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The Effect of Temperature Variations on Physiological Comfort in Ibadan, Nigeria

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ABSTRACT

Among the very important factors affecting man's response and activities in the environment is temperature. The conditions both inside and outside vary considerably in time and space. This seriously affects human physiological comfort and workers' productivity. The secondary data (temperature parameters) collected from the Nigerian Meteorological Agency (NIMET) and primary data (structured questionnaire) of 220 copies administered to Ibadan residents, 215 were returned and used in the study. These data were analysed using Time series, regression and correlation analytical tools in Statistical Packages For Social Sciences (SPSS). Time series analysis revealed the trend and pattern of the various temperature parameters which include daily minimum, maximum and mean temperatures. On the other hand, simple descriptive analysis was used to describe the socio-demographic and socio-economic characteristics of the respondents while correlation analysis, cross-tabulation and Chi-square were used to show the relationship between temperature variations and physiological comfort. Time series analysis revealed that most variations tend towards an increasing trend in air temperature especially at minimum temperature levels with the coefficient of variability (CV) ranging between 13 and 21%. Correlation analysis revealed that there was a significant inverse relationship between temperature variation and physiological comfort ($r = -0.60$, $p<.01$). Cross-tabulation and chi-square analysis of the relationship between temperature and physiological comfort indicates that there was a significant relationship between temperature variation and physiological comfort ($X^2=189.65$, $df=16$, p□.05). The study, therefore recommends adequate, regular and up-to-date records of climatic elements be properly compiled and kept. The government should take action in treating air pollution in the industrial areas and deforestation in the rural areas, hence the tree planting program will be embraced by citizens.

Keywords: *Temperature, Human physiological comfort, Time series analysis, Ibadan.*

INTRODUCTION

For quite a few decades, air temperatures have been on the rise globally, which could easily be attributed to the excessive emission of greenhouse gases into the environment. Consequently, the effect has been felt not only on the environment, and humans alone but also on the performance and productivity of individuals (Kjellstrom et al. 2016). Hence, the application of biometeorological indices to understand thermal comfort and its effect on human beings becomes very crucial (Telma et al., 2015). Richard (2022) noted that one of the core concepts of human biometeorology is the effective and practical assessment and forecasting of the thermal environment due to concerns about thermal comfort, discomfort, and health effects. In this context, the term 'thermal environment' encompasses both the atmospheric heat exchanges with the body (stress) and the body's physiological response (strain). This is due to the need for human beings to balance their heat budget in any climate to a state very close to thermal neutrality to optimize their comfort, performance, and health (Jendritzky et. al., 2006; Lai et al., 2020).

Human physiological comfort, health and efficiency especially at work are greatly affected by weather elements especially temperature which is the most noticeable element of weather and climate (Smith et al. 2014; Kjellstrom, et al. 2016). Its variability (i.e. temperature) is the crucial property which brings about comfort and discomfort.

Achieving thermal comfort is challenging because one would need to account for six factors such as: air temperature, radiant heat, relative humidity, moving air, physical exertion and clothing (Oke, 2011; Newton, 2021). More so, human variability i.e. variability between people e.g. different metabolic rates, level of physical fitness, medical conditions (including medication), acclimatisation, level of hydration, age, smoking and etc. makes achieving thermal comfort a challenge (Alberta Open Government Program, 2014). These factors all affect how people perceive their comfort levels, even if they are doing the same work in the same environment.

The body temperature of a healthy person varies within very narrow limits. The rectal temperature is usually 37ºC ±0.5ºC, and in the armpit it is 36.6ºC ±0.5ºC (Del Bene, 1990; Lim et al., 2008; Osilla et al., 2022). The temperature of the skin and subcutaneous tissue in the limbs is not only lower than the body temperature but also appears to vary over quite wide limits (28ºC ±15ºC) without any after-effects being noticed by a healthy person (Ronanovsky, 2014).

Heat exchange between the human body and the environment is governed by three factors namely radiation, convection and evaporation. Following Landsberg (1969), the bodily heat balance can be expressed by the following equation:

$$M – W ± R ± C - E = 0$$

This means that to maintain thermal equilibrium, the metabolic heat (M) created chemically within the human body and (W), which is the rate at which external work (force x distance) is being performed together with the heat gained or lost by radiation (R) and convection (C) and the heat lost by evaporation (E), must add up to zero.

If more heat is lost than produced the body temperature falls. This can be prevented by increasing the metabolism rate through muscular activity. Muscular activity may take place voluntarily through work or exercise or involuntarily through shivering. On the other hand, if more heat is produced than lost, the body temperature rises. To prevent overheating, the human body usually resorts to sweating and panting while there is an increase in the skin temperature.

Comfort can best be defined as a state of physical ease and freedom from pains or constraint (Oxford English Dictionary, 2018). It can also be defined as the easing or alleviation of a person's feelings of grief or distress (Lexicon English Dictionary, 2021). People feel uncomfortable when they are too hot or too cold, or when the air is odorous and stale. Positive comfort conditions are those that do not distract by causing unpleasant sensations of temperature, drafts, humidity, or other aspects of the environment. Ideally, in a properly conditioned space, people should not be aware of equipment noise, heat, or air motion.

Ibadan with its climatic characteristics is considered to be humid with high temperatures especially during the wet season (Ojo, 1977; Bello, 1997). As it were, humid air always causes discomfort. For example, in a hot, moist environment, the evaporation of sweat on the skin surface might be retained, leading to difficulty for the body to lose heat. And a man would be uncomfortable. While in a cold environment, the excessive moisture in the air would absorb heat from the skin and increase heat conduction of the clothes causing more discomfort in a wet, cold condition than in a dry, cold condition.

Based on thermal physiology principles it can be predicted that a high level of direct heat exposure in workers will affect their ability to continuously carry out work. Core body temperature needs to be maintained close to 37ºC in order for body systems to function properly. If the body temperature exceeds 38ºC heat strain will occur with exhaustion as one important effect for workers (Kelli, 2021).

Dehydration from sweating also contributes to heat exhaustion and more severe heat stroke effects. Heat exposure is thus an important factor in worker productivity (Jendritzky, et. al. 2006; Kelli, 2021). Climate change will increase heat exposure and this will be of particular importance in locations that are already hot during seasons of the year. Occupational health guidelines for protection against excessive heat effects proscribe an increasing length of rest periods during working hours with high heat exposure. Ibadan Metropolis cannot be an exception in the above corollary because the temperature characteristic is such that there is a considerable increase during the afternoon period when people are still actively at work and it is also when the maximum temperature is being obtained. Generally most of the workplaces in Ibadan are not air-conditioned (a situation that is capable of reducing the effect of high temperature) and as such, efficiency and productivity might be hampered. It is against this backdrop that this study seeks to examine the effect of temperature variation on the physiological comfort of Ibadan residents by achieving the following objectives: determining the temporal changes or variations of temperature over time, and establishing the relationship between temperature variations and physiological comfort of the residents in the study area.

MATERIALS AND METHODS

Study Area

Ibadan, the capital of Oyo state, was carved out from the former Western state or region of Nigeria on 3rd February 1976. The study area 'Ibadan' lies between latitude 7^{o} 20 ' N, and 7^{o} 28 ' N and longitude 3^{o} 50' E and 3^{0} 57' E. It has a land area of about 240km square and it is located at the transition zone between the forest and grassland areas of the country, Nigeria. The population of Ibadan was estimated at 3,874,908 (World Population Review, 2023). Ayeni (1994) also noted that "the population of Ibadan has continuously been

on the increase and these high rates of growth are due to implementations and inaccuracies of census estimates. There are eleven (11) Local Government Areas in Ibadan Metropolitan area consisting of five urban local governments in the city and six semi-urban local government areas in the less city. According to Ojo, (1977) the climate of Ibadan is dominated by the influence of three main wind currents, which are the tropical maritime (MT) air mass, the tropical continental (CT) air mass and the equatorial easterlies. The annual temperature ranges between 21.15 to 34.8 ° C and the annual rainfall is about 1,467mm.

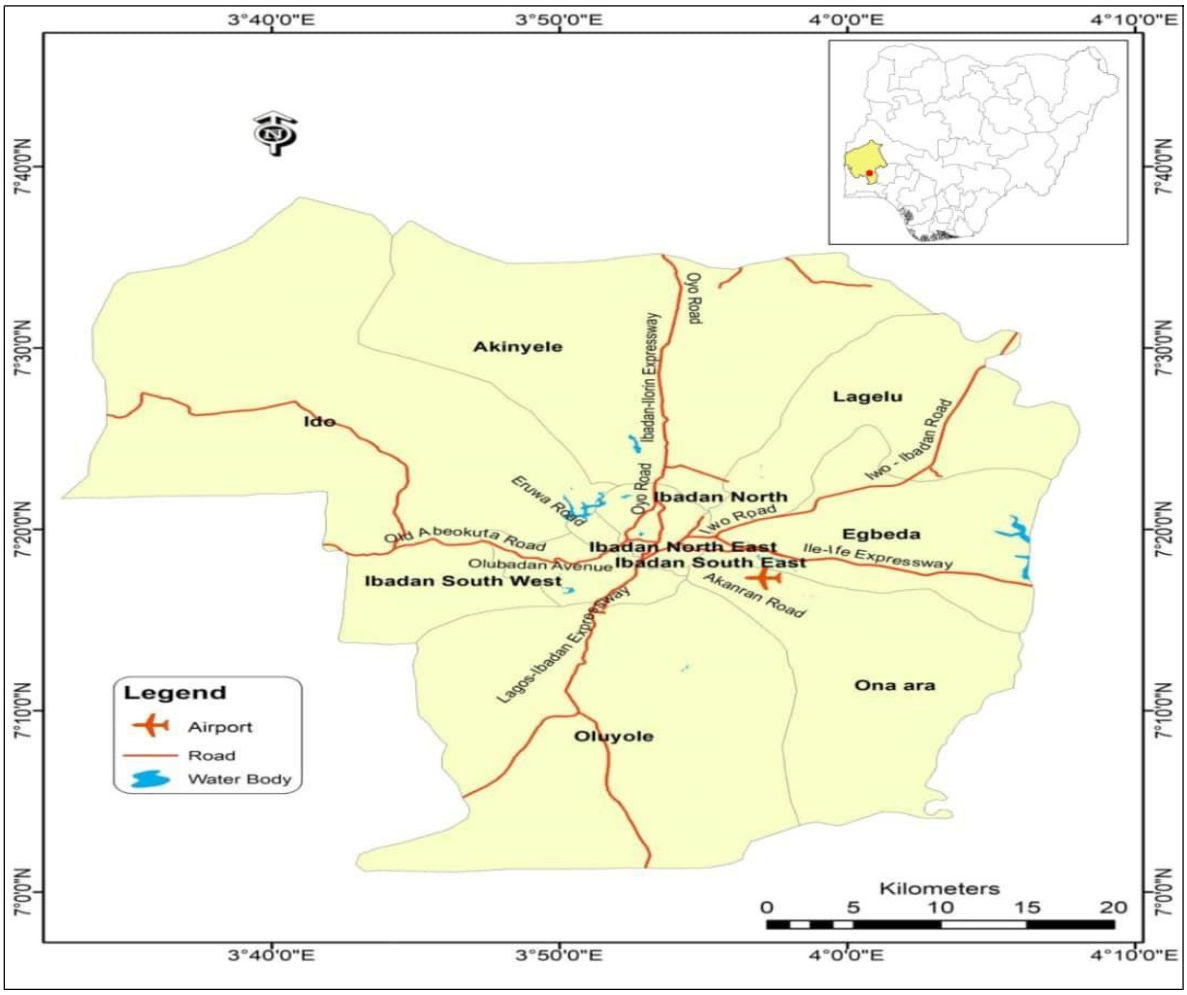


Figure 1. Ibadan Metropolis, Nigeria

Research Design, Population and Sample Size.
The research design adopted for this study was a survey design approach. The data were obtained through primary and secondary sources. The primary data were sourced from the field survey conducted through the administration of questionnaires to various respondents in the study area. This is attempted to complement the meteorological data (i.e. the maximum and minimum temperature data) collected from the Meteorological station. A questionnaire was designed to reflect the aim and objectives of the study and administered to 220 respondents. The set of questionnaires was directed to respondents both in their houses or offices. Data on age, marital status, number of households, and level of education and occupation of respondents were obtained. On the other hand, the secondary data spanning a period of thirty-four years were obtained from the Archives of the Nigerian Meteorological Agency (NIMET) Ibadan station. Specifically, minimum, maximum and mean daily air temperatures were obtained. These were used to demonstrate the extent to which temperature has varied over time.

Agbola and Olutubara (2004) identified the research population as the entire relevant cases or objects of interest in a study. The population for this study, therefore, comprised every Ibadan resident who has stayed for a minimum of ten years. More so, both indoor and outdoor work categories are considered worthy of completing this questionnaire. The following occupations are considered very important to this research: Construction Work, Traffic Police, Street Vendor, Bus/Taxi/Auto Driver, Office Work, Students, Farming, and Craft/Artisan. These are the group of occupations which are believed to be vulnerable to heat stress as evidenced by Roy et al. (2011).

The proportion of the population considered as the sample size is quite plausible. Here, a total of two hundred and twenty (220) copies of questionnaires were administered to selected indoor and outdoor workers through stratified and purposive sampling techniques. Twenty copies of the questionnaires were distributed using stratified sampling techniques among the eleven (11) Local government areas of the metropolis, while the purposive sampling techniques were further used to target respondents from various occupations that are thought to be impacted by temperature variations. In this case, at least two (2) respondents from the same indoor or outdoor occupation in a local government area were considered. To justify the sample size, larger populations permit smaller sampling ratios for equally good samples (Yusuf, 2003). Neuman (1991) reiterated that as the population size grows, the returns in accuracy for sample size shrink.

Data Analysis
Both descriptive and inferential statistics were employed in analysing the data. Analysis of the socio-demographic characteristics of the respondents and the effect of temperature variations on human physiological comfort in the study area was carried out using both statistical methods. The frequency distribution of each of the socio-demographic characteristics of the respondents was extracted and analysed to identify patterns and trends in each variable. Time series analysis was used to determine temporal variation in the distribution of daily minimum, maximum and mean temperature in Ibadan between 1990 and 2023. Regression and correlation analysis were also used to examine the relationship between temperature variations and physiological comfort in Ibadan.

The Linear Regression Model that was employed as one of the inferential techniques in analysing the data goes thus:

$$y = b_0 + b_1x_1 + \varepsilon$$

Where, **y** = value of the dependent variable (Physiological Comfort), $\mathbf{b_0}$ = a constant value, $\mathbf{b_1}$ = the predictor coefficient, the slope of the regression line, $\mathbf{x_1}$ = the predictor variables or independent variables (Temperature Variation); **ε** = error term.

RESULTS AND DISCUSSION
Meteorological Data
Daily minimum and maximum temperature between 1990 and 2023 made up the data for this study, which was then projected through 2021 using a linear trend model. Time series analysis was used to show temporal variation/changes in daily maximum, minimum and mean temperature in Ibadan for the period under study.

Time Series or Trend Analysis
Data on daily minimum and maximum temperature from 1990 to 2023 are presented in Figure 2, 3 and 4. These Figures show that there has been a steady increase in temperature i.e. an upward or positive trend when analysed using trend analysis a statistical package under time series analysis.

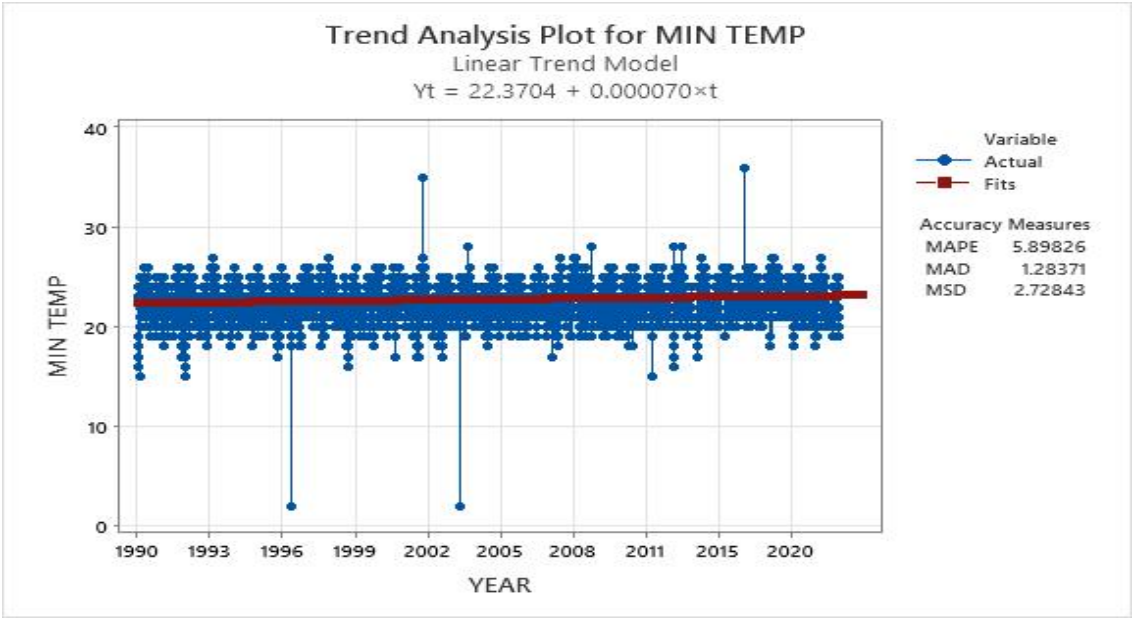


Figure 2: Linear Trend Analysis of Daily Minimum Temperature of Ibadan.

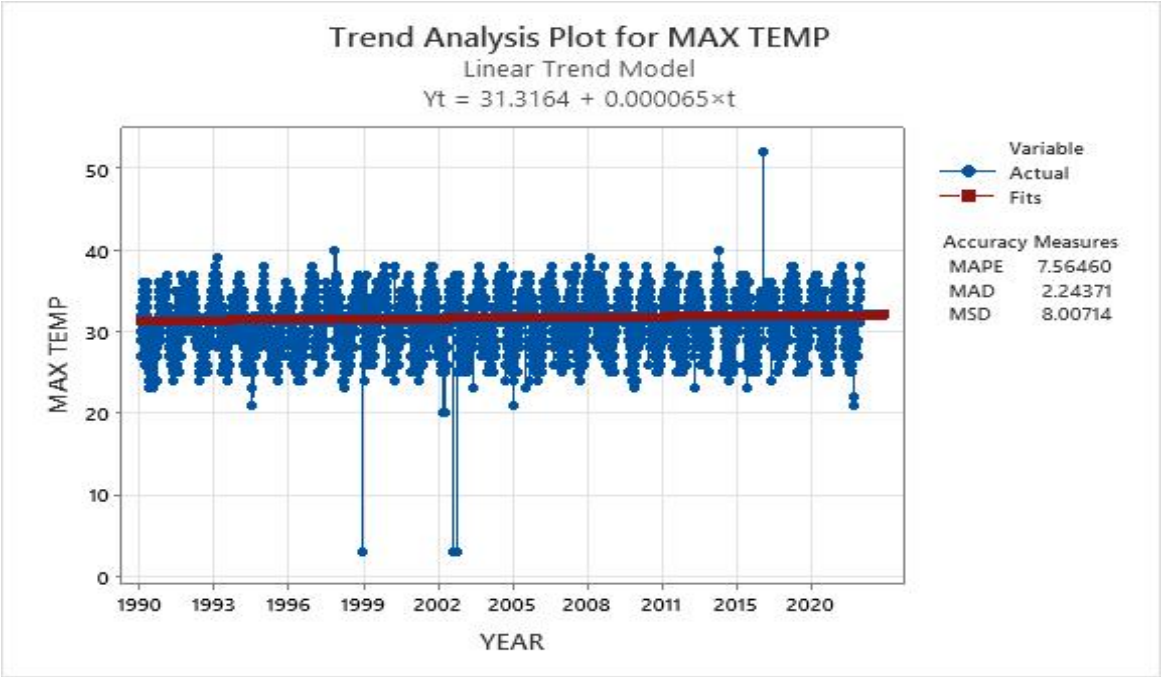


Figure 3: Linear Trend Analysis of Daily Maximum Temperature of Ibadan.

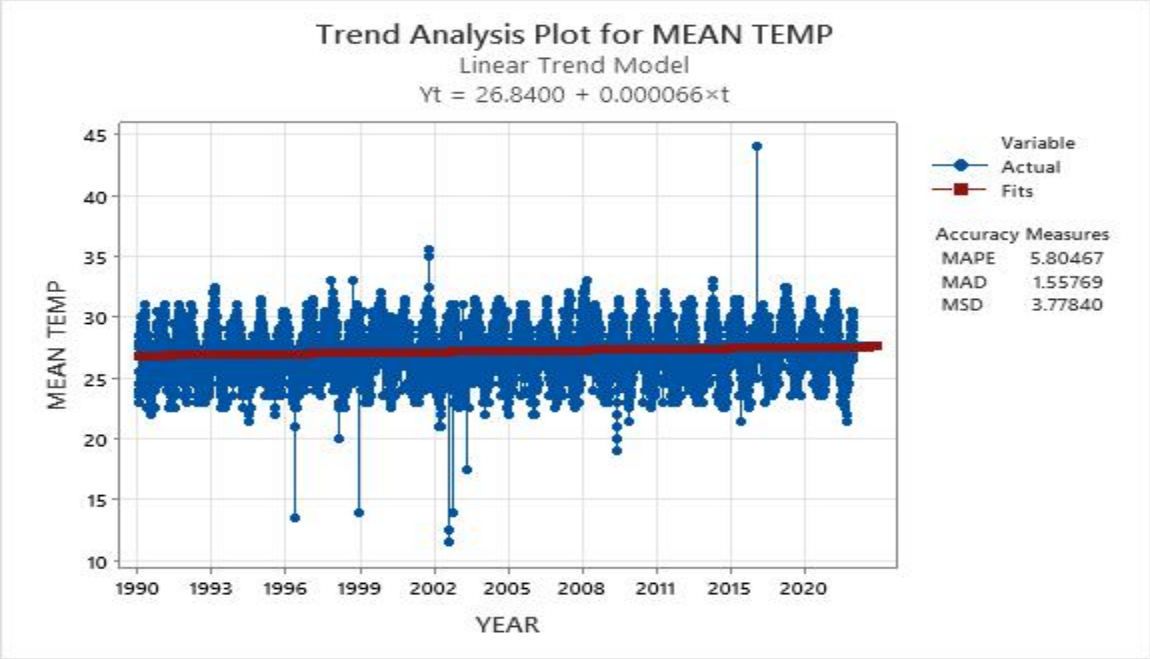


Figure 4: Linear Trend Analysis of Mean Daily Temperature of Ibadan.

The mean temperature of Ibadan daily did not deviate from the former i.e. minimum and maximum temperature data. An upward or positive trend was found on the linear trend model and on the graph it produces.

This also suggests consistently warmer days in the future. This could be said to be a result of excessive accumulation of greenhouse gases in the atmosphere.

Socio-demographic Characteristics of the Respondents

Table 1 shows that among respondents, males accounted for 57.7% while 42.3% were females. The mean age of the respondents was 34 years with the age range 31-40 years having the highest proportion. More than half of the respondents were married (61.4%) while about half (48.8%) were of medium family size.

Table 1: Demographic characteristics of respondents

Variable	Measurement	Count	Percent (%)	Cumulative Percent (%)	Mean
Sex	Male	124	57.7	57.7	
	Female	91	42.3	100.0	
Age	18 - 20 Years	20	9.3	9.3	34
	21 - 30 Years	62	28.8	38.1	
	31 - 40 Years	78	36.3	74.4	
	41 - 50 Years	46	21.4	95.8	
	51 - 60 Years	9	4.2	100.0	
Marital Status	Single	75	34.9	34.9	
	Married	132	61.4	96.3	
	Divorced	8	3.7	100.0	
Family size	2-3 Family Members	50	23.3	23.3	
	4-6 Family Members	105	48.8	72.1	
	7-9 Family Members	30	14.0	86.0	
	10 Members and above	30	14.0	100.0	

Source: Fieldwork (2021)

Table 2: Socioeconomic characteristics of respondents

Variable	Measurement	Count	Percent (%)	Cumulative Percent (%)
Level of Education	Primary School Education	5	2.3	2.3
	Senior Sec. School Education	48	22.3	24.6
	Diploma/NCE	54	25.1	49.7
	Graduate	84	39.1	88.8
	Postgraduate	24	11.2	100.0
Occupational Status	Indoor	87	40.5	40.5
	Outdoor	128	59.5	100.0
Occupation	Construction Work	16	7.4	7.4
	Traffic Police	27	12.6	20.0
	Street Vendor	24	11.2	31.2
	Bus/Taxi/Automobile Driver	20	9.3	40.5
	Office Work	43	20.0	60.5
	Students	41	19.1	79.5
	Farming	13	6.0	85.6
	Artisan	31	14.4	100.0
Monthly Income	Less than 10,000	37	17.2	17.2
	11,000-25,000	43	20.0	37.2
	25,000-50,000	43	20.0	57.2
	51,000-100,000	61	28.4	85.6
	101,000-150,000	26	12.1	97.7
	151,000-200,000	5	2.3	100.0
Duration of stay in Ibadan	1 - 5 Years	17	7.9	7.9
	6 - 10 Years	57	26.5	34.4
	11 - 15 Years	72	33.5	67.9
	16 Years and above	69	32.1	100.0

Source: Fieldwork (2021)

Socioeconomic characteristics of respondents are presented on Table 2. It is remarkable to note that greater fraction of the respondents were first-degree holders (39.1%); one quarter had Nigeria Certificate in Education (25.1%); slightly above one-fifth had only Senior Secondary School Education (22.3%)

while the least educated respondents had no less than primary school education (2.3%). Forty percent of the respondents were engaged in indoor jobs whereas about sixty percent practised outdoor jobs. Respondents were asked to specify their main occupations. 7.4% of the respondents were construction workers, 12.6% were traffic police; others were street vendors (11.2%), bus/taxi/automobile drivers(9.3%), 19.1% were student, farmers (6%), Artisan (14.4%) while one-fifth of the respondents were office workers (20%).

Physiological comfort and temperature variations in Ibadan.

The main objective of this study is to conduct a survey of physiological comfort in connection to temperature variations. To help determine the most acceptable result, questions that raises concerns about core temperature, rectal temperature, and thermal stress arising from temperature as felt by respondents are sorted for.

Table 3: Temperature changes in Ibadan and physiological comfort.

STATEMENTS	SA (%)	A (%)	N (%)	D (%)	SD (%)	Mean	Decision
Internal heat is produced when the temperature rises, hence body discomfort.	25	52	13	8	2	3.90	High Perception
When the temperature rises, I sweat profusely and cold when it drops below normal.	37	40	11	7	5	3.97	High Perception
The level of comfort is increased by sweat, particularly in the morning.	10	6	21	41	22	2.41	Low Perception
Most of the time, from midday to four o'clock, there is a rise in the amount of heat discomfort.	42	41	6	10	1	4.13	High Perception
A common occurrence during hot weather is an increase in heart rate.	27	38	14	17	4	3.67	High Perception
When temperatures are high, work performance improves.	7	11	15	44	23	2.35	low Perception
When exposed to heat for an extended period of time, weight loss is a regular occurrence.	19	26	20	31	4	3.25	Low Perception
Constant perspiration causes irritants including body itch, heat rashes, headaches, and more.	25	48	13	12	2	3.82	High Perception

Source: Fieldwork (2023)

Note: N=104, SA=Strongly Agree, A=Agree, NA=Neither Agree, D=Disagree and SD=Strongly Disagree. Decision – Weighted Average = 27.50/8 = 3.43.

Table 2 provides a thorough account of how the residents of Ibadan felt about their comfort as the temperature changed, especially when it went above normal. A high perception was reported of the statement that internal heat is produced when the temperature rises, hence body discomfort, and that when the temperature rises, residents sweat profusely and feel cold when it drops below normal.

Also, most of the time, from midday to four o'clock, there is a rise in the amount of heat discomfort, and a common occurrence during hot weather is an increase in heart rate and constant perspiration that causes irritants including body itch, heat rashes, headaches, and more. However, low perceptions were reported that the level of comfort is increased by sweat, particularly in the morning, and that when temperatures are high, work performance improves. Low perception was also noted when residents are exposed to heat for an extended period of time; weight loss is a regular occurrence.

Test of Hypothesis

H_0: *There is no significant relationship between Temperature Variation and Human Physiological Comfort in Ibadan.*

Table 4: Linear regression analysis of the relationship between temperature variation and human physiological comfort

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.429[a]	0.184	0.180	1.860

Analysis of Variance

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	166.444	1	166.444	48.098	0.000[a]
Residual	737.091	213	3.461		
Total	903.535	214			

Source: Fieldwork (2023)

Table 4 presents the results of the hypothesis set (H_0) which unveils that there is a positive and significant relationship between Temperature Variation and Human Physiological Comfort in Ibadan ($F(1, 213) = 48.098$, $P<0.01$). Temperature Variation accounted for nearly twenty per cent (18.4%) of the total variance in the respondents' Physiological Comfort. The null hypothesis is therefore rejected.

Table 5 Correlation Coefficients of the Relationship between Temperature Variation and Human Physiological Comfort

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
(Constant)	9.962	0.731		13.632	0.000
Temperature Variation	0.343	0.049	0.429	6.935	0.000

Dependent Variable: Human Physiological Comfort

The results in Table 4 also indicate that the predictor variable has a significantly positive slope ($B = 0.343$, $p<0.01$) and correlation with the Physiological Comfort of the respondent ($r = 0.429$). This establishes the fact that the change in Human Physiological Comfort is a function of the temperature variation that occurs over time.

Discussion

Temporal Variations in Daily Minimum and Maximum Temperature in Ibadan

Data was analysed using SPSS (Statistical Package for Social Sciences). The results of the Time Series Plot as shown in Figures 2 to 4 indicate statistically significant variations in the temperature series. Most variations tends towards increasing trend in air temperature especially at minimum temperature level with the coefficient of variability (CV) ranging between 13 and 21%.

The results of this study corroborate the findings of most studies carried out with respect to climate change, for example, Gurudeo and Mahbub (2010) found some changes over time in the 50 years data of rainfall and temperature in a research carried out in Australia. In another study conducted by Gillion (2005) in the Antarctic Peninsula for the period of 1950-2004, results show that there was a general increase in the mean surface temperature at the station.

In Adeshina and Odekunle (2011), study of climate change and adaptation in Nigeria; the results obtained for the minimum temperature generally indicated upward trends which can be ascribed to global warming. This is also in agreement with the assessment of the impact of climate change on water resource at Jebba hydropower reservoir using trend and reduction pattern methods by Salami (2011), statistical analysis here also revealed significant positive trends, which indicated that the parameters tend to increase.

However, the results of this study slightly deviate from the findings of Ogolo and Adeyemi (2009) who conducted a study of variations and trends of some meteorological parameters at Ibadan and found air temperature to be the least variable parameter having the coefficient of variability (CV) to range between 1-4% as against 22-97% of rainfall. With the ten (10) years data employed for the research, they observed an increasing trend in air temperature but not statistically significant. Therefore, it could be concluded that comparing the temperature data in Ibadan with the global

temperature trends, a warming drift was observed in the temperature series in the station.

Temperature Variations and Human Physiological Comfort

According to the results from Tables 3 and 4, it was discovered that there is a positive and significant relationship between temperature variation and human physiological comfort in Ibadan.

From a biological standpoint, the human body can be described as a constant-temperature apparatus. Heat is continuously produced by bodily processes and dissipated in an automatically regulated manner to maintain the body temperature at its correct level despite variations in ambient conditions. The findings of this study align with the explanation made by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc, about the thermal environmental conditions for human occupancy. It states in terms of physiology, that the experience of comfort is the achievement of thermal equilibrium with the minimum amount of body regulation. The human body normally rejects heat to the environment using evaporative cooling (sweating) and the heat transfer mechanisms of radiation, convection, and conduction.

The relationship between temperature fluctuation and human physiological comfort revealed by this study is also supported by the report of the study of spatial and seasonal patterns of physiologic comfort in Nigeria carried out by Ayoade (1978). He stated in his study that human health, energy, efficiency and physiologic comfort are affected more by climatic conditions than any other element of man's physical environment. He stressed further that the effects of climate on man particularly his physiologic comfort and physical and mental efficiency constitute a major theme of the science of bioclimatology.

Physiologic comfort, as defined by W.M.O. (1964) in a survey of Human Biometeorology, gives credence to the findings of this study. According to W.M.O's definition, Physiologic comfort is a feeling state in which a person has no wish to increase or decrease insolation or to adjust the ambient thermal environment. Nonetheless, it is imperative to state that the comfort of a given individual is affected by many variables. Health, age, activity, clothing, gender, food, and acclimatisation are all determining factors of the comfort conditions for any particular person. Since these factors will not be identical for all people, room conditions are expected to be available under which a majority of the expected occupants will feel comfortable.

CONCLUSION

The findings of this study offer remarkable insights into the temporal variation in the distribution of daily temperature in Ibadan for over thirty (30) years.

The study equally revealed that the average daily temperature has been increasing slowly over time with its attendant effects on human physiological comfort and physical wellbeing. This is because the minimum temperature trend was increasing faster than the decrease taking place in the maximum temperature trend. However if these temperatures continue in their respective trends, there is every possibility that Ibadan and many other cities in Nigeria as well as several other countries in the tropical regions will continue to experience global warming. The effect of it will be felt mostly in agriculture and many other sectors of the economy.

For Nigeria and the world at large to move out of the very challenging situation it has found itself, the government through its various intervention programmes must address some of these challenges. The citizens on their own should embrace eco-friendly activities and abstain from activities that are harmful to their immediate environment. This would help prevent environmental degradation and enhance healthy living.

The following are some recommendations that are derived from the findings of this study, which are considered important for the Nigerian government at all levels.

1. Most climatological research works suffer from a lack of adequate record of climatic elements. It is either that the records of such climatic elements are not being properly kept or there are no instruments to measure them. At times when instruments are available there is no manpower to monitor them. This study therefore recommends that adequate, regular and up-to-date records of climatic elements be properly compiled and well kept. More modern instruments e.g. automatic recording instruments should be installed in various meteorological stations to monitor the changes that occur in weather from time to time. All existing climatological stations should be served with at least an assistant to take the daily climate records.
2. Every effort must be made by the central office in Abuja to see that climatological stations send adequate records of their measurements promptly, and should ensure that such records are well kept. In this era of electronic computers, it is suggested here that climatic records be computerised for proper storage, easy retrieval, and quick extraction of data.

3. An illiterate populace is prone to misinterpreting good government policies that are intended to improve their lives, it also affects information dissemination among the people. Efforts of the government to encourage proper education in both rural and urban areas are a step in the right direction. If the people become literate it will create in them the awareness and consciousness of government policies.
4. The factors that engender habitability are very germane in the quality of life of the Nigerian masses. All communities in the country are worth living in, but some perennial problems prevail, and they aggravate the abysmally low level of living of the Nigerian citizens. If the Nigerian government, through the instrumentality of the Federal Environmental Protection Agency (FEPA), steps up actions in treating air pollution in the industrial areas and deforestation in the rural areas. If alternative ways of utilising the gases that are presently being flared are sought, the concentration of greenhouse gases (e.g. C02, CFCS etc) in the atmosphere would then reduce to the nearest minimum.
5. In order to guide against future atmospheric warming, the Nigerian government should discourage bush burning, gas flaring and non-conservative exercise and enjoin the citizens to participate actively in the tree planting programme as it is evident that vegetal cover exerts much influence on the surface air temperature condition of a place. This will help to mitigate the potential effects of global warming on agriculture, water resources, coastal zones and human settlement at a worldwide scale.

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