Assessing Temperature Variabilities and Its Implications for Health and Livelihoods in Abuja Metropolis From 2019-2024

S.O. Okpa and G.N. Woke
Institute of Natural Resources, Environment and Sustainable Development

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Abstract: *This paper is on the assessment of temperature variabilities and its implications for health and livelihoods in Abuja metropolis from 2019-2024 as well as the assessment of high temperature and coping mechanisms in Abuja metropolis. High temperature facilitates heat stress, deaths, cardiovascular diseases, mental health, asthma and risk of accidents. Cross sectional survey design techniques were deployed with questionnaire as the primary source of data. Analysis on household size of the study showed that 18.37% accounted for 0-3 households, 41.47% accounted for 4-6, while 39.64% and 0.52% accounted for 7-10 and 11 and above respectively. The result further reveals that males have 81.4% and females 18.6% in terms of sex respondents while bracket ranges from 18-25 (19.69%), 26-35 (23.62%), 31-45 (26.50%), 46-55 (17.59) and 56 above had (12.60%) respectively. Two hypotheses of the study revealed a significant effect of health risk associated with high temperature in the study area and significant effect of the strategies adopted by the residents to cushion the impact of high temperature in Abuja metropolis. Findings of the study amongst others show that the mean yearly temperature (January – December, 2019 – 2023 January- August 2024) are within WHO acceptable limit of 37^0C in all the months, tall buildings within many urban areas provide multiple surfaces for the reflection and absorption of heat, stony materials absorb solar radiation and thus heat up the environment in the city, climate change causes high temperature and that high temperature causes asthma attacks, respiratory and cardiovascular health conditions. Arising from the above, the study recommended that proper implementation of environmental impact assessment of road construction and high-rise buildings should be taken seriously.*

Keywords: temperature variabilities, health, livelihoods, Abuja metropolis

INTRODUCTION

The effect of high temperature in Abuja can be particularly harmful during the day with its attendant heat wave as it deprives the residents of the cool relief found in the night. However, the effects are strongest in densely populated areas, having unseasoned greatest impact and harm to the elderly, infants, children, and people with chronic diseases (Nwaerimaet, al. 2018). Increased vehicular air emissions of carbon monoxide, burning of gasoline and diesel fuel by factories that emit harmful by-products of nitrogen dioxide, carbon monoxide, benzene, and formaldehyde in Abuja has become a dominant factor responsible for high temperatures arising from air traps pollutants closer to the ground which aggravates respiratory problems and health issues, increased energy consumption, rising demand for cooling systems during prolonged heat spells which translates to increased energy consumption and consequent environmental impacts. Conversely, urban high temperature resulting from urban heat islands (UHI) decreases air quality and water quality as warmer waters flow into the earth, streams and put stress on the ecosystems. Literatures have shown that structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies. Thus, industrialization and high-rise building structures that act as wind breakers contribute immensely to high temperature relative to outlying areas. In most of urban space in Abuja metropolis, issues of high temperature occurrence manifest when natural land cover such as scrubland, grassland, barren land, and wetlands are replaced with dense concentrations of pavement, buildings and other surfaces that absorb and retain heat. These consequently manifests in the increase of energy costs (e.g., for air conditioning), air pollution levels, heat-related illness and mortality. Akanne (2010) defined high temperature as the relative warmth of a city compared with surrounding rural areas caused by heat trapping due to land use. Amit, (2010) noted factors responsible for high temperature to include configuration and design of the built environment, street layout and building size and heat-absorbing properties of urban building. He noted that human-made building materials such as pavement and concrete reflect less sunlight and absorb more heat than natural surfaces in the study area. These urban surfaces quickly heat up during the day and slowly release heat at night, contributing to higher temperatures throughout day and night periods. The United Nations Environment Program, in its latest handbook on urban cooling published in November 2021, noted that the urban population exposed to high temperatures (i.e., average summer temperatures above 35 °C) is expected to increase by 800%, 1.6 billion by the middle of the century. Statistics have shown that South and East Asia, and the Middle-East, are highly exposed to high temperature stress hazards, and that this exposure increases by 20% to 60% with global mean temperature change from 1.5 to 3 degrees celsius.

In West Africa, and Central and South America regions, about 20 to more than 50% of the population are exposed to severe heat stress each year. For global warming of 3 degrees, European countries will also be exposed several times per year to conditions with daily mean heat stress level equal to the maximum heat stress of the 2003 heat wave. In the United State of America (USA) high temperature have resulted to 5.5% cases of carcinoma squamous cell higher for every 1°C increment in average temperatures, noting that basal cell carcinoma was 2.9 % more common with every 1°C increase. Horton (2016) reported incidences of deaths from heat waves in Europe and 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 (Ri-Yu 2016; &Nilson 2016). Extant literature has it that many populations in tropical and subtropical climates are chronically exposed to high temperatures. In mid to high latitudes, population exposure to excess heat is seasonal. Abuja in Nigeria as a tropical country, outdoor and manual workers, athletes and civil and public servants, private companies and industry employees are exposed to excess heat because of their work and are also susceptible to exceptional heat stress. The urban and rural poor are often disproportionately exposed to overheating due to low quality housing and lack of access to cooling. Due to building materials, informal settlements are often hotter than other urban areas in some parts of the metropolis. Studies indicated that gender can play an important role in determining heat exposure, for example where women are primarily responsible for cooking indoors during hot weather. Thus, prolong exposure to high temperature results in incidences of heat-related illnesses (e.g. heat cramps, heat syncope, heat exhaustion, heat stroke and possible death (Geof&Jim, 2012). Deaths and hospitalizations triggered by extreme hot weather occur rapidly (same day and following days), which means interventions also need to be rapid when a heat alert is issued. High temperature can also disrupt and compromise essential health services, such as the loss of power supply and transport, reduction of working productivity and increases the risk of accidents (Sanusi et, al. 2016) and it is very difficult to complete work or learning in very hot weather, high temperatures may lead schools and other institutions to close. The scale and nature of the health impacts of heat depend on the timing, intensity and duration of a heat event, and the level of acclimatization and adaptability of the local population, infrastructure and institutions to the prevailing climate. However, studies have shown that key action such as avoidance of going outside and doing strenuous activity during the hottest time of day, staying in the shade while perceived temperatures in the sun can be 10–15 ˚C higher, spending 2–3 hours during the day in a cool place, usage of the night air to cool down your home by opening windows after dark when the outdoor temperature is lower than the indoor temperature etc as coping mechanisms that can reduce high temperature menace.

However, majority of the studies by Meng (2014), Stewart, (2012), Srivanit & Hokao, (2013) with Karimipour (2022) concentrated on Evaluation Methods of Urban Thermal Environment, Systematic review and scientific critique of methodology in modern urban heat island, Evaluating the cooling effects of greening for improving the outdoor thermal environment at an institutional campus in the summer and Implications of Urban Design Strategies for Urban Heat Islands respectively. To the best of knowledge of the researcher, little or no work has been done on the assessment of high temperature and coping mechanism in Abuja metropolis. Against this background, the research assesses high temperature and coping mechanism in Abuja (FCT). This is to identify the coping strategies adopted by the residents in the study area as a background to highlight its implications on the rural communities' vulnerability to high temperature health risk. The research also underlines the need to identify coping strategies and mitigation measures to cushion the impacts of high temperature and how to integrate these strategies into the Government health care system development plan. It is at this backdrop that this study is focusing on assessment of high temperature and coping mechanism in Abuja metropolis.This study aimed to investigate temperature variabilities and its implications for health and livelihoods in Abuja Metropolis.

MATERIALS AND METHODS

Study Area

F.C.T lies between latitudes 8° 25´and 9° 25´ north of the Equator and longitudes 6° 45´ and 7°45´ East of Greenwich Meridian, Abuja the FCT is geographically located in the centre of the country with a landmass of approximately 8000 km² of which the actual city that is, the Federal Capital City (FCC) occupies 250 km2 landmass. Also, there is a divergent temperature level across the study area. Map of the study area is as shown in Figure 3.1. below

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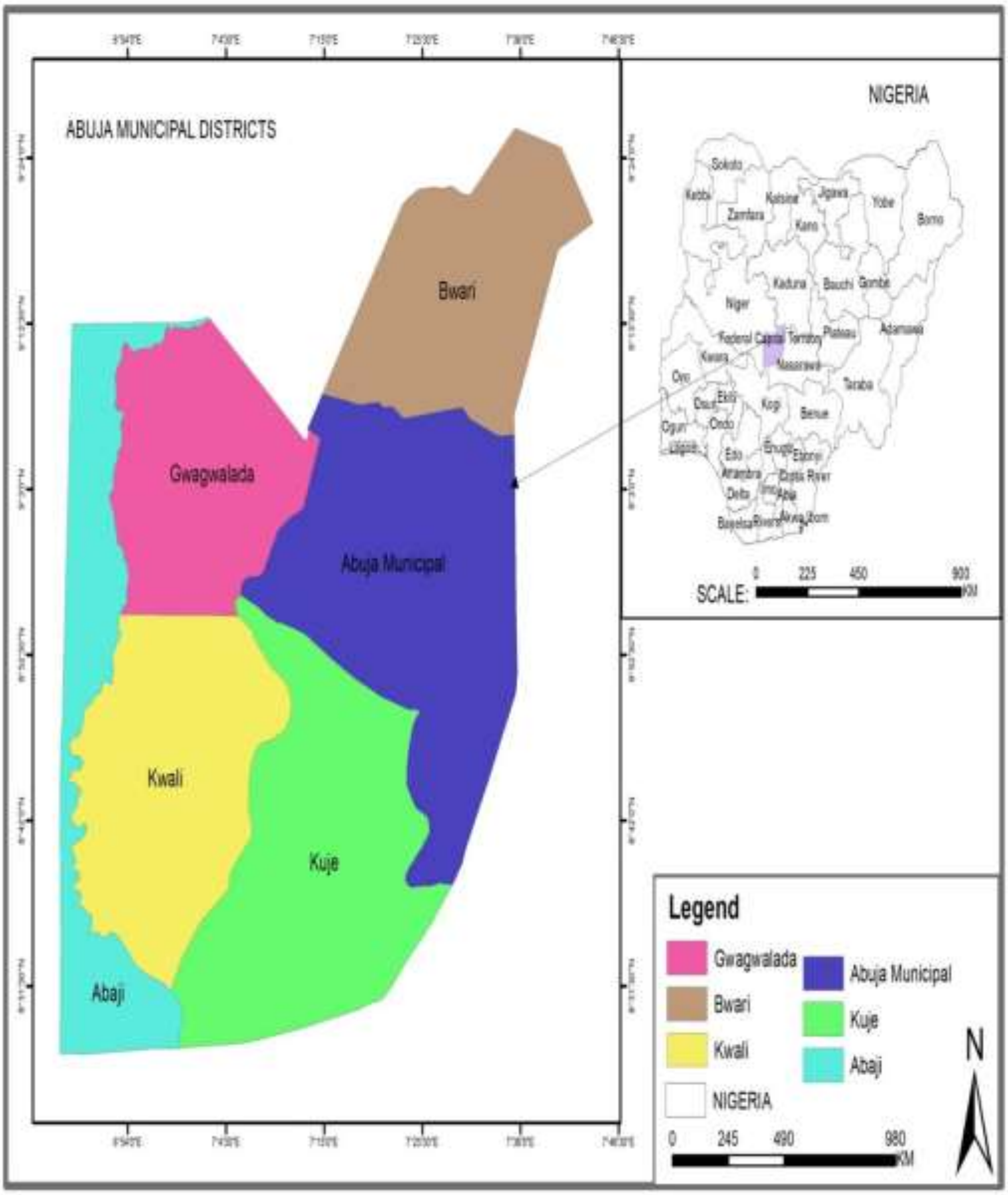

Fig: 1 Map showing Abuja Municipality

Source: University of Port Harcourt Cartographic Laboratory, (2023)

METHOD OF DATA ANALYSIS

The outcomes of the investigation of the research was analysed using tables and basic percentages. The results were analysed using descriptive and inferential statistical methods. The data was also presented in a tabular manner with explanations to provide a better understanding of the findings. Hypotheses I which state that there is no statistically significant effect in strategies adopted by the residents to cushion the impact of high temperature in Abuja metropolis was tested using Chi square statistical tool package for social sciences (IBM/SPSS) version 22 . The choice of Chi Square statistically tool was that it is used to investigate whether distributions of categorical variables differs from another. It’s a measure for comparing expectations and testing relationship between categorical variables (Mmom, 2007), thus is apt for the study.

For hypothesis 2 which states that there is no statistically significant variation in high temperature across Abuja metropolis from the year (2019 -2024) was tested with ANOVA statistical package for social sciences (IBM/SPSS) version 22. The chioce of ANOVA was predicated on the fact that it is a versatile and powerful statistical technique and very essential when researching multiple groups or categories. It also helps to know whether or not there was significant differences between the means of independent variable under investigation (Akuezuilo&Agu, 2002).

Results and Discussion

The results of sample and sampling technique, Average monthly temperature of FCT, Mean yearly temperature ,Coping measures to solve menace of high temperature in the study area, Coping measures adopted by residents to cushion the impact of high temperature Variation in yearly temperature of FCT and Summary of ANOVA are presented in Table 1-8 and Fig 2

Sample and Sampling Technique

The study used the purposive sampling technique in which 60 percent of the communities in FCT were chosen for the study based on the communities with highest number of population density and temperature variations. This implies that the sample size for the study was 400 samples.as shown on Table 4 below.

Table 1: Sampled Communities Population and Sample Size

S/N	Community	Population	Percentage	Sample Size
1	Gwagwalada	781, 389	34.96	139.88
2	Kuje	731, 465	32.74	130.94
3	Abaji	721, 630	32.30	129.18
	Total	2,234,484	100	400

Table 2. Average monthly temperature of FCT from Jan-Dec 2019-2023, Jan-Aug 2024)

	YEAR 2019 -2024					
	2019	2020	2021	2022	2023	2024
January	28.1	27	29.1	27.1	27.5	27
February	29.5	29.2	30.1	29.9	29.9	29.8
March	31.7	31.9	30.9	32	30.2	31.8
April	31.5	30.1	31	29.6	30.3	31.2
May	29.1	29	28.8	28.3	29.2	29.1
June	27.5	27.7	27	26.7	27.3	26.9
July	26.9	26.4	25.7	26.2	27.4	26
August	26.1	26.2	26.4	25.2	26.8	25.6
September	27.1	26.1	27.4	25.6	26.9	
October	26.7	27.9	27.6	27.2	28	
November	28.1	29.2	28.9	28	28.8	
December	27.1	29.1	27.7	27.1	28	

Table 2 on the average monthly temperature of FCT from Jan-Dec 2019-2023; Jan-Aug 2024), according to the Nigerian Meteorological Agency (NiMet) Gazzette, temperature across the study area in the Months of January - December 2019 was 28.1oc, 29.5oc,, 31.7oc, 31.5oc, 29.1oc, 27.5oc, 26.9oc, 26.1oc, 27.1oc, 26.7oc, 28.1oc, 27.1oc with the months of March and April having the highest at 31.7 and 31.5 respectively. From the months of January - December 2020 was 27oc, 29.2oc,, 31.9oc, 30.1oc, 29oc, 27.7oc, 26.4oc, 26.2oc, 26.1oc, 27.9oc, 29.2oc, 29.1oc with the months of March and

April having the highest at 31.9oc, 30.1oc respectively. From the months of January - December 2021 was 29.1oc, 30.1oc,, 30.9oc, 30.1oc, 31oc, 28.8oc, 27oc, 25.7oc, 26.1oc, 27.6oc, 28.8oc, 27.7oc with the months of March and April having the highest at 30.9oc, 31oc respectively. From the months of January - December 2022 was 27.1oc, 29.9oc,, 32oc, 29.6oc, 28.3oc, 26.7oc, 26.2oc, 25.2oc, 25.6oc, 28oc, 27.2oc, 27.1oc with the months of march and April having the highest at 30.9ococ, 31oc respectively. From the months of January - December 2023 was 27.5oc, 29.9oc,, 30.2oc, 30.3oc, 29.2oc, 27.3oc, 27.4oc, 26.8oc, 26.1oc, 28oc, 28.8oc, 28oc with the months of March and April having the highest at 30.2oc, 30. 3oc respectively. Finally, from the months of January - December 2024 was 27oc, 29.8oc,, 31.8oc, 31.2oc, 28.1oc, 26.9oc, 26oc, 25.6oc with the months of March and April having the highest at 31.8oc, 31.2oc respectively.

Table 3. Mean yearly temperature (Jan-Dec, 2019-2023, Jan-Aug 2024)

Month	YEAR 2019 -2024								
	2019	2020	2021	2022	2023	2024	Mean	WHO Acceptable Limit	Answer Alternative
Jan	28.1	27	29.1	27.1	27.5	27	27.63	37oc	Normal
Feb	29.5	29.2	30.1	29.9	29.9	29.8	29.73	37oc	Normal
March	31.7	31.9	30.9	32	30.2	31.8	31.42	37oc	Normal
April	31.5	30.1	31	29.6	30.3	31.2	30.62	37oc	Normal
May	29.1	29	28.8	28.3	29.2	28.1	28.88	37oc	Normal
June	27.5	27.7	27	26.7	27.3	26.9	27.18	37oc	Normal
July	26.9	26.4	25.7	26.2	27.4	26	26.43	37oc	Normal
August	26.1	26.2	26.4	25.2	26.8	25.6	26.05	37oc	Normal

Source: NiMET, 2024

According to the Nigerian Meteorological Agency (NiMet) Gazzette, mean temperature across the study area in the Month of January-December 2019-2023, January- August 2024. The month of March had the highest mean temperature of 31.42oc, April 30.62oc, February has 29.73oc, January 27.63oc, July 27.4oc, June 27.18oc, while the least was August having 26.05 oc. All the mean temperatures were

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within WHO permissible environment temperature of 37oc with the work of Spagnolo & De Dear, (2003) that mitigation measures approach to minimising the impact and extent of climate change includes keep people inside their homes increasing the importance of real estate decisions.

Also, 39.37% of the respondent strongly agreed that high temperatures could also lead to hospitalization, which affects health insurance, 44.62% of them agreed, 8.14%of them disagreed, while 5.25% of them strongly disagreed. This showed that majority of the respondents which amounted to 83.99% were of the opinion that high temperatures could also lead to hospitalization, which affects health insurance. This agrees with Barclay (2008) who reported that changes in temperature can affect the development and survival of malaria parasites and the mosquitoes that carry them which triggers malaria ad hospitalization. Again, it corroborates with Wandiga & Barclay (2008) study which shows that the frequency of outbreaks had been more pronounced, requiring only two months for the emergence of a malaria epidermic. that leads to hospitalization. 47.24% of the respondents strongly agreed that workers become more fatigued and generally slow down, which can cause them to make mistakes that lead to injuries or even death, 34.12% of them agreed, 10.50% of them disagreed, while 8.14% strongly disagreed.

Data analysis on High temperature has adverse effect on the productivity of the construction industry, 61.15% respondents strongly agreed, 34. 38% of the respondents agreed, 2.36% of them disagreed, while 2.10% of them strongly disagreed. Thus, it is crystal clear that majority which accounted for 95.53% were of the opinion that high temperature has adverse effect on the productivity of the construction industry. Finally, 53.81% of the respondents agreed that high temperature is a significant cause of mortality in the Abuja, metropolis, 32.28% of them agreed, 8.66% of them disagreed, while 5.23% of them strongly disagreed., This corroborates with Lindemann, (2017) study that over half of known human pathogenic diseases can be aggravated by high temperature.

Table 4: Coping measure in the study area.
Coping measures to solve menace of high temperature in the study area.

S/N	Answer Alternatives	SA	A	D	SD	Total
1	Use of air conditioning or fan is a measure to solve menace of high temperature in the study area.	180(47.24%)	130(34.12%)	40(10.50%)	31(8.14%)	381(100%)
2	Wearing light and loose-fitting clothing is a measure to solve menace of high temperature in the study area.	167(43.83%)	183(48.03%)	20 (5.25%)	11(2.89%)	381(100%)
3	Keeping cool is a measure to solve menace of high temperature.	140(36.75%)	121(31.76%)	50(13.12%)	70(18.37%)	381(100%)

4	Keeping skin wet is a measure to solve menace of high temperature in the study area.	231(60.63%)	121(31. 76%)	19(4.99%)	10(2.62%)	381(100%)
5	Using a spray bottle or damp sponge and by taking cool showers is a measure to solve menace of high temperature in the study area.	234(61.42%)	122(32. 02%)	19(4.99%)	6(1.57%)	381(100%)
6	Staying hydrated during days of extreme heat is a measure to solve menace of high temperature in the study area.	217(56.96%)	115(30. 18%)	29(7.61%)	20(5.25%)	381(100%)
7	Keep drinking water before one feel thirsty, especially when outdoors or performing physical activity	219(57.48%)	114(29.92%)	30(7.87%)	18(4.72%)	381(100

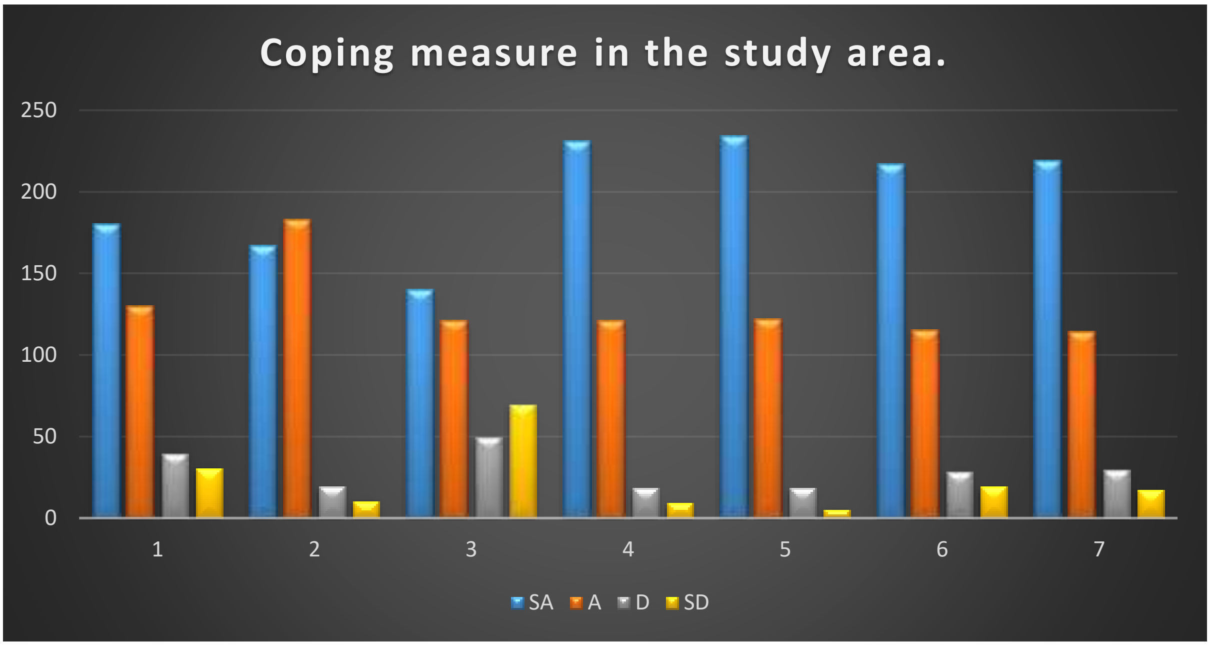

Fig 2. coping measures to solve menace of high temperature in the study area.

Source: Researcher's Fieldwork, (2024)

Table 3 above provides response to objective 2. The information reflected on the table shows respondents opinion on coping measure to solve menace of high temperature in the study area. The data shows that 47.24% of the respondents strongly agreed that the use of air conditioning or fan was a measure to solve menace of high temperature in the study area, 34.12% of the respondents agreed, 10.50% of them disagreed, while 8.14% of them strongly disagreed. This shows that 81.36% which accounted for the majority of respondents opinion was that the use of air conditioning or fan was a measure to solve menace of high temperature in the study area. This was in line with Jendritzky& Walther,(2000) that maintaining a regular sleep schedule, eating a balanced diet, staying hydrated, and taking breaks from heat exposure can also be beneficial, Likewise, Pickup & Dear, (2000) asserted that often, lack of access to cooling measures like air conditioning, makes the respondents more prone to heat stress. Furthermore, Pickup et, al.(2000) noted that worker involved in strenuous outdoor work or those lacking adequate cooling facilities which are often lower-wage jobs were at risk of increased heat exposure. 43.83% of the respondents strongly agreed that wearing light and loose-fitting clothing was a measure to solve menace of high temperature in the study area, 48.03%) of them agreed, 5.25% of them disagreed, while 2.89% of them strongly disagreed.36.75% of the respondents strongly agreed that to Keep cool was a measure to solve menace of high temperature in the study area, 31.76% of them agreed, 13.12% of them disagreed, while 18.37%of them strongly disagreed. 60.63% of the respondents strongly agreed that keeping skin wet was a measure to solve menace of high temperature in the study area, 31. 76% of them agreed, 4.99% of them disagreed, while 2.62% of them strongly disagreed. 61.42% of the respondents strongly agreed that using a spray bottle or damp sponge and by taking cool showers was a measure to solve menace of high temperature in the study area, 32. 02% of them agreed, 4.99%% of them disagreed, while 1.57%% of them strongly disagreed. 56.96% of the respondents strongly agreed that staying hydrated during days of extreme heat was a measure to solve menace of high temperature in the study area, 30.18% of them agreed, 61% of them disagreed, while 5.25% of them strongly disagreed. Finally, 57.48% of the respondents strongly agreed that to keep drinking water before one feels thirsty, especially if outdoors or performing physical activity is another measure . The study area. Showed that 29.92% agreed, 7.87% of disagreed, while 4.72% of them strongly disagreed.

Table 5 Coping measures adopted by residents to cushion the impact of high temperature

Hypothesis 1 which states that there is no statistically significant relationship in coping measures adopted by residents to cushion the impact of high temperature in the study area was tested using Chi square statistical tool package for social sciences (IBM/SPSS) version 22.

S/N	Answer Alternatives	SA	A	D	SD	Total
1	Use of air conditioning or fan is a measure to solve menace of high temperature in the study area.	180(47.24%)	130(34.12%)	40(10.50%)	31(8.14%)	381(100%)
2	Wearing light and loose-fitting clothingis a measure to solve menace of high temperature in the study area.	167(43.83%)	183(48.03%)	20 (5.25%)	11(2.89%)	381(100%)
3	Keep cool is a measure to solve menace of high temperature.	140(36.75%)	121(31.76%)	50(13.12%)	70(18.37%)	381(100%)
4	Keeping skin wetis a measure to solve menace of high temperature in the study area.	231(60.63%)	121(31.76%)	19(4.99%)	10(2.62%)	381(100%)
5	Using a spray bottle or dampsponge and by taking cool showers is a measure to solve menace of high temperature in the study area.	234(61.42%)	122(32.02%)	19(4.99%)	6(1.57%)	381(100%)
6	Staying hydrated during days of extreme heatis a measure to solve menace of high temperature in the study area.	217(56.96%)	115(30.18%)	29(7.61%)	20(5.25%)	381(100%)
7	Keep drinking water before you feel thirsty, especially when outdoors or performing physical activity	219(57.48%)	114(29.92%)	30(7.87%)	18(4.72%)	381(100

Table 6: Summary of chi-square analysis on coping measures adopted by residents to cushion the impact of high temperature in Abuja metropolis.

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	217.646a	18	.000
Likelihood Ratio	193.754	18	.000
Linear-by-Linear Association	34.503	1	.000
N of Valid Cases	2667		

Table 7: Determine Variation in yearly temperature of FCT from Jan-Dec 2019-2023

January-August, 2024

Month	YEAR 2019 -2024					
	2019	2020	2021	2022	2023	2024
January	28.1	27	29.1	27.1	27.5	27
February	29.5	29.2	30.1	29.9	29.9	29.8
March	31.7	31.9	30.9	32	30.2	31.8
April	31.5	30.1	31	29.6	30.3	31.2
May	29.1	29	28.8	28.3	29.2	29.1

June	27.5	27.7	27	26.7	27.3	26.9
July	26.9	26.4	25.7	26.2	27.4	26
August	26.1	26.2	26.4	25.2	26.8	25.6
September	27.1	26.1	27.4	25.6	26.9	
October	26.7	27.9	27.6	27.2	28	
November	28.1	29.2	28.9	28	28.8	
December	27.1	29.1	27.7	27.1	28	

Source: NiMET, 2024

Hypothesis 2 which states that there is no statistically significant variation in temperature from the year 2019-2024 across Abuja metropolis was tested using Analysis of Variance (ANOVA) statistical tool package for social sciences (IBM/SPSS) version 22

Table 8: Summary of ANOVA computation on Yearly temperature of FCT from Jan-Dec 2019-2023; Jan-Aug, 2024

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.877	5	.775	.234	.946
Within Groups	205.433	62	3.313		
Total	209.310	67			

Table 6 showed that the calculated F-value for group is .234 at degrees of freedom of 5 and 62 at $p<0.05$. The calculated F-value was significant at $p<0.05$ which is less than 0.05 level of probability ($F = .234$, $df = 5/62$, $p>0.05$). The alternate hypothesis is therefore accepted. This showed that there is a statistical significant variation of yealy temperature from Jan-Dec 2019-2023; Jan-August, 2024 across Abuja metropolis.

SUMMARY AND CONCLUSION

This study assessed high temperature and coping mechanisms in Abuja metropolis, Nigeria. To achieve this aim, the study ascertained the causes of high temperature and the impacts of high temperature on socio-economic activities in Abuja metropolis, determined the health risk associated with high temperature in Abuja metropolis, verified the most vulnerable to high temperature and geographical locations in Abuja metropolis and identify coping and mitigation measures to solve menace of high temperature in the study area. The study theoretical framework anchored on Carbon Dioxide theory of Climate Change and Green House theory. The study adopted cross sectional survey design techniques with questionnaire as the primary source of data. The study data were analyzed using descriptive statistics. The aim of the study was to assess high temperature and coping mechanism in Abuja metropolis. The study concludes that the elderly, infants, pregnant women, workers and farmers are most vulnerable to high temperature in the study area. The study also asserted that high temperature causes mean economic losses, keep people inside their homes, can also lead to hospitalization, which affects health insurance, workers become more fatigued and generally slows down man hour input, which can cause mistakes that lead to injuries or even death, Mortality index from high temperature in Abuja metropolis will continue to rise if conditions don't change. The study also highlighted that health risk associated with High Temperature in the study area includes hyperthermia, asthma attacks, respiratory and cardiovascular health conditions, cholera, meningitis and pneumonia.

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