PHENOTYPIC CONSIDERATION IN URBAN THERMAL SENSITIVITY /ADAPTATION OF RESIDENTS IN CALABAR METROPOLIS, CROSS RIVER STATE

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Abstract

The study is focused on identification of the link between body size and thermal sensitivity in Calabar, Cross River State, Nigeria. Numerous investigations have been carried out on similar lines in other parts of the world but there is practical dearth of information in this domain of knowledge in the area of study. The subjects/population of this study are adult residents domiciled in the central city of Calabar where urban heat warming is clearly exemplified. The problem statement is predicated on the prevalent urban heat scenario in the area and the general public outcry on the adverse effects of the heat incidence in the area. From existing literature, it has been recognised that thermal discomfort is to an extent subjective of age, sex and phenotypic make up. Here in this study, three recognised phenotypes have been identified as variables subjects for investigation. They include; endomorphs, mesomorphs and ectomorphs. The objective is to elucidate their relative heat sensitivity indices. The justification is viewed from the valuable contributions this study can make to such fields as urban environmental management, individual livelihood sustainability and the general public health benefits. In terms of methodology, the study area has been clearly explained based on its geographical location (sub equatorial, marine coastal belt) weather/climatic characteristics, and so on. The population as stated earlier comprises adult residents domiciled in the Calabar central business district. Population sampling was achieved through a multi stage sampling procedure. The questionnaire instrument was employed in primary data collection, while other surrogate measures was achieved through biophysical data capturing. Data analysis was carried out through hypothesis testing using one way analysis of variance (ANOVA) following the result. The Fcal ratio stood at 16.960 while the critical value f_{α} stood at 4.51 at 0.05 level of significance. Since Fcal > f_{α}, the null hypothesis was rejected while the alternate hypothesis was accepted this means there is a significant variation in the thermal sensitivity of persons with different phenotype ratios.
Keyword: Phenotypic, Thermal Sensiticty/Adaptation , Environment

1.0 Introduction/background

Thermal sensitivity has been proven to be relative to body size or phenotype. A number of a studies have been carried out in many cities of developing regions to establish the co-connection between relative body size and thermal regimes. Mental equinamity and/or emotional distraught have been recognised as factors of changing thermal regimes. Balogun and Balogun (2014) have conducted a study in Akure, Nigeria to investigate the urban bioclimatic discomfort indices of residents in the city. Their attention was directed at

establishing a link between heat development and the index of human discomfort. They employed the Thermohygrometric Index (THI), the Discomfort Index (DI) and the Relative Strain Index (RSI) to evaluate the precinct of the body discomfort index as a predicates of urban temperature regimes, climate change and overall dislocation of the global meridional planetry circulation has caused the temperature of most city environments to pose health challenges to residents. This trend has spurred enormous concern for an understanding of the actual impact of thermal regimes on individuals. Unarguably, urban areas have become hearths of thermal radiation leading to the creation of urban heat impact on individuals.

Facts have been established that thermal responses or sensitivities varies between individuals. Investigations have been carried out concerning variation of heat sensitivity among individuals of different ages, sexes and body sizes in different parts of the world. Impact studies have equally been undertaken in different areas and reports have been provided accordingly. From the reports, health problems such as heat stroke,heat syndromes and practical death tolls have been recorded in cities of developed regions. Generally, thermal sensitivity directs attention to extremes in the region of (hot) or very frigid (cold) conditions. These extremes exude differences in feelings among individuals on the basis of their neurotic or phenotypic categories. It is thus, the focus of this research to investigate and unravel the true precinct of this trend in the study area, Calabar, Nigeria.

1.1 Statement of the problem

Stimuli sensation varies among individuals at all times. Thermohy grometric index and relative strain index appeal to this essence of variegated responses among persons of different body sizes of or physiologic morphology.

It has also been established through vigorous findings that body physiology or phenotype is closely linked with temperament or emotional excitation. On this basis, psychologists have categorised individuals into three broad groups on the basis of their visceral or phenotypic build-up such as Endomorphs (extra-large), Mesomorphs (medial morphology) and Ectomorphs (skinny shape or slim bodied).

These categorizations correspond to varying modes of responses to environmental stimuli ideally the endomorphs are receptive of mild to cold weather, the mesomorphs to ambient conditions and then the ectomorphs to the warm thermal regimes. Such pigeon holings are at the overall conception of issues. The realistic perspectives of the individual sensation in the context of time and place remains gravely unexplored with particular reference to the city of Calabar.

The expediency of undertaking this research in the area is borne out of the realities of the current climate change/global warming scenarios which have gravely exercabated the existing urban heat warming in cities of the world and particularly so in Calabar where the tropical weather regimes confers on it the torrid condition of weather. There is also the general public complaint of current unbearable urban heat effect among urban residents.

These are many other challenges necessitate the essence of this envisaged study.

1.2 Justification of the study

A research undertaking of this nature can never be more appropriate in times like this, going by the current scenario of global warming and climate change which have contributed to the creation of heat domes in urban centres due to the nature of the urban landscape fabrics and land cover characteristics.

Thermal sensitivity studies have featured prominently in urban environmental studies due to the earlier recognition of the fact and that cities have their distinct climatic regimes in terms of higher temperatures, different pressure/wind patterns and so on.

The study is necessary for providing insights into urban environmental capacity building in such areas as development of recreation facilities, urban housing development, environmental regulation for residents, adaptation and/or mitigation of environmental constraints and so on.

The entire gamut of the credibility of a study of this nature cannot be reached in that environmental temperature regime affects both the somatic and psychological responses of individuals at all times and so is

quite determinant of the behavioural orientation of individuals.
Negative thermal sensitivity can agitate erratic tendencies in individuals by way of emotional outburst in the form of expression of anger. Thus, this study remains valuable as an instrument in creating awareness in individuals on possible ways of adaptation or mitigation rather than resorting to vulnerability traits. It is a useful guide on selection of garbs or wears at particular seasons or days or the choice of food or beverage to select.

1.3 Objectives of the study

The overall purpose of this study is to evaluate individuals sensitivity to temperature patterns on the basis of the body type or phenotype (physical body build ups).
The specific objectives is as follows:

1. To investigate heat sensitivity pattern of individuals of different phenotypes.

1.4 Research Hypothesis

Ho: there is no significant variation in the heal sensitivity response of individual with different phenotypic body builds

Hi: there is a significant variation in the heat sensitivity response of individual with different phenotypic body builds in the area of study, calabar Nigeria.

2.0 Literature review

Studies on phenotypic thermal acclimation abound in the literature for different cities of the world. Mayness et al (2004) investigated thermal acclimation of women in Pretoria South Africa where they identified thermal tolerance among individuals of different phenotypic composition and were able to adduce that people of lean body sizes are more adaptable to high thermal regimes than those of obese body sizes. Following this, their conclusion was reached that people with different phenotypic compositions acclimate at different rates to thermal regimes. They also reported their findings on differences in rectal temperature, change in body pulse rate, changes in perspiration and metabolic rates. Deriving from a related report (NOAA, 1995), women generally are better at heat or thermal acclimation than men because they are said to perspire less and so they lose less salt than men. Another report generally provided that extreme weather trends generally retard human productive capacities.

A variety of studies have been carried out to investigate thermal sensitivity and animal metabolic rate rates generally with varying shades of findings. Sylyole, E. J. and Prod'hom, L. S. (1996) have investigated the relationship between body size, thermal balance and thermal insulation of infants under different ambient air conditions. The method involved is gradient layer direct calonmetric study made on the thermal balance of small-for-date, appropriate for date and large for date term infants during the first two days of life. The findings were that there was a negative correlation between metabolic rate per kilogramme and body weight while for surface area the correlation became positive. The conclusion was that small-for-date new born infants are handicapped not only by the unfavourable surface to mass ratio but also by limited specific body insulation. The result explains why new infants babies need adequate protection from the vagaries of external weather conditions.

Another related enquiry focused on "body size", effects and temperature on population. This review focused on the critical link between the performance of individual organisms and the ecology and evolution of species. Here the position was held that the intrinsic rate of exponential growth of a population growth max and the carrying capacity, k, depend on individual metabolic rate and resource supply (Savage et al, 2004).The theory

makes explicit the relationship between resource supply in the environment and the production of new biomass and individuals. The focus of this study departs fundamentally from the problem statement of this research proposal.

Further investigations on human body thermal sensitivity was carried out by Luo et al (2006). Their objective was to detect local thermal sensitivity over different parts of human body. Their objectives were achieved by inducing skin temperatures over 318 different spots by using thermal probes 14mm in diameter and subjective thermal sensation were surveyed over 10 seconds. The results showed that cool and warm sensitivities were seen to vary widely by body part. It showed that the foot lower leg and upper chest are much less sensitive than average. The cheeks, back and seat area are 2-3 times as sensitive to cooling and warming stimuli. Also everybody part exhibits stronger sensitivity to cooling (1.3 – 1.6) times stronger than warming. Findings from the above study revealed that thermal sensitivity varies between individuals according to body size (phenotype) and according to different spots on an individual's body and also that sensitivity to cold is higher than sensitivity to warm.

Another very relevant undertaking in the direction of this study was by Meyer et al (2017) on "Body Temperature Measurements for Metabolic Phenotyping in Mice". This experiment in mice was as basis for revealing correlations and inferring causality among specific physiological pathways. The method of thermometry using a probe in different parts of the body was applied. Different parts of the body are given specific ascriptions such as "Rectal (or Colonic) Thermometry" (This involves temperature measurement through the anus), Thermocouples, Thermistors and RTDs (RTDs means, Resistant Temperature Detectors). The thermocouples, thermistors and RTDs are all electrically operated devices of temperature measurements. Generally, the results revealed that deeper in-depth thermometry produce higher temperatures than external near surface probing. By and large thermal sensitivity varies between individuals and within individuals as well.

3.0 Methodology of the study

3.1 Research design

This research design is a field survey design aimed at data collection using the questionnaire as the basic instrument for the study. Biophysical field data was employed such as temperature recording at designated points for purposes of providing base-hire information on the thermal characteristics of the area, coordinates of field locations where data capturing may be undertaken will also be read off and documented.

3.2 Area of Study

Calabar is the primate settlement among geopolitical units that makeup Cross River State of Nigeria. It is the capital city of the state and is located on the Gulf of Guinea facing the Atlantic Ocean. The ocean with warm Guinea current provides the driving force for its weather regimes and overall thermal characteristics. The prevailing Tropical Maritime Air mass (MT air mass) with its moisture laden characteristics transports rainfall onshore with the aid of the South West trades wind.

Geographically, Calabar is located between 4.5^0N – 5^0N and 8^0E – 8.3^0E. The northings or latitudinal grid situates Calabar in a subequatorial climatic belt with its warm rainy season weather (March – October) and dry equable weather (November – February). In the alternate dry season weather regime, the tropical continental air mass which generates the North East Trades Winds (Harmatan) prevails. The influence of these pressure/wind systems significantly affect the thermal characteristics of the area on temporal or seasonal

basis. Incidents of land and sea breeze have common occurrences in the derived regimes of weather flux and significant impact in the ambient air thermal regimes.

In terms of landscape/land cover characteristics, Calabar like many city domains experience high degree or albedo or emissivity due to surface evaporation caused by sensible heat flux and latent heat of vaporization. These weather mechanisms lead to the creation of an urban heat dome (Gray and Fisher, 2002) with a warm cloud of air of over city atmosphere. Here lies the basis of the Calabar urban heat island which provided the impetus for this research proposal.

3.3 Population of the study

The population comprises adult male and female residents living in the city core area which was somewhat recognised as the central business district (CBD). Such areas were later designated as clusters or city blocks where sampling was undertaken.

3.4 Sampling technique

Multi stage sampling was carried out beginning with purposive cluster sampling, followed by systematic sampling, stratified sampling for selection of male/female respondents and finally random sampling for drawing out the representative number to be utilized.

3.5 Method for data collection

Essential procedures for data collection involve the following:

i) Field legibility survey or reconnaissance survey
ii) Field data collection proper.

3.6 Method of data analysis

Data was analysed using of statistical techniques analysis of variance.
The ANOVA technique was based on hypothesis earlier stated in the null form as Ho: there is no significant variation in the heal sensitivity response of individual with different phenotypic body builds in Calabar Nigeria.
In line with the hypothesis, ten sensitivity parameters were carefully selected and utilized in construction of questionnaire for data collection the results of which are represented in table 1 below
The four points likerts rating scales were explored for responds responses as follows: A –Agree, SA- Strongly Agree, D- Disagree and SD- Strongly Disagree

Presentation of data

Table 1: analysis of parameters of urban emissivity/adaptation in Calabar , Nigeria

S/N	PARAMETERS OF response	Rating scales				
		A	SA	D	SD	TOTAL
1.	Warm weather optimality	120	40	25	14	199
2.	Positive response to extremely cold weather	68	54	38	9	199
3.	Emotional instability during extremely hot weather	96	68	14	2	200
4.	Weakness/enervation in hot weather conditions	124	64	7	4	199
5.	Depression and mood swing during extremely cold weather	74	68	33	21	200

6.	Adequate sleep during hot weather	20	22	64	92	198
7.	Multiple body pains in extreme weather conditions	62	74	23	21	200
8.	Development of rigor/goose pimples in very cold weather	68	72	31	8	199
9.	Increased appetite in hot weather	65	77	33	5	200
10.	Development of rashes in hot weather effects	46	48	67	38	199

The Table represents the diverse responses of the respondents to varying temperature/ weather condition , Climatogically , temperature is an important index of weather regimes. This informed the problem identification of this study

Two hundred (200) respondents were selected through multistage sampling.
The choice of the subjects focused on body weight (Phenotype) which is an important criterion for comfort or discomfort index of thermohygrometric sensitivity (Batogun and Balogun , 2014)
From the Table statistical analysis based on the technique of one way Analysis of variance was computed as in the process below

Hypothesis restated in null form

Ho; there is no significant variation in the heat sensitivity of individual with different phenotypic ratios

Data analysis

One-Way (ANOVA) analysis of variance of variation in the heat sensitivity of individual with different phenotypic ratios

Variable Source	df	SS	MS	F-ratio
Treatment	3	18,841.35	6280.45	
Error	36	32482.75	902.299	6.960
Total	39	51324.1		

*Significant at .05

Reject Ho if $F_{cal\_}$ ratio > F α otherwise do not reject
Comparing both value reject Ho because $F_{cal\_}$ ratio= 6.960> $F_{(3,36)}$ = 4.51 at 0.05 level of significance and it was concluded that there is a variation in the heat sensitivity of individual with different phenotypic ratios.

Results/findings

From the result of the hypothesis testing the f ratio calculated stood at 960 at 0.05 level of significance while the critical or table value stood at 4.51 at 0.05 level of significance. This means that Fcal >fα(ie the calculated values is greater than the table value. This leads to the decision rule that there is a significance variation in the heat sensitivity response of individual with different phenotypes or body build. It follows that the null hypotheses is rejected while the alternative hypothesis is upheld.
This result therefore is conformal with the findings of previous studies carried out in the filed. There is

therefore a close corroboration with the works of Balogun and Balogu (2014) on their urban heat island and bioclimatic conditions in humid tropical city, Akure Nigeria. There is also a prosimate link with the earlier works by Ifeluwa, Balogun, Ahmed, Balogun and Zacharia (2011) on heat island characteristics in the same city , Akure Nigeria.
Balogun and Balogu (2014) focussed on the links between urban heat incidence and the index of human discomfort which may lead to heat stress or heat risk. Along the objectives of this study Balogun et al is (2014) investigation and findings provide great insight to the problem identification of this study in area they employed a number related indices in their exploration of the heat sensitivity responses of individual based on their concepts of the thermohygrometricindex(THI), discomfort index (DI) and the relative strain index, (RSI).

The THI focuses on relationship between temperature and relative humidity which is a significant factor in the weather systems of the tropical Biome. Intense insolation and high relative humidity produce maximum discomfort due to the atmosphere air becoming sultry leading to intense metabolic processes manifesting in increased perspiration.

The discomfort index appeals directly to the proper domain of this study which involves the index of human skin discomfort.
And again, the relative strain index is also significant in the explanation of index of individual responses or discomfort.
The result of this enquiry further support. Maynes et al (2004). The study on thermal acclimation of women in Pretoria South Africa broaden the horizon of understanding of the fact that there is difference in thermal tolerance among individuals of different phenotypes composition and this led to their conclusion that people of lean body sizes are more acclimated to high thermal regimes than those of obsess morphology. The result of this findings also substantiated an NOAA (1995) report that women generally are better at thermal acclimation than men because they are said to perspire less and so they loose less salt than men. Again further insight is provided inline with result of this investigation based on the relationship between body size, thermal balance and thermal insulation of infants under different ambient air conditions. The findings of this study led to the explanation of why new infants need adequate protection from the changing weather regimes. Evidently, the result so far provided, conveys a great deal of implications in the direction of human health, environmental mainstreaming individual awareness of the impact of changing weather regimes and lots more. Therefore , inline with the justification of this work, will add or extend the frontiers of knowledge in the field of urban environmental planning.

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Appendix

A QUESTIONNAIRE INSTRUMENT FOR INVESTIGATION OF PHENOTYPIC TYPES AND URBAN THERMAL SENSATION IN CALABAR BY DR THOMAS IYAJI

Rapport:

Dear respondents,

This instrument is for investigation of the differences in individual responses to temperature changes in the urban environment of Calabar Cross River State. It is primary aimed at acquisition of knowledge for environmental planning. Individual identity was held instruct confidentiality. Please provide an unbiased response to the items contained.

PART 1 PERSONAL DATA

Tick (√) as appropriate

1. Sex: Male [ ] , Female [ ]
2. Age: [ ] 12-18 years, [ ] 19-30years, [ ] 31 years +
3. Body weight: [ ] 30-5kg, [ ]46-75kg, [ ] 76+
4. Body tanning: [ ] Negroid (black), [ ]Caucasian(yellow), [ ] Albino /Mulato
5. Occupation: [ ] Indoor engagement, [ ] Outdoor engagement

PART II (THERMAL SENSITIVITY INDICESS)

Respond by choosing any item of your choice in with the 4 points likert scales as such as:

[ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree

1. Warm weather is my optimal weather [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree
2. I feel real good during periods of extremely cool weather conditions [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree
3. Extremely hot weather conditions affect my emotional state [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree
4. Hot weather conditions weakens /enervates my energy [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree
5. Extremely cold weather conditions depresses my spirit and causes my mood swing [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree
6. I sleep well during hot weather condition [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree
7. I experience multiple body pains during periods of extreme weather effects [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree
8. I often develop rigor/goose pimples during periods of extremely cool weather [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree
9. My appetite grows higher during periods of hot weather conditions [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree
10. I easily develop heat rashes during periods of extremely hot weather [ ] A= agree, [ ] SA= strongly agree, [ ] D Disagree, [ ] SD= Strongly Disagree