solar radiation and there is a need for more awareness on the usefulness of tree incorporation in our cities and parks to serve as shade to ambient workers. The implication is a reduction in the incidences of morbidity and mortality from heat waves. This review dwelled extensively in elucidating current issues on heat waves in other climes and the need for a replication in Nigeria.

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