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Resident's perception and response to temperature variations in emerging Urban centres in Nigeria: An example from Jalingo, Nigeria

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ABSTRACT

The research analyzed the resident's perception and response to temperature variation in Jalingo metropolis. Energy and comfort are affected more by temperature than by any other element of the physical environment. Physiological functions of the human body respond to changes in temperature, and incidences of certain diseases vary with temperature and the seasons. The state of the atmosphere (hot or cold air) even influences our mental and emotional outlook. The aim of the study was to analyze human perception and response to temperature variations among residents in Jalingo. Primary data was collected using pre-tested, well-structured questionnaires. Secondary data was obtained from the archive of the upper Benue River Basin Development Authority, Yola for the period of ten years (2006-2015). A multi stage sampling technique was used in the selection of the respondents. This study concludes that temperature is greatly affecting the health as well as the socio-economic activities of the inhabitants of Jalingo. The result also shows that there is just a little variation over the years even though temperature remains high. It is therefore recommended that Government should develop and implement early warning systems and intervention strategies to mitigate the health effects of extreme temperature events. Enhancing adaptation to heat events can be accomplished through the adjustment of indoor temperature via the improvement of building design, thereby ensuring that the indoor temperature predominantly falls within a comfortable range, irrespective of the outdoor temperature. Lastly, the Taraba state government, through pertinent agencies such as the Ministry of Education and Environment, should establish weather stations in all the Local Government Area (LGA) headquarters in the state, thereby enhancing accessibility to climatic data for regular monitoring purposes.

Keywords: Temperature Variation, Human Perception, Energy, Comfort

1. INTRODUCTION

There exists a prevailing consensus among scientists that climate change is presently occurring, and that it is primarily caused by the emission of greenhouse gases (GHG) by humans (IPCC, 2007). The intergovernmental panel on climate change has determined that the warming of the climate system is undeniably happening, as is evident from the observation of increases in global average air and ocean temperatures, extensive melting of snow and ice, and the rise in global average sea level (IPCC, 2007). Over the past century, global average temperatures have risen by approximately 0.75°C and sea levels have increased by more than 4cm (IPCC, 2007). The primary source of energy for the Earth's atmosphere is solar radiation. Once absorbed by the Earth or the atmosphere, it is partially transformed into sensible heat, which is commonly referred to as temperature. The most significant impact of radiation is its influence on temperature in terms of annual, seasonal, and daily fluctuations.

The Earth, which was once a beautiful habitat for various organisms, including mankind, now exhibits a distressing appearance due to the shifting patterns of sea-ice, winter snows, alterations in the average position of storm tracks, changes in the location and extent of desert regions, the accumulation of heat-trapping greenhouse gases (GHGs), and the escalating environmentally unfriendly activities of humans. In addition to the aforementioned natural causes of climate change, their rates have been influenced by recent human activities. However, the increasing anthropogenic causes have amplified the natural causes and are independently contributing even more to the problem, although they can sometimes be reversed. Considering the current rate of urbanization, an economy heavily reliant on land, inadequate technology, a high illiteracy rate, and pervasive poverty, it is imperative to emphasize that efforts and actions aimed at mitigating the consequences of our actions and inactions must commence immediately for the sake of both present and future generations (Adelekan and Gbadegesin, 2005).

It can be challenging for numerous individuals to comprehend the significance of apparently minor temperature fluctuations due to the fact that daily temperatures can differ by more than 10 °C from one day to the next. Nevertheless, there exists a substantial disparity between daily temperatures and the average global temperatures that persist year after year. The variance in global average temperature between the present and the previous ice age is roughly 5 °C (IPCC, 2007). The consequences of a 2-4 °C increase in global average temperature is numerous and grave. It is anticipated that future occurrences of heat waves and heavy precipitation will become more severe and frequent in many regions. Research also suggests that while climate change may not impact the frequency of tropical cyclones, it could heighten their severity.

Every one of us will be impacted by climate change, however, certain individuals and locations will be more susceptible. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability to climate change as "the extent to which a system is prone to, or incapable of handling, detrimental effects of climate change, including variations and extremes in climate" (IPCC, 2007). Vulnerability consists of three components: exposure, sensitivity, and adaptive capacity. Exposure refers to the degree to which a system is subjected to altered climatic conditions; sensitivity refers to the degree to which a system will respond to a changing climate; and adaptive capacity refers to the ability of a system to manage the impacts of climate change. Understanding who is vulnerable and why can assist in the prevention, coping, and adaptation to the detrimental effects of climate change. Climate change poses a threat to human health, both globally and domestically.

Therefore, public health adaptation has become a significant matter on the climate change agenda. In fact, climate adaptation is not an entirely novel concept in the realm of public health. Due to the significance of climate in relation to human health, there are well-documented historical observations of human adaptation to the climate. Throughout human history, individuals have adjusted their behavioral patterns, technologies, and socio-economic systems to adapt to a variety of climatic fluctuations, ranging from arctic cold to desert heat. However, climate change brings forth new challenges that may surpass our past experiences. The rapid rate of warming projected in the forthcoming decades implies that future adaptation will be unlike anything we have witnessed in the past. Extreme and unconventional meteorological occurrences have the potential to become customary phenomena.

Consequently, the existing systems, infrastructure, practices, and strategies that are well-suited to the current climate will progressively become unsuitable and ill-suited. The annual temperatures exhibit considerable variations across different locations and seasons. These fluctuations have an impact on the socio-economic activities of the regions, as well as on other climatic factors such as

rainfall patterns and humidity. The alteration in global climate resulting from global warming and human activities affects the microclimate of the area. The temperature has a greater effect on human health, energy, and comfort compared to any other physical environmental factor. The physiological functions of the human body respond to temperature changes, and the occurrence of certain diseases varies with temperature and the seasons. The selection of food and clothing is also influenced by weather and climate conditions. The state of the atmosphere, whether it is hot or cold, even affects our mental and emotional outlook.

The human body maintains a balance between the heat it receives and the heat it loses through the chemical process of metabolism and the physiological processes of thermoregulation in response to external factors such as radiation, temperature, moisture, and air movement. There is a significant concern regarding the impact of temperature variations on human life, especially in tropical regions where high temperatures are being experienced due to solar radiation. It is also challenging to concentrate properly on activities such as reading or assimilating information in a lecture hall when the temperature is excessively high. Sometimes, individuals especially students, experience headaches and illness under high temperatures, which in turn affects their comprehension and academic performance. Similarly, under cool or cold weather conditions, one may feel uncomfortable, inactive, and in some cases, develop a cold. This has prompted numerous investigations aimed at understanding the extent of human responses in relation to seasonal temperature variations.

Among such studies are those conducted by in Enugu. However, it is known that Jalingo exhibits a moderate degree of temperature variation, with maximum values reaching as high as 35°C and minimum values as low as 15°C. This is likely to have a negative impact on the physiological comfort of the inhabitants. Therefore, the objective of this study was to analyze the perception and response of Jalingo residents to temperature variations. The specific objectives were: (i) To examine the level of perception and behavioral responses of the residents in the study area towards temperature variability, (ii) to examine the variations in temperature from 2006 to 2015, and (iii) to examine some of the prominent adaptation strategies employed by the inhabitants to cope with temperature variations.

Literature Review

The literature review explores the impact of climatological factors on human thermal comfort or discomfort. These factors include temperature, wind speed, solar radiation, and relative humidity. It has been observed that heat stress in hot regions and seasons can lead to discomfort and even death, particularly among the elderly. In areas with constant temperature shifts, such as increasing in summer and decreasing in winter, the midpoint of comfort temperature is 22°C in summer and 17°C in winter in the UK. The disturbance of heat balance can result in two main patterns of physiological adjustment. One pattern is insulation adjustment, which involves peripheral vasoconstriction in response to cold exposure. This adjustment restricts heat transfer from internal organs to the skin, leading to a decrease in skin temperature and body heat loss. A study conducted by in Eindhoven, Netherlands investigated the seasonal changes in metabolic and temperature response to cold air in humans. The findings revealed individual variation in cold response, with the metabolic response showing significance relation in both winter and summer.

Although the pattern of response remains consistent during acclimatization, the average magnitude of the metabolic response increases in winter. There is no seasonal change in the isolative vasomotor response and body heat debt, indicating that even in modern society with clothing and central heating, cold acclimatization occurs. However, the duration of exposure varies for different temperature groups. It has been observed that the decrease in body temperature caused by cold conditions is slower compared to the increase caused by hot conditions. Human beings are classified as homoeothermic organisms, meaning they have a mechanism for regulating their internal body temperature to maintain healthy operation in changing environmental conditions. Each homoeothermic organism has an ideal internal body temperature at which chemical combustion occurs at an optimal level, avoiding extreme variations in its rate. The notion of human comfort encompasses the set of conditions that are suitable for a minimum of 80% of individuals in terms of temperature perception.

In simpler terms, people should not feel cold or excessively warm, and any discomfort experienced should be attributed to local climate issues. Argues that adhering to indoor comfort standards as outlined by organizations such as ASHRAE can lead to dangerously unsustainable patterns of energy consumption. If the response to climate change entails a global expectation for homes to be mechanically cooled or heated in order to achieve a uniform indoor environment, existing environmental problems will be aggravated. In light of these concerns, social and environmental scientists have started to reevaluate the standards and expectations of comfort. Technologies or design features currently deemed efficient may prove to be less effective in the future. Propose that current

building regulations, which prioritize high levels of insulation and air-tightness, may result in overheating in the future. Consequently, artificial cooling methods may be necessary to dissipate excess heat.

A study conducted by reveals that so-called "passive" design features, such as conservatories, often require cooling in the summer and heating in the winter. The energy consumption associated with these spaces is likely to significantly increase in the future. Examined the potential impact of climate change on comfort conditions within buildings and the health of occupants. One concern raised is that rising temperatures and increased humidity could heighten the risk of airborne infections (such as legionella) or contribute to reported cases of sick building syndrome. Studies on extreme events, like heat waves, also shed light on the health implications and the social and technical adjustments that might be necessary to mitigate the effects of climate change. They suggest that institutional and infrastructural changes will be required. Engineers and economists have developed predictive models to assess the implications of global climate change on indoor environments.

By combining the findings of these models with different economic, social, and technological scenarios, these authors determine the specific indoor conditions that will need to be provided. In formulating strategies and responses, a distinction has been made between sudden or extreme climate changes and more gradual changes. It has been argued that mitigation measures may be necessary for sudden or extreme events, while adaptation is seen as more feasible for gradual or step changes. One of the strategies proposed for adapting to climate change is to enhance the energy efficiency of buildings so that standards can be maintained in less demanding ways. This approach is advocated by who suggest that a significant portion of the heat gained from improving the energy efficiency of homes can be considered as improved comfort rather than energy savings.

The estimation of savings in comfort or energy is predicated on the assumption that comfort standards will remain unchanged. Surveys conducted on the living conditions in households indicate that expectations and standards of comfort are undergoing alterations. The evaluation of thermal stress and its translation into physiological strain is a complex process. There are numerous indices available to assess thermal stress; however, the majority of these indices do not take into consideration physiological variables such as core temperature, heart rate, and sweat rate. The necessity of wearing protective clothing in harsh environments, such as those affected by nuclear, chemical, or biological contamination, can result in intolerable heat strain, as the clothing restricts the workers' ability to dissipate heat to the surroundings. Nevertheless, the perception of comfort varies among individuals based on factors such as age, health, gender, stature, skin color, clothing, physical activity, and housing type.

According to the climate in Jimeta can become extreme during each season of the year. Consequently, the local residents generally perceive the climate as hot and unfavorable during the dry season, and very cold during the peak of the harmattan season. In fact, 70% of the respondents described the climate as harsh and uncomfortable. However, certain diseases and illnesses that afflict people are attributed to different seasons of the year. For example, malaria infections are more prevalent in the rainy season due to the abundance of mosquitoes, while cases of cerebrospinal meningitis and measles tend to peak during the harmattan period. The most common climate-related diseases in the area, ranked by frequency of occurrence, include malaria, feverish conditions, skin infections, measles, cerebrospinal meningitis, and pneumonia. The high temperatures compel individuals to bathe multiple times a day in an attempt to alleviate the heat scorch.

In a separate study conducted by the discomfort index for Abuja, Nigeria was calculated using Thom's method. It was found that the discomfort index for Abuja was recorded at 24.2°C. Thom had previously defined a maximum index value of 26.5°C and above, indicating the threshold at which the weather is considered to cause some level of discomfort in the form of heat stress. Additionally, a value of 18.9°C was identified as the level below which some form of cold stress occurs. Observed that the discomfort index, as measured by the temperature humidity index (THI), was higher during the afternoon and evening periods. Similarly, when using Thom's method to calculate the discomfort index, no significant difference was found. It was asserted that all inhabitants of urban and suburban areas may experience a high level of discomfort during the afternoon. Conducted an experiment to demonstrate the expression of the first principle of thermodynamics in relation to the human body.

The model used consisted of two nodes: the core or internal part of the human body, which produces energy through metabolic activity and mechanical work (muscles), and the skin, which exchanges energy and matter externally was not the sole researcher to address these topics, but he was the first to focus on applying the principles of thermodynamics to the energy exchanges between humans and their environment. Conducted research on the impact of climate change processes on the comfort level of Shiraz station in Iran. From their findings, it was concluded that during the first 11 years, the months of May, September, and June fell within the comfort region, while August and July were on the periphery of the comfort region, and the remaining months were further away. It

was also observed that April was within the comfort region during warm hours. The month closest to the comfort region was November. In cold nighttime conditions, no month fell within the comfort region, but July, August, and June were the closest to this region.

However, January, December, and February were the farthest from the comfort region and were situated near the freezing line. These findings were influenced by global warming. There are essentially two primary response strategies to variations in temperature. The first strategy aims to control or prevent changes in temperature, which is referred to as mitigation measures. The second strategy aims to adapt or accommodate the impact of temperature variations, and is known as adaptation measures (Adebayo, 2012). Adaptation can be defined as any short or long-term strategies that have the potential to reduce adverse health impacts or enhance resilience in response to observed or anticipated changes in temperature. Given the likelihood that the frequency, variability, and characteristics of climate will change at a relatively accelerated pace, the existing public health practices, policies, strategies, and infrastructure will increasingly become unsuitable and ill-suited. Consequently, it has become imperative for public health to adapt to variations in temperature. Adaptation has the potential to mitigate vulnerability.

Individuals can adapt to higher temperatures by, for instance, increasing the use of air conditioning, modifying their behaviors, and improving the design of buildings and urban planning. The extent of future adaptation determines the degree of impact on years of life lost due to temperature variations. Public health adaptation can operate at two levels, namely building adaptive capacity and implementing adaptation actions. Adaptive capacity encompasses the available resources for adaptation, as well as the ability to utilize these resources effectively and efficiently. While all societies possess inherent capabilities to cope with certain climate changes, the distribution of adaptive capacities may vary across countries or within societies (IPCC, 2007). Populations in small islands and developing countries are particularly susceptible to death and injury resulting from increasingly extreme events.

Individuals of lower socio-economic status and the elderly are often the most vulnerable to climate change. Consequently, access to resources can be influenced by a range of social, economic, and institutional factors. For instance, presented the findings of their survey of experts in public health and climate change, which indicated that per capita income, universal health care coverage, and high availability of information were the most significant determinants of adaptive capacity in relation to the health risks associated with climate change. Finally, the ability of public health to adapt to changes in temperature can be constrained by human cognition. Having knowledge about climate change is necessary, but not enough for adaptation. Decision-making and behavioral change in response to climate change will also be influenced by perceptions of risk, vulnerability, and adaptive capacity. For instance, although the public may be aware of an upcoming heat wave, they may not consider themselves vulnerable to its impacts.

Individuals with higher incomes may perceive a lower risk from climate change because they have the financial resources to deal with the associated threats. The way individuals interpret information can be shaped by personal experiences, values, priorities, and other contextual factors. Conducted a telephone survey to examine public perception and response to heat warnings in four cities in North America during the summers of 2004 and 2005. Among respondents who were older or had chronic illnesses, 60% reported that they did not consider themselves at risk from the health effects of heat. Additionally, a relatively small number of respondents reported taking preventive actions in response to heat events. A study involving interviews with older individuals in London and Norwich also confirmed these findings. Therefore, even with the most advanced warning system in place, its effectiveness will be reduced if the public lacks the motivation to respond.

2. MATERIALS AND METHODS

The Study Area

Jalingo is Located between latitude 08° 54′ 18″ to latitude 08°90′ 24″ North of the equator, and longitude 11° 22′ 13″ E to 11° 37′ 18″ east of greenwich meridian (Figure 1). The town is bounded by Lau local government area from the North, Karim Lamido local government in the Northwest, Ardo-Kola local government from the West and Yorro local government from the east. Jalingo area has an estimated landmass of about 4,250 square kilometre, the town is further divided in to 10 wards. The relief of Jalingo LGA consists of undulating plain interspersed with mountain ranges. Between Kwaji-Mika to the east and Kona to the west, stretching to Kassa Gongon to the south exist this compact massif of rock outcrops. The mountain ranges run from Kona area through the border between Jalingo and Lau LGAs down to Yorro and Ardo Kola LGAs in a circular form to Gongon area, thus given a periscopic semi-circle shape that is

almost like a shield to Jalingo town. Jalingo metropolis is drained by two rivers, Mayogwoi and Lamurde which empty into the Benue system at Tau village. The valleys of these rivers are dotted with ox-bow lakes which are as a result of depositional activities.

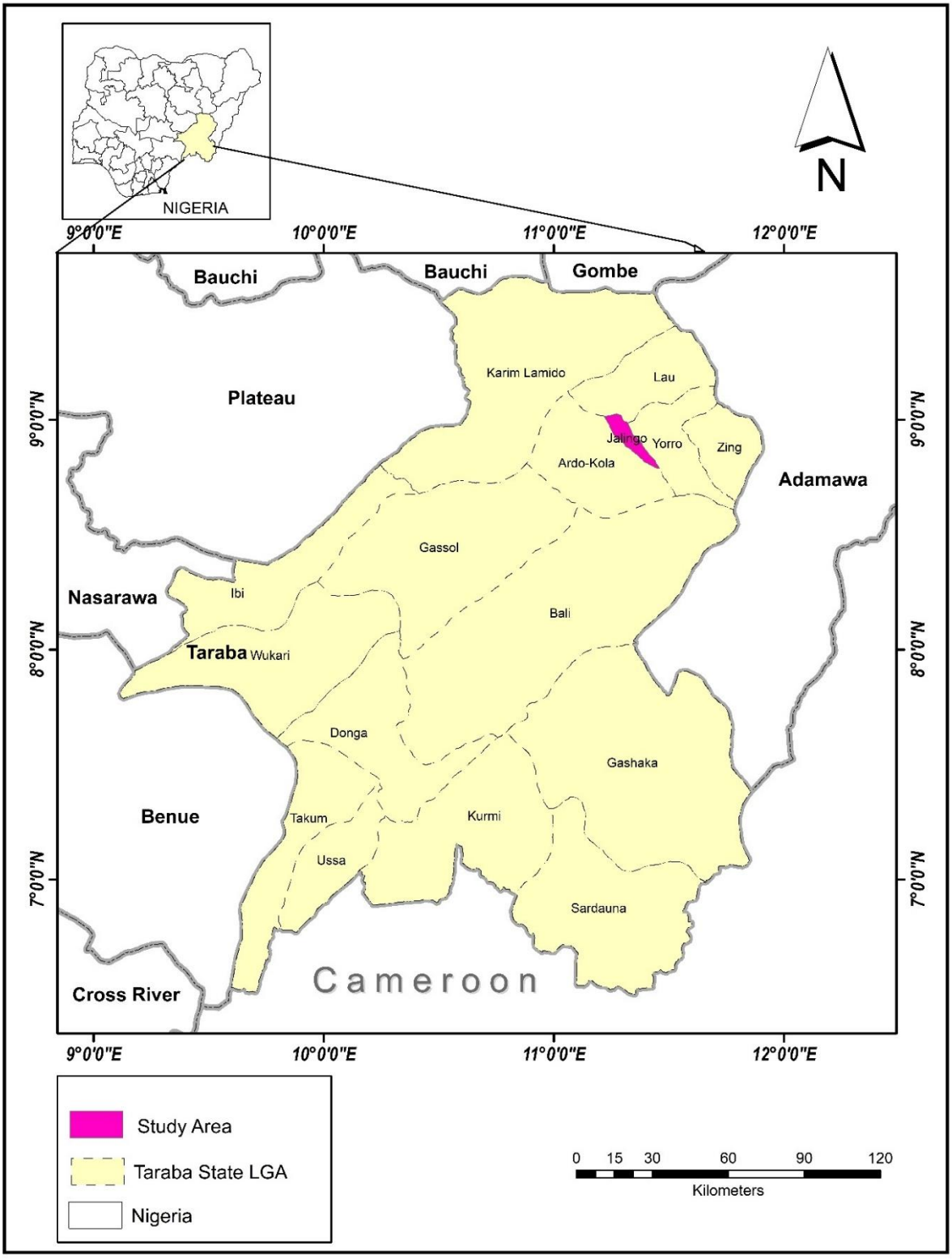

Figure 1 Map of Study Area
Source: Administrative Map of Taraba

The climate of Jalingo is characterized as tropical marked by dry and rainy season. The dry season usually starts by November and ends in March while the rainy season starts around April and ends around October. The average annual temperature is 27.9°C in Jalingo. In a year, the average rainfall is 958mm. Precipitation is lowest in January, with average 217mm, the most precipitation falls in august. At an average temperature of 32.2°C, April is the hottest month of the year and December has the lowest average temperature in a year with 25.9°C. The temperature is generally high throughout dry season and low during rainy season records indicate that temperature drops to 28°C during the rainy season and harmattan seasons and rises to 38°C during hot seasons. The total amount of rainfall received in the study area annually is about 980mm while mean annual temperature is about 33°C. The hottest months are April and May while the coldest months are November and December. The average daily hours of sunshine are about 8 to 9 hours.

3. RESULTS AND DISCUSSION

Below are the data collected from both primary and secondary sources for this study. They include data on climatic records of temperature of the study area for ten years (2006-2015) and those obtained from the questionnaire administration.

Characteristics of the Respondents

The demographic data on gender shows that 56% of the respondents are male while 44% are female as shown in (Table 1).

Table 1 Gender of Respondents

Gender	Frequency	Percentage (%)
Male	60	56%
Female	48	44%
Total	108	100

Source: Field work, 2023.

Table 2 Age of Respondents

Age	Frequency	Percentage (%)
15-20 years	42	39%
21-30 years	44	41%
30 above	22	20%
Total	108	100

Source: Field work, 2023.

The age distribution of the respondents is presented in (Table 2). The table generally reveals that 39% of the respondents were between the age of 15-20 years, 41% were between the age of 21-30 years of age, while 20% of the respondents were between the age of 30 and above. This implies that majority of the respondents are relatively young and active and hence, are able to assess any variation in temperature in the study area. This has direct bearing on the ease of temperature variation adaptation strategies. The study targeted more of the young population because the aged population are less able to engage in research, finding new ideas as well as innovations, and also the aged group are less able to adapt to the problem of temperature variability.

The result shows that 82% of the respondents in the study area are single, 15% are married, and only 3% of the respondents are separated. This implies that majority of the respondents are single which is psychologically good for the purpose of this study as they are assumed to have less responsibility to deal with (Table 3).

Table 3 Marital Status of Respondent

Marital status	Frequency	Percentage (%)
Single	89	82%
Married	16	15%
Divorce	0	0

Separated	3	3%
Total	108	100

Source: Field work, 2023.

Table 4 Occupation of Respondent

Occupation	Frequency	Percentage (%)
Students	48	44%
Civil servants	34	32%
Farmers	26	24%
Total	108	100

Source: Field world, 2023.

Occupation of residents has a great influence on their level of awareness about changes in temperature in the study area (Table 4). According to table 4 above, about 44% of the respondents are students, 32% of the respondents are civil servants, only about 24% are farmers. This result indicates that the highest percentage of the respondents are students, followed by civil servants and then farmers having the lowest. It was very difficult for the researcher to identify the real farmers in the study area as most farmers tend to engage in two or more occupational activities.

Table 5 Education Level of Respondent

Education	Frequency	Percentage (%)
Primary education	4	4%
Secondary education	46	42%
Tertiary education	58	54%
Total	108	100

Source: Field work 2023.

Education is an important factor that determines the ability of an individual to understand policies and programs relating to temperature including both its effects and adaptation. The educational distribution of the respondents as measured by years of formal education is presented in (Table 5). The table reveals that about 4% of the respondents attained primary education, 42% attained secondary education, while 54% attained tertiary education. Thus, majority of the respondents have some form of formal education. This result implies that literacy level is high among the respondents. Education plays an important role in creating awareness because educated people are better equipped and trained to source information that could result in temperature variability adaptation to adjust quickly to equilibrium than the uneducated people. This study reveals a positive relationship between the level of education and awareness about temperature variability among respondents in the study area. This means the higher the educational background of the respondents, the higher their level of awareness about temperature variability.

Perception and Response to Temperature Variation

This is the perception and response of the residents about temperature variation in the study area. The following data were obtained from the questionnaire administered.

Table 6 Most Convenient Season in Terms of Thermal Condition

Seasons	Frequency	Percentage (%)
Dry season	33	38%
Wet season	65	60%
Harmattan	7	7%
Total	108	100

Source: Field work 2023.

According to the Table 6, the result indicates that 38% of the respondents believed they are more convenient during dry season, 60% believed wet season is more convenient in terms of thermal condition in the area, and only 7% of the respondents claimed that harmattan is more convenient.

Table 7 Awareness of Changes in Temperature Variability

Level of awareness	Frequency	Percentage (%)
Not aware	22	20%
Partially aware	39	36%
Strongly aware	47	44%
Total	108	100

Source: Field work, 2023.

The environmental elements are not always stable, there are changes due to either natural phenomena or human interference, such changes include; period of onset and cessation of rain (rainfall is an important element in determining the temperature of a place), duration and intensity of sunlight (this has direct bearing on temperature) Etc. Awareness on temperature variability and changes help people plan their economic activities and reduce health related risks associated with temperature. When the residents were asked whether they are aware of any variation or changes in temperature in the recent years in the study area, their responses ranges from not aware (20%), partially aware (36%) to strongly aware about (44%) as shown in the (Table 7). This result implies that there is partially high level of awareness among the residents of Jalingo metropolis. But there is a need for more enlightenment about the various changes that occurs in the environment such as increase in temperature.

Association Between Resident's Characteristics and their Level of Awareness about Changes in Temperature Variability

In order to test for association to determine if residents environmental awareness depends significantly on their socio-economic characteristics particularly age and educational background, the data were subjected to Chi-square test.

Decision Rule

The Chi-square (x2) test represents the difference between the given frequencies and the expected frequencies obtained. If for instance the calculated value of X2 is greater than the tabulated value, there is an association between the variables being measured, thereby confirming the alternative hypothesis. However, the tabulated value is greater than the calculated value of X2, there is no association between the variables. Implying rejecting the alternative and accepting the null hypothesis. In this research therefore, 5% level of significance is employed. The following results was obtained;

To test whether there is association between the age of respondents and their level of awareness about changes in temperature variability, Table 8 displays the chi-square distribution of the respondent's age in the study area.

The X2 calculated = 3.95

The X2 tabulated = 9.4 at significant level of 5%. This means that the alternative hypothesis is rejected in favour of the null hypothesis which states that "there is no association between resident's age and their level of awareness about temperature variability". Therefore, this means that both aging and young people in the study are able to adapt and improve ideas and innovations towards temperature variation.

To test whether there is association between education of residents and their level of awareness about changes in temperature variability. Table 9 displays chi-square distribution of the respondent's educational level in the study area.

The X2 calculated = 5.3 which is greater than the tabulated value of (3.36) at significant level of 0.05% level of significant. This means that the null hypothesis is rejected in favour of the alternative hypothesis which states that "there is association between the resident's level of education and their awareness about changes in temperature variability".

The result revealed that the level of education of the respondents determine their level of awareness about changes in temperature variability in the study area. This implies that as the level of education of the respondents increases, their level of awareness about

changes in temperature variability also increase. Therefore, adaptation measures on temperature variability will be easier and faster among the educated people.

Table 8a Age of Respondents - Observed Frequency (OF)

Awareness	15-20 year	21-30 years	30 above	Total
Not aware	5	11	6	22
Partially aware	15	17	7	39
Strongly aware	18	14	15	47
Total	38	42	28	108

Source: Field work, 2023.

Table 8b Age of Respondents - Expected Frequency (EF)

Awareness	15-20year	21-30years	30 above	Total
Not aware	7	9	6	22
Partially aware	14	15	10	39
Strongly aware	17	18	12	47
Total	38	42	28	108

Source: Field work, 2023.

Table 8c Association between the age of respondents and their level of awareness about changes in temperature variability.

S/N	OF	EF	OF-EF	(OF-EF)2	(of-ef)2/ef
1.	5	7	-2	4	0.57
2.	15	14	1	1	0.07
3.	18	17	1	1	0.06
4.	11	9	2	4	0.4
5.	17	15	2	4	0.3
6.	14	18	-4	16	0.9
7.	6	6	0	0	0
8.	7	10	-3	9	0.9
9.	15	12	3	9	0.75
Total					3.95

Chi-square value = 3.95, Critical value = 9.4, DF = 4

Table 9a Educational level of respondents - Observed frequency (OF)

Awareness	Primary	Secondary	Tertiary	Total
Not aware	0	3	2	5
Partially aware	2	20	18	40
Strongly aware	0	23	40	63
Total	2	46	60	108

Source: Field work, 2023.

Table 9b Educational level of respondents - Expected frequency (EF)

Awareness	Primary	Secondary	Tertiary	Total
Not aware	0	2	3	5
Partially aware	1	17	22	40

Strongly aware	1	27	35	63
Total	2	46	60	108

Source: Field work, 2023.

Table 9c Association between education of residents and their level of awareness about changes in temperature variability.

S/N	OF	EF	OF-EF	(OF-EF)2	(of-ef)2/ef
1.	0	0	0	0	0
2.	2	1	1	1	1
3.	0	1	-1	1	1
4.	3	2	1	1	0.5
5.	20	17	3	9	0.5
6.	23	27	-4	16	0.6
7.	2	3	-1	1	0.3
8.	18	22	-4	16	0.72
9.	40	35	5	25	0.7
Total					5.3

Chi-square value = 5.3, Critical value = 3.36, DF= 4

Table 10 Effect of Temperature on Thermal Comfort

Does temperature affect thermal comfort?	Frequency	Percentage (%)
Yes	93	86%
No	15	14%
Total	108	100

Source: Field work, 2023.

When the residents were asked whether or not temperature affects their thermal comfortability, their responses ranges from 86% who believes temperature does affects their thermal comfortability to 14% who believed that temperature does not affect their thermal comfort (Table 10). This result implies that most of the people in the study area agreed that temperature has a significant effect on thermal comfort in the study area.

Table 11 Diseases Commonly Associated with Temperature

Diseases	Frequencies	Percentages (%)
Meningitis	41	38%
Malaria	48	44%
Cholera	19	18%
Total	108	100

High occurrence of diseases is the major problem associated with temperature variations (Table 11). When the residents were asked about the major diseases that are commonly associated with temperature, their responses ranges from meningitis (38%), malaria (44%), to cholera (18%). This result indicates that malaria is more commonly associated with temperature in the study area. This result corroborated the findings of Oruonye, (2014), which shows that "the local people in Taraba state have observed with pain the increasing incidence of insect pest to their crop plants and mosquito infestation as a result of increase in temperature. The insect pest usually appears during the short period of dry spells during the growing season. The insect pest attacks the crops and the crops dies forcing farmers to replant again. In the past, mosquito infestation was unknown on the Mambilla plateau.

The area is the highest point in the country with altitude of about 2000m.a.s.l. Today, the local people in the area are now adapting to the culture of sleeping inside mosquito nets which in the past they do not. The people in Yelwa area also complained of increasing

incidence of mosquito infestation. Effort was made to ascertain the level of mosquito infestation by obtaining data on malaria incidence from the government general hospital Gembu for the period of 8 years. The result shows that the incidence of malaria is usually high during the months of May, June and July, when the environment is relatively warmer. While the lowest incidence was recorded in the months of December and January, during the harmattan season when the environment is relatively cold.

Table 12 Diseases Associated with Dry Season

Diseases	Frequencies	Percentages (%)
Measles	25	23%
Fever	19	18%
Malaria	5	5%
Meningitis	28	26%
Cholera	31	28%
Total	108	100

Source: Field work 2023.

Table 12 shows the responses on dry season occurrence of diseases. The result shows 28% of the respondents said cholera occurs very high during dry season, 26% said meningitis, 23% believed measles occurs very high during dry season, 18% said fever and only 5% said malaria. The result indicates that majority of the respondents believed cholera is the most occurrence disease during dry season, followed by meningitis and then measles. This is true as cholera is a disease that occurs as a result of inadequate clean drinking water. During dry season, it is a common knowledge that the water table drops dramatically leading to complete dryness of most ponds, wells and rivers.

Table 13 Diseases Associated with Rainy Season

Diseases	Frequencies	Percentages (%)
Pneumonia	39	36%
Measles	0	0
Fever	18	17%
Malaria	41	38%
Meningitis	0	0
Cholera	10	9%
Total	108	100

Source: Filed work, 2023.

Table 13 above shows the responses on wet season occurrence of diseases. 36% of the respondents said pneumonia occurs very high, 17% said fever, 38% of the respondents believed malaria occurs very high in the study area, and only 9% said cholera occurs during wet season. This result shows that malaria is the most occurrence disease during rainy season followed by pneumonia and then fever and the remaining diseases occurring at lower rates.

Table 14 Perception to the Problem of Temperature Variability

Perception	Frequencies	Percentages (%)
Increasing	78	72%
Decreasing	25	23%
No change	5	5%
Total	108	100

Source: Field work 2023.

When the residents were asked whether temperature in the study area is increasing, decreasing or remains unchanged, 72% of the respondents believed that temperature of the study area is indeed increasing, 23% believed it is decreasing while 5% believed the temperature is constant (Table 14). This result implies that temperature is increasing as majority of the respondents believed so. The result corroborated the findings of Oruonye, (2014) which reveals that the local people of most parts of Taraba state complained of rising temperature in the environment. On the Mambilla plateau, the local people who in the past could not sleep at night without a blanket covering due to severity of cold, can now sleep without blanket covering comfortably because the environment is becoming warmer at night as a result of changes in diurnal temperature variability. This is a clear case of warming temperature regime in the environment. In other parts of the state, especially in the north, the people complained of increase in heat as a result increasing temperature, this they observed to be high during dry season.

Table 15 Heat Challenges in the Study Area

Heat challenges	Frequencies	Percentages (%)
Sun burn	46	43%
Dust	6	5%
Heat stress	41	38%
Cold	15	14%
Total	108	100

Source: Field work 2023.

When the residents were asked which season, they mostly experience heat challenges, their responses were, 81% dry season, and 19% said wet season. This shows that heat challenges are mostly associated with dry season when temperatures are normally high. When the residents were asked about the nature of heat challenges, they were experiencing in the study area, 43% of the respondents said they are experiencing sun burn, 38% said heat stress, 14% said cold, while only 5% said they are experiencing dust in their environment (Table 15). The result implies that sun burn is the most experienced heat challenge in the area followed by heat stress. This means the temperature condition of the area under investigation is somewhat warm.

Table 16 Assessment of Temperature

Temperature condition	Frequencies	Percentages (%)
Warm	52	48%
Moderate	42	39%
Cool	14	13%
Total	108	100

Source: Field work 2023.

The assessment of temperature condition in the study area by the respondents is generally presented in the (Table 16). According to the table, 48% of the respondents assessed the temperature condition to be warm, 39% claimed the temperature condition has been moderate and only 13% insisted that the condition is cool. This shows that majority of the respondents believed that the temperature condition of the study area is warm. The respondent's assessment of warming temperature condition in the study area corroborates with the experts report on temperature trend in other parts of northern Taraba (Oruonye, 2014).

Assessment of Academic or Job Performance in Relation to Temperature

When the respondents were asked about their academic or job performance under high temperatures, their responses ranges from 40% low, 45% moderate and 15% high. Under low temperatures their responses ranges from 47% high, 42% moderate and 11% low. This result implies that the residents perform well when the temperature condition is either moderate or low, thus high temperature has a significant effect on the residents job or academics performance in the study area.

Residents Adaptation Measures to the Problem of Temperature Variability

When the residents were asked if they have been making any effort to adapt or adjust to changes in temperature variation regarding their health, thermal comfortability and socio-economic activities, 89% of the respondents responded in affirmative while 11% insisted that they have not been making any effort. In terms of accessibility to adequate information on how to adapt to changes in temperature variability, 79% believed that they do have access to adequate information while 21% claimed they do not have access to adequate information (Table 17).

Table 17 Factors That Limit Adaptation Strategies

Factors	Frequencies	Percentages (%)
Lack of information	23	21%
Poverty	49	45%
Lack of access to appropriate technology	31	29%
No idea	5	5%
Total	108	100

Source: Field work, 2023.

When the residents were asked what major challenge can hinder or limit their adaptation efforts in the present circumstances, the respondent's responses ranges from information accessibility (21%), poverty (45%), lack of access to appropriate technology (29%), and only 5% claimed they have no idea as shown in the (Table 17).

Table 18 How to Minimize Health Effect of High Temperature

Method	Frequencies	Percentages (%)
Use of AC	37	34%
Umbrella	0	0
Constant bathing	48	44%
Fans	23	21%
Total	108	100

Source: Field work, 2023.

On how the residents adjust and minimize the health effect of high temperatures, the respondents' responses ranges from use of air condition (34%), use of umbrella (0), constant bathing (44%) to use of fans (21%) as shown in the (Table 18).

Summary

This research work aimed at analysing human perception and response to temperature variations among residents in Jalingo metropolis, then examine variations in temperature for the period of ten years (2006-2015), and also examine some of the prominent temperature variation adaptation strategies employed by the residents in Jalingo. Using a literature review, this research examined how temperature varies from place to place and how it is distributed unevenly across the globe as a result of factors ranging from latitudinal differences, altitude, to difference in thermal properties of land and ocean surface. The method adopted in this research work was a multi-stage sampling technique to select 110 respondents. However, 108 questionnaires were retrieved and the data was analysed using descriptive statistics such as frequencies, percentages, and charts. Inferential statistics such as chi-square was also used to test association between respondent's socio-economic characteristics and their level of awareness about temperature variability. The result of the perception and responses of residents in the study area shows that temperature is greatly affecting the health as well as the socioeconomic activities of the inhabitants of Jalingo.

The result of temperature variability shows that there is just a little variation over the years even though temperature remains high. It also shows that the increase incidence of malaria infestation in Jalingo is as a result of the increase in temperature. Significant efforts are being made by the residents in Jalingo as the study reveals to adapt to the problems of temperature variations in various ways.

However, there are constraints and barriers to the adaptation arising from lack of information on temperature adaptation strategies, poverty, and lack of access to appropriate technology. Finally, public health adaptation to extreme temperature is necessary and pressing. This research discussed how the residents minimized health effect of temperature. Strategies to minimize the health effect of temperature can fall into two categories: Reducing the heat or cold exposure using appropriate technology at various houses, places of work or in our cars through mode of dressings and modern technological equipment. The second category is by managing the health effect of high and low temperatures.

4. CONCLUSION

This research work has examined the human perception and responses to temperature variation among residents in Jalingo. The findings of the study showed that about 80% of the residents are either partially or strongly aware of the changes in temperature variation in the study area. The study also showed that 72% of the residents believed that temperature in the study area is increasing thus the environment is becoming warmer. This result is in agreement with experts findings in other parts of the state. The study also showed that there is a significant change in temperature variation from 2006-2015 based on the past climatic records obtained from the archive of Upper Benue River Basin Development Authority Yola. In 2006, the mean annual minimum temperature was recorded at 22.50c and the mean maximum value was recorded at 33.420c.

While in 2015, the mean annual minimum temperature was recorded at 24.800c and the mean maximum value was recorded at 360c. This shows a great range of variation in temperature. The implication of such variation in temperature is the increase incidence of insect pest, mosquito infestation, increase occurrence of diseases such as malaria, meningitis and cholera, incidence of heat challenges such as sun burn, heat stress, heat exhaustion, thermal discomfort among residents etc. despite the residents awareness about changes in temperature variation, lack of information, poverty, lack of access to appropriate technology hinders their adaptation efforts. Therefore, it is necessary to create more awareness and enlightenment about changes in temperature variation as well as alternative measures in managing it.

Recommendations

Based on the findings of the study, the following recommendations are presented: -

Government should develop and implement early warning systems and intervention strategies to mitigate the health effects of extreme temperature events.

Adaptation to heat events can be improved by adjusting indoor temperature through improved building design so that the indoor temperature is more often in a comfortable range regardless of the outdoor temperature.

To curtail the problem of "heat island effect" in cities, high density communities can be developed with mixed land use and good connectivity to promote active transport. Government should increase the amount of green space and trees in the cities, as trees provide shade and improve air quality. Trees and vegetation help reduce daytime temperature and the urban heat island effect through the process of evapotranspiration. In terms of building design, the use of reflective paving and roofing materials can be promoted as well as increasing ventilation and air flow between buildings.

Government should also provide adequate public spaces through urban planning to promote social cohesion, which reduces health risks faced by people who are socially isolated.

Lastly, Taraba state government through the relevant agencies such as (ministry of education and environment) should establish weather stations in all the LGsAs headquarters in the state to enhance access to climatic data for regular monitoring.

Ethical approval

Not applicable.

Informed consent

Not applicable.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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Data and materials availability

All data associated with this study are present in the paper.

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