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Assessment of Workplace Indoor Thermophysiological Comfort of Staff of Ekiti State University, Ado-Ekiti, Nigeria

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Abstract **Original Research Article**

This study assessed workplace indoor thermophysiological comfort of staff of Ekiti State University, Ado-Ekiti, Nigeria. Thermophysiological comfort simply means the degree of comfort that result from the complex interaction between body and the environment. Data for this study were collected from both objective and subjective evaluation was done to obtain data on the thermophysiological comfort of staff in EKSU. For the objective evaluation, data was collected using whirling/sling psychrometer. The whirling psychrometer was used to measure the indoor air temperature and relative humidity. Readings were taken in the offices of the selected samples. This was done between 10am and 3pm at one hour intervals (10:30am, 11:30am, 12:30am, 1:30pm, and 2:30pm). Results from this study revealed that, subjective thermophysiological comfort of staff between 1pm and 2pm showed that none of the respondents were feeling colder than comfortable and much cooler than comfortable, 0.5% were slightly cooler than comfortable, 28% of the respondents were comfortable, 56.2% of the respondents were slightly warmer than comfortable, 12% of the respondents were much warmer than comfortable, while 3.3% of the respondents were hotter than comfortable. This study therefore recommended that, the school management should ensure that the offices of members of staff are provided with air-conditioner system particularly in offices that have more than two members of staff. This study therefore concluded that, there was a significant relationship between workplace indoor thermophysiological comfort, health and productivity of workers in the study area.

Keywords: Assessment, Indoor, Thermophysiological-Comfort and Workplace.

1.1. INTRODUCTION

In its simplest form, workplace environment means the situations or conditions under which people work. A more elaborate definition was put forward by Briner (2000) who thought that a workplace environment is a very broad category that encompasses the physical setting (e.g. heat, equipment, etc.), characteristics of the job itself (e.g. workload, task complexity), broader organizational features (e.g. culture, history) and even aspects of the extra organizational settings (e.g. industry sector, work-home relationship, etc.). Yusuf and Metiboba (2012) highlighted that workplace environment is composed of three major sub-environments, which include the physical environment, the human environment, and the organisational environment.

The physical environment constitutes the elements in the work environment that are associated with employees' aptitudes (Hafeez, et al., 2019). The workplace's physical environment is composed of land, air, water, plants, buildings, and other infrastructure that are organized to ensure work efficiency and productivity. The human environment deals with the interaction that takes place between employees and employers. The organizational environment, on the other hand, focuses more on the goal and objectives of the organization which reflects in the role and characteristics of activities that are carried out within the organization (Yusuf and Metiboba, 2012).

However, some authors have classified the workplace environment into conducive and toxic environments (Akinyele, 2010; Assaf and Alswalha, 2013). Olukunle (2015) found out that there can be a change of attitude of workers from being responsible to irresponsible under a toxic workplace environment, and from being irresponsible to responsible under a conducive workplace environment. He further noted that conducive workplace environments give pleasurable experiences or comfort to the employees and help them actualize in the dimensions of personality profile while toxic workplace environments give painful experiences or discomfort and de-actualize employees' behaviour (Olukunle, 2015).

The term comfort, in simple language, can be regarded as a cause of relief from discomfort and/or of a state of comfort (Katharine and Raymond, 1991). Merriam-Webster Dictionary defined comfort as an experience that is enjoyable and pleasurable. Comfort, in another regard, is a sense of physical or psychological ease, often characterized as a lack of hardship (Miller, 2009).

1.2 Statement of the Research Problem

The issue of health and productivity of workers has been a major concern of researchers in environmental health and management. Attention has been especially drawn to developing countries of the world; where working conditions keep getting 'unacceptable' in the face of rapidly improving technology. Some of these conditions include poor building structure, lack of power supply, poor ventilation, and unplanned workplace ergonomics, to mention a few. The quality and comfort of the workplace indoor environment are important because workers spend quality time in there which might affect their overall well-being and subsequently the growth and development of any country.

1.3. Aim and Objectives of the Study

This study aims to carefully assess the effects of workplace indoor thermophysiological comfort of Ekiti State University, Ado-Ekiti. The specific objectives of the study are to:

i. assess the problem of workplace indoor thermophysiological comfort of Staff of Ekiti State University, Ado-Ekiti;

ii. Investigate the effects of workplace indoor thermophysiological comfort on the Staff of Ekiti State University, Ado-Ekiti;

iii. Recommend possible solutions to the identified problems.

1.4. The Study Area: Ekiti State University, Ado-Ekiti

On January 14, 1981, Chief Adekunle Ajasin led by the civilian government of the then Ondo State, announced its intent to establish a Multi-Campus University in the state, and a body of planning committee was set up. The outcome of the exercise led to the founding of the University, in March 1982. The University was established as Obafemi Awolowo University, Ado-Ekiti on 30 March 1982 by the administration of late Chief Michael Adekunle Ajasin, the first Civilian Governor of Ondo State.

In the year 2010, there was a change of Government in Ekiti State and the new Government convened a Statewide Education Summit in 2011 to consider the best ways to sustain tertiary education and to fund public institutions owned by the Government of Ekiti State. Part of the decisions taken at the summit was to merge the three state-owned universities as a single public institution. The Ekiti State Government by law merged The University of Ado-Ekiti, Nigeria; The University of Education, Ikere-Ekiti and the University of Science and Technology, Ifaki-Ekiti as a new university and renamed it as: Ekiti State University, Ado-Ekiti, Nigeria.

Location

The geographical coordinates of Ekiti State University, Ado-Ekiti is between Latitudes 7°42 - 7°44 North of the Equator and Longitude 5°14 - 5°16 East of the Greenwich Meridian (See Figure 1.1, 1.2, 1.3). Ekiti State University, Ado-Ekiti is located within the neighbourhoods of Ado-Ekiti and Iworoko - Ekiti. It is about 14 kilometers away from Ado-Ekiti metropolis but less than 1 kilometer to Iworoko-Ekiti thereby making Iworoko the closest community (Owoeye and Ogunleye, 2016).

Figure 1: Ekiti State within Nigeria

***Source: Nations Online Project (www.nationsonline.org/oneworld/map)*, 2022**

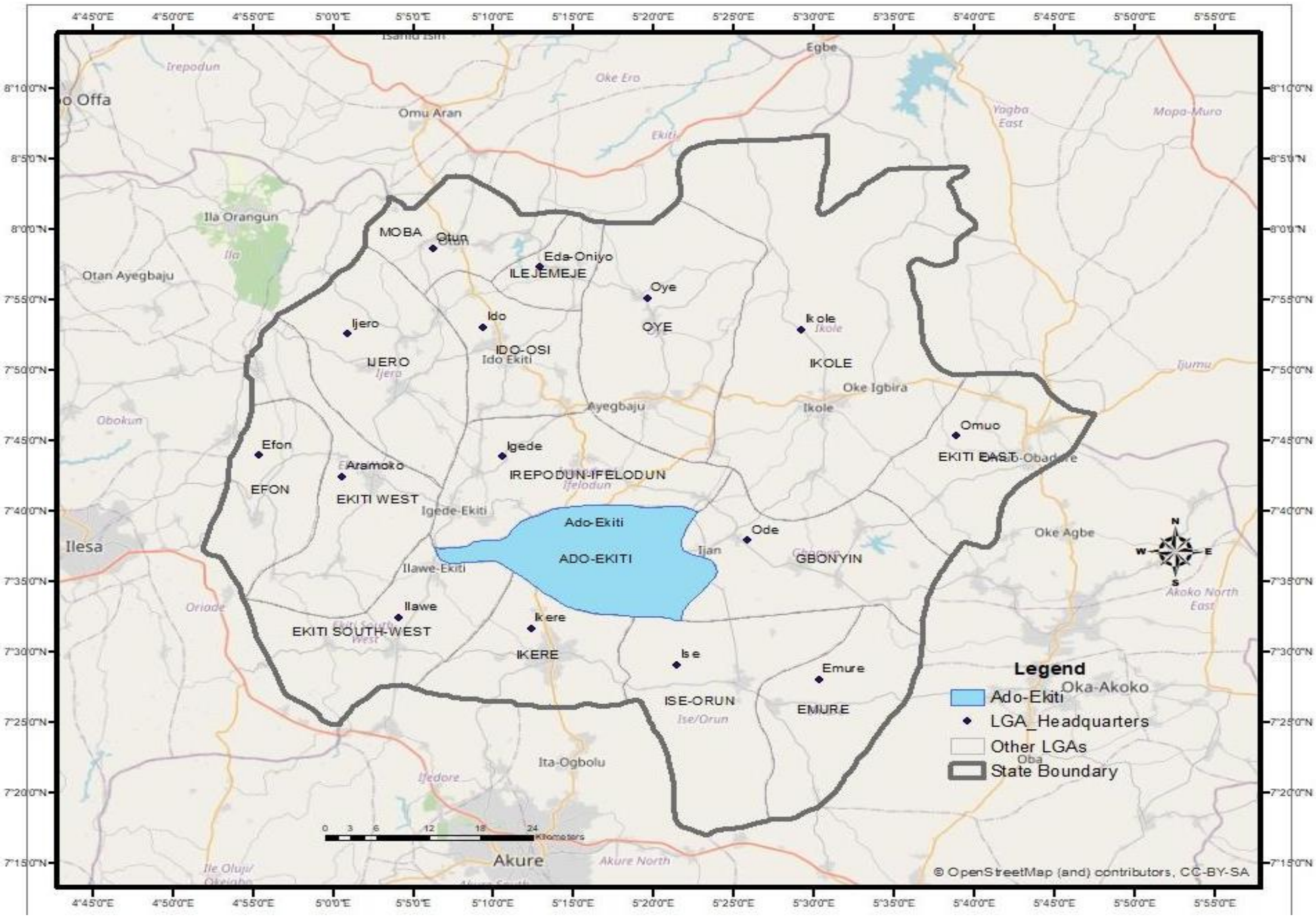

Figure 2: ***Ekiti State indicating EKSU in Ado-Ekiti***

Source: Ekiti State Ministry of Physical, Urban and Regional Planning, 2022

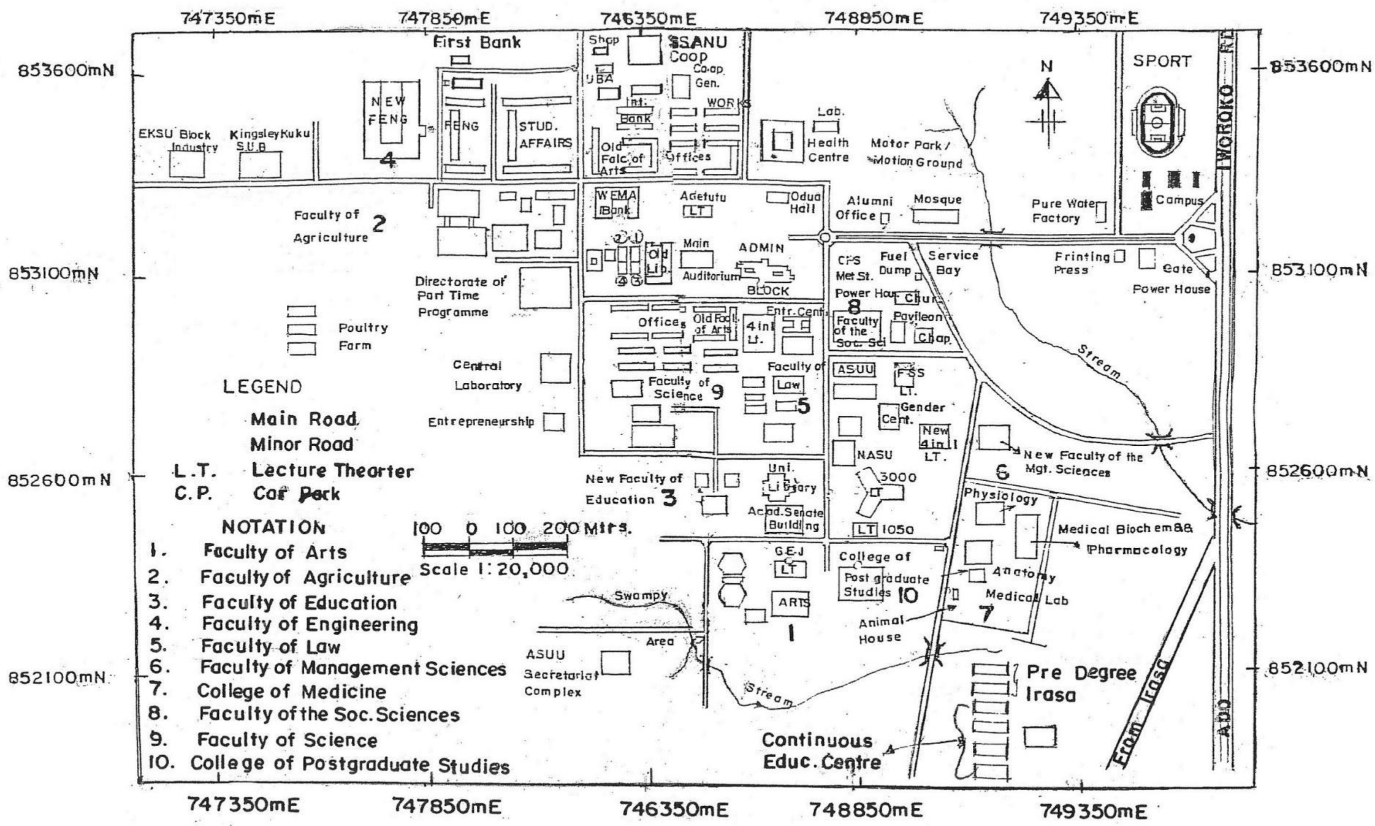

Figure 3. Map of Ekiti State University, Ado-Ekiti

Source: Cartography Unit, Department of Geography and Planning Science, Ekiti State University, Ado-Ekiti, 2022

Climate

Ekiti State University (EKSU) experiences tropical wet and dry climate based on the Koppen climate classification. The wet season lasts from April to October with a break in August and dry season lasts from November to March. Howbeit, the temperature of the area is almost uniform throughout the year, with very little deviation from the mean annual temperature of 27°C, February and March are the hottest with the temperature of 28°C and 29°C respectively, while June with mean temperature of 25°C is the coolest (Adebayo, 1993).

1.5. Literature Review and Theoretical Framework

Thermophysiological comfort simply means the degree of comfort that result from the complex interaction between body and the environment. According to Angelova (2016), thermophysiological comfort encompasses both the thermoregulation of the human body and its interaction with the physical environment. In essence, heat is produced by the body and loss to the environment.

In another regard, Owolabi and Adebayo (2013) asserted that the amount of metabolic heat productivity varies with factors such as the type of activity, age, sex, weight and height. The maintenance of the body temperature, however, requires a balance to be attained between heat loss and heat gain. They further posited that heat gain occurs through nasal processes, absorption from the surrounding air, if it is above skin temperature. Heat loss takes place through radiation, conduction, convection and evaporation of moisture from the skin surface. If more heat is gained than is lost, the body temperature will rise and subsequently discomfort is experienced. To maintain heat balance, factors such as the nature of work and physical condition of the workplace environment must be well juxtaposed for sustainable decisions and planning.

Heat transfer theory is a scientific theory that developed its idea from the second thermodynamic law. This law was prominently attributed to Rudolf Clausius in 1850 who examined the relationship between heat transfer and work. In his statement "Heat can never pass from a colder to a warmer body without some other change connected therewith and occurring at the same time". In other words, heat transfer occurs through a material medium. Heat transfer takes place between bodies as a result of temperature difference. The three modes by which heat can be transferred from one place to another are: conduction, convection and radiation. Hence, the body gains and losses heat through radiation, conduction and evaporation.

Epstien and Moran (2006) were of the opinion that the amount of heat that can be exchanged is a function of sweat evaporation (≈18.6 watt per 1 mmHg) change in ambient vapour pressure, below 42 mmHg (assuming a mean skin temperature of 36^{o}C).

Radiation is the transfer of energy (heat) through air molecules. In essence when the air temperature is hot, the body becomes hot subsequently. The amount of heat loss through radiation depends on the temperature and the radiating powers of surrounding objects such as walls, pavements, vegetation etc. In this regard, the temperature of air and that of the surrounding objects should be the same as that of the body (Robert, 1904).

1.6. Methodology

Both descriptive design and quasi-experimental research designs were used in this study. The descriptive research describes the condition of the sample the way it exists; it merely shows the condition or relationship that exists. The quasi-experimental design, on the other hand, is a type of research design used in place of true-experimental design, most especially when the researcher has no control over the independent variable and where there is lack of control groups.

Sources of Data

Data was obtained from both primary and secondary sources. Data was obtained from primary source through the use of questionnaire and whirling/sling psychrometer while secondary sourced data was obtained from Ekiti State University Health Centre.

Sampling Procedure

The sample procedure includes that of the objective measurement and survey subjective thermophysiological comfort. For the objective measurement, a total of 120 offices were selected using simple random sampling technique. 10 offices were randomly selected from 12 buildings in Ekiti State University, Ado-Ekiti. These buildings include: Faculties of the Social Sciences, Arts, Education, Engineering, Law, Management Science, Science, Agricultural Science, College of Medicine and New Academic Building, Omolayo Administration Building and Directorate of Student Affairs.

For the survey (subjective measurement), a total of 400 samples were selected using the stratified sampling technique. The samples were selected from each of the aforementioned buildings depending on the number of offices and capacity of each building. Based on the technique used, the sample was divided into two strata which were gender (male and female) and job category (academic and non-academic).

Research Instrument

The research instrument that was used for this study was subdivided under semi-experimental and descriptive design. For the objective measurement, the whirling/sling psychrometer was used. The whirling/sling psychrometer is made up of two standard Thermometers (Dry Bulb Thermometer and Wet Bulb Thermometer) mounted on a frame with a handle. The Wet Bulb Thermometer has a moistened piece of cloth wrapped about the bulb. The instrument was whirled around for several minutes and then the results were read and recorded.

Figure .4: Sling/Whirling Psychrometer

Source: (science.waltermack.com) Accessed May 15, 2021

Validity and Reliability of Instrument (Questionnaire)

Face and Content validity was used to test the validity of the research instrument (questionnaire). This involved giving the research instrument to professionals in the field of Test and Measurement so as to ascertain if the questions in the questionnaire measured what it was purposed to measure. Thereafter, the instrument was given to the research Supervisor for vetting and correction before producing the final copies.

Reliability of the instrument was done using test-retest reliability method. The research instrument was administered on different twenty (20) samples twice at one week interval. Data obtained were correlated using Pearson Product Moment Correlation Coefficient (PPMCC) and a correlation coefficient of 0.81 was obtained which indicated that the instrument was reliable.

Method of Data Collection

Both objective and subjective evaluation was done to obtain data on the thermophysiological comfort of staff in EKSU. For the objective evaluation, data was collected using whirling/sling psychrometer. The whirling psychrometer was used to measure the indoor air temperature and relative humidity. Readings were taken in the offices of the selected samples. This was done between 10am and 3pm at one hour intervals (10:30am, 11:30am, 12:30am, 1:30pm, and 2:30pm). It, therefore, gave a total of 5 readings in each office.

Data on the relative humidity was measured using the result from dry bulb thermometer (Td) and wet-bulb thermometer (Tw). After whiling the psychrometer for few seconds, readings were taken immediately. The relative humidity (RH) was calculated from the dry bulb temperature (Td) and wet bulb temperature (Tw) using the following formula:

$$RH = 100 * \frac{\exp((17.625 * Tw) / (243.04 + Tw)}{\exp((17.625 * Td) / (243.04 + Td)}$$

Where

RH = Relative Humidity

exp = Exponential constant

Tw = Wet-bulb temperature

Td = Dry-bulb temperature

For the subjective evaluation, subjective thermal comfort scale was included in the questionnaire which was used to determine the subjective thermophysiological comfort. These set of data were useful in determining the subjective judgment of each respondent based on their personal experience. Data on perceived health effects and productivity was also obtained using the questionnaire. To this end, a total of Four Hundred (400) copies of the questionnaire were administered on the respondents.

Method of Data Analysis

Statistical data analysis was done with the aid of Statistical Package for Social Science (SPSS v.23) software. Both descriptive statistics and inferential statistics were used to analyze the data obtained. For the objective evaluation, data obtained was interpreted using the Humidex (Humidity Index). Humidex is an index developed and used by Canadian Meteorologists that combines air temperature and relative humidity, in shaded areas, to predict the level of thermal comfort (Figure 3.2). Data collected on the subjective evaluation, perceived health effects and staff productivity were analyzed using simple percentage and mean descriptive statistics. Simple linear regression analysis was used to test the research hypotheses. Results obtained were presented in tables and charts.

Relative Humidity (%)

Temperature (°C)	100%	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%	30%	25%	20%
21°C	29	29	28	27	27	26	26	24	24	23	23	22					
22°C	31	29	29	28	28	27	26	26	24	24	23	23					
23°C	33	32	32	31	30	29	28	27	27	26	25	24	23				
24°C	35	34	33	33	32	31	30	29	28	28	27	26	26	25			
25°C	37	36	35	34	33	33	32	31	30	29	28	27	27	26			
26°C	39	38	37	36	35	34	33	32	31	31	29	28	28	27			
27°C	41	40	39	38	37	36	35	34	33	32	31	30	29	28	28		
28°C	43	42	41	41	39	38	37	36	35	34	33	32	31	29	28		
29°C	46	45	44	43	42	41	39	38	37	36	34	33	32	31	30		
30°C	48	47	46	44	43	42	41	40	38	37	36	35	34	33	31	31	
31°C	50	49	48	46	45	44	43	41	40	39	38	36	35	34	33	31	
32°C	52	51	50	49	47	46	45	43	42	41	39	38	37	36	34	33	
33°C	55	54	52	51	50	48	47	46	44	43	42	40	38	37	36	34	
34°C	58	57	55	53	52	51	49	48	47	45	43	42	41	39	37	36	
35°C		58	57	56	54	52	51	49	48	47	45	43	42	41	38	37	
36°C			58	57	56	54	53	51	50	48	47	45	43	42	40	38	
37°C					58	57	55	53	51	50	49	47	45	43	42	40	
38°C							57	56	54	52	51	49	47	46	43	42	40
39°C									56	54	53	51	49	47	45	43	41
40°C										57	54	52	51	49	47	44	43

Humidex	Degree of Discomfort
20 - 29	No discomfort
30 - 39	Some discomfort
40 - 45	Great discomfort; avoid exertion
46 +	Dangerous; possible heat stroke

Figure .1: Humidex (Humidity Index)

Source: ***University of Manitoba, Canada, retrieved from www.github.com, 2021***

1.7. Results and Discussion

Workplace Indoor Thermophysiological Comfort of Staff

Objective Evaluation

Table 4.1: Humidex of Staff Thermophysiological Comfort between 10am and 11am

Humidex	Degree of Discomfort	*f*	%	Mean AT	Mean RH
20 – 29	No Discomfort	0	0.0	28.2^{o}C	79%
30 – 39	Some Discomfort	106	88.3		
40 – 45	Great Discomfort	14	11.7		
46 +	Dangerous	0	0.0		
	Total	120	100.0		

Source: Field Survey, 2021

Table 1: Humidex of Staff Thermophysiological Comfort between 11am and 12noon

Humidex	Degree of Discomfort	*f*	%	Mean AT	Mean RH
20 – 29	No Discomfort	0	0.0	28.5^{o}C	79%
30 – 39	Some Discomfort	77	64.2		
40 – 45	Great Discomfort	43	35.8		
46 +	Dangerous	0	0.0		
	Total	120	100.0		

Source: Field Survey, 2021

Results presented in Table .1 on staff thermo physiological comfort between 10am and 11am using the humidex revealed that 88.3% of the staff were predicted to experience some discomfort in their offices between 10am and 11am, 11.7% of the sampled staff were predicted to experience great discomfort between 10am and 11am while none of the staff experienced no discomfort or a dangerous indoor environment. From the result obtained, it can be deduced that most of the respondents experienced little thermophysiological discomfort if they remain indoor within those periods. This was because the average air temperature in the offices is 28.2^{o}C with about 79% average relative humidity.

Results presented in Table 2 on staff thermophysiological comfort between 11am and 12noon using the humidex revealed that 64.2% of the staff were predicted to experience some discomfort in their offices between 11am and 12am, 35.8% of the sampled staff were predicted to experience great discomfort between 11am and 12am while none of the staff experienced no discomfort or a dangerous indoor environment. The result obtained indicated that there was an increase in the degree of discomfort experienced by the staff. However, most of the respondents still experienced only a mild degree of discomfort in which most of them can still perform their works effectively. The mean Air Temperature and relative humidity obtained also indicated that most of the respondents experienced little discomfort.

Table 2: Humidex Table showing Staff Thermophysiological Comfort between 12noon and 1pm

Humidex	**Degree of Discomfort**	***f***	**%**	**Mean AT**	**Mean RH**
20 – 29	No Discomfort	0	0.0	29.1°C	78%
30 – 39	Some Discomfort	40	33.3		
40 – 45	Great Discomfort	80	66.7		
46 +	Dangerous	0	0.0		
	Total	120	100.0		

Source: Field Survey, 2021

Table 3: Humidex Table showing Staff Thermophysiological Comfort between 1pm and 2pm

Humidex	**Degree of Discomfort**	***f***	**%**	**Mean AT**	**Mean RH**
20 – 29	No Discomfort	0	0.0	29.6°C	76%
30 – 39	Some Discomfort	22	18.3		
40 – 45	Great Discomfort	98	81.7		
46 +	Dangerous	0	0.0		
	Total	120	100.0		

Source: Field Survey, 2021

Results presented in Table 3 on staff thermophysiological comfort between 12am and 1pm using the humidex revealed that 33.3% of the staff were predicted to experience some discomfort in their offices between 12noon and 1pm, 66.7% of the sampled staff were predicted to experience great discomfort between 12noon and 1pm while none of the staff experienced no discomfort or a dangerous indoor environment. From the foregoing it can be deduced that the percentage of the staff that experienced great discomfort is high. In other words, it became more discomforting to stay in the offices around this time particularly when it was not an air-conditioned office. It was also revealed that the average air temperature is 29.1°C while the average relative humidity was 78% which were quite high.

Results presented in Table 4.4 on staff thermophysiological comfort between 1pm and 2pm using the humidex revealed that 18.3% of the staff were predicted to experience some discomfort in their offices between 1pm and 2pm, 81.7% of the sampled staff were predicted to experienced great discomfort between 12noon and 1pm while none of the staff experienced no discomfort or a dangerous indoor environment. The result obtained revealed that most of the respondents were not comfortable between 1pm and 2pm. Howbeit, few of the respondents experienced little discomfort during this period. The result obtained also showed that the mean average temperature was 29.6^{o}C with average relative humidity of 76%. The relative humidity was quite on the high side as compared to the temperature which made it quite difficult for evaporation to take place from the skin and much discomfort experienced.

B. Subjective Evaluation

I. Subjective Thermophysiological Comfort based on Time

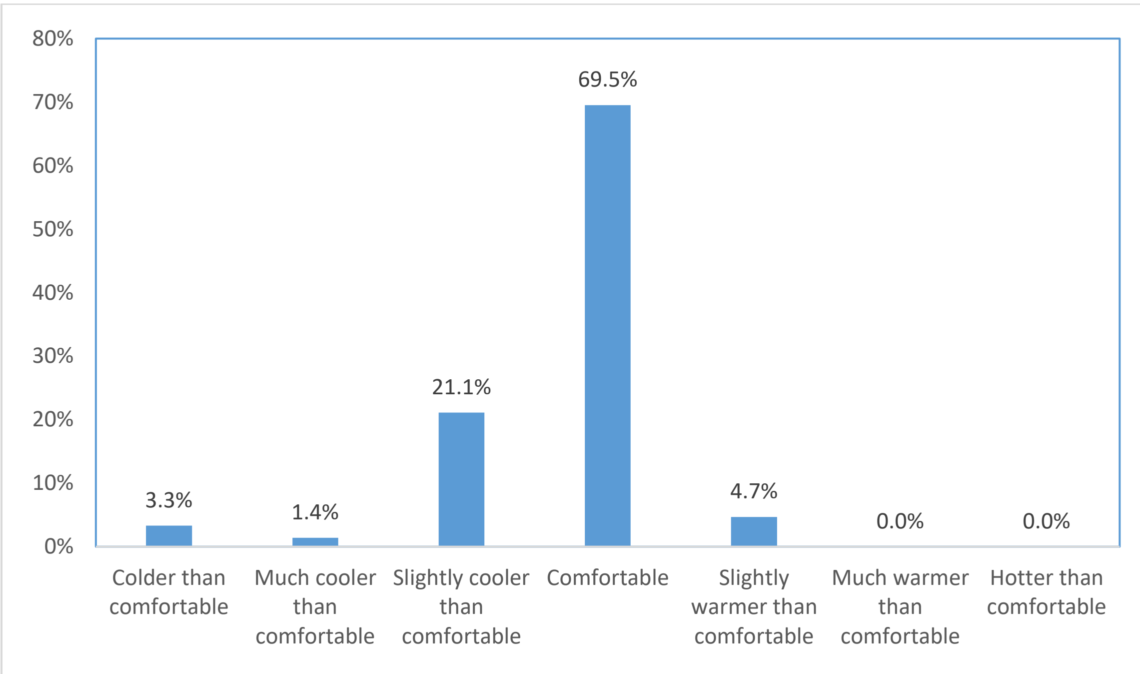

Figure 2: Subjective thermophysiological comfort of Staff between 10amand 11am

Source: Field Survey, 2021

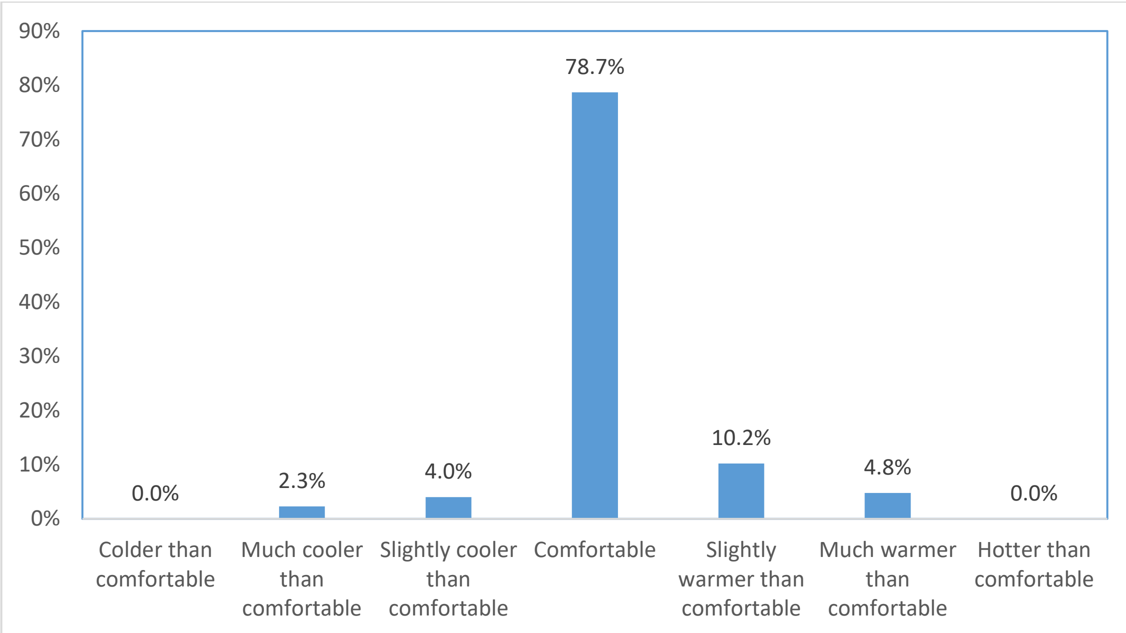

Figure 8: Subjective thermophysiological comfort of Staff between 11am and 12noon

Source: Field Survey, 2021

As shown in Figure 2, the subjective thermophysiological comfort of staff between 10am and 11am revealed that 3.3% of the respondents felt colder than comfortable, 1.4% of the respondents felt much cooler than comfortable, 21.1% of the respondents felt slightly cooler than comfortable, 69.5% of the respondents felt comfortable, 4.7% of the respondents felt slightly warmer than comfortable while none of the respondents felt hot between 10am and 11am. From the results obtained, it can be deduced that most of the respondents felt comfortable between 10am and 11am. Howbeit, some of the respondents felt cooler than comfortable during the period (3.3%). This was in connection with the predicted level of comfort which revealed that most of the respondents felt slightly uncomfortable which in the real sense they can still cope with due to the fact that the air temperature at that period was still low.

In Figure 3, the subjective thermophysiological comfort of staff between 11am and 12 noon revealed that none of the respondents felt colder than comfortable, 2.3% of the respondents felt much cooler than comfortable, 4% of the respondents felt slightly cooler than comfortable 78.7% of the respondents felt comfortable, 10.2% of the respondents felt slightly warmer than comfortable, 4.8% of the respondents felt much warmer than comfortable while none of the respondents do not feel hot between 11am and 12noon. Furthermore, it could be deduced that most of the felt comfortable between 11am and 12noon with a total percentage of 78.7%. In addition, few of the respondents noted that they felt slightly warmer and much warmer during this period because the surrounding environment had started getting heated up.

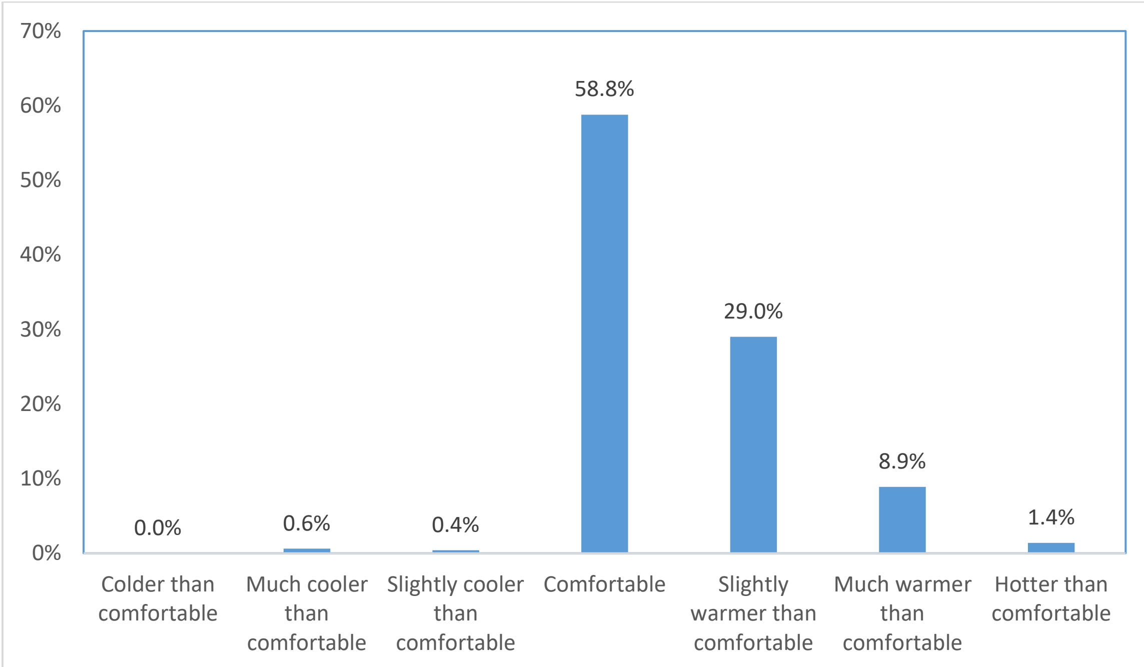

Figure 4: Subjective thermophysiological comfort of Staff between 12noon and 1pm
Source: Field Survey, 2021

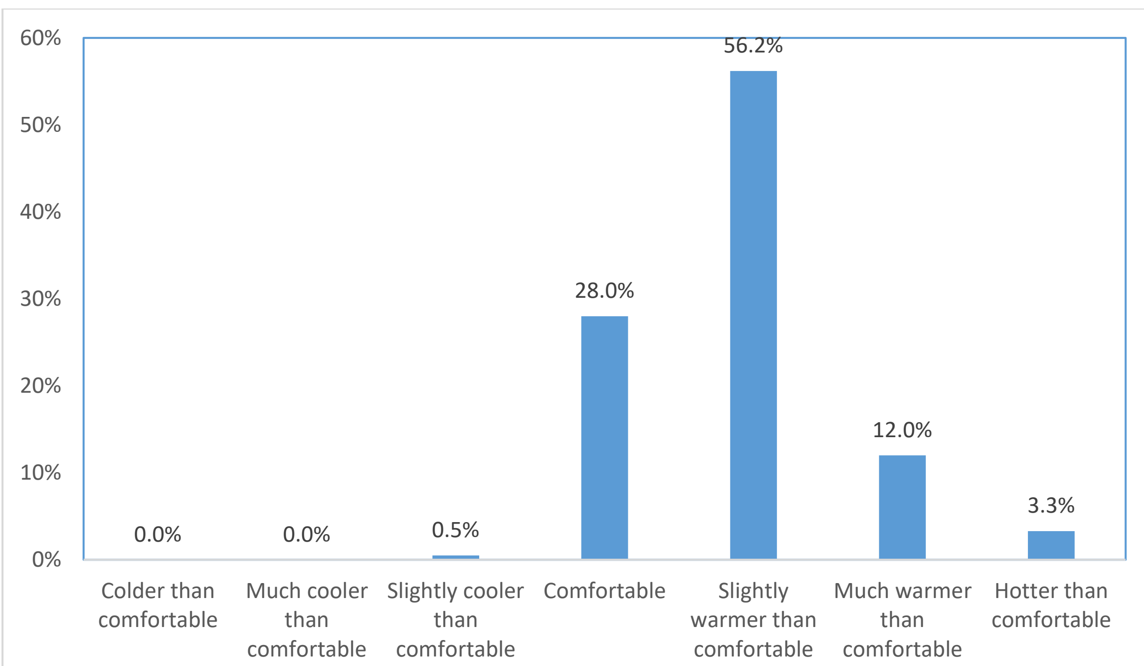

Figure 5: Subjective thermophysiological comfort of Staff between 1pm and 2pm

Source: Field Survey, 2021

In Figure 5 on the subjective thermophysiological comfort of staff between 12noon and 1pm showed that none of the respondents were feeling colder than comfortable, 0.6% were much cooler than comfortable, 0.4% of the respondents were slightly cooler than comfortable, 58.8% of the respondents were comfortable, 29% of the respondents were slightly warmer than comfortable, 8.9% were much warmer than comfortable while 1.4% of the respondents were hotter than comfortable. The result obtained showed that majority of the respondents usually felt comfortable at work between 12noon and 1pm with a total percentage of 58.8% of the respondents. However, some percentages of the respondents also felt slightly warmer, much warmer and hotter than comfortable.

In Figure 5 on the subjective thermophysiological comfort of staff between 1pm and 2pm showed that none of the respondents were feeling colder than comfortable and much cooler than comfortable, 0.5% were slightly cooler than comfortable, 28% of the respondents were comfortable, 56.2% of the respondents were slightly warmer than comfortable, 12% of the respondents were much warmer than comfortable while 3.3% of the respondents were hotter than comfortable. It was discovered that the percentage of the respondents that felt comfortable has dropped drastically with only 28.5% of the respondents feeling comfortable while a total of 72.5% of the respondents felt slightly warmer, warmer and colder than comfortable. It means that most of the respondents were uncomfortable between 1pm and 2pm.

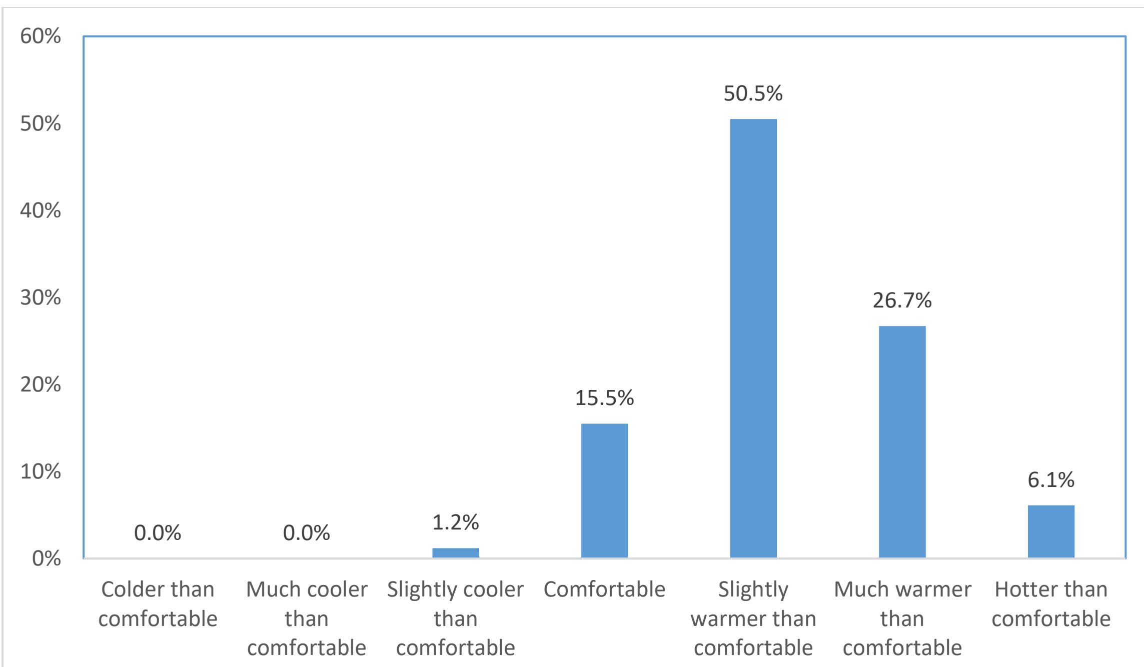

Figure 6: Subjective thermophysiological comfort of Staff between 2pm and 3pm

Source: Field Survey, 2021

In Figure 6, on the subjective thermophysiological comfort of staff between 2pm and 3pm showed that none of the respondents were feeling colder than comfortable and much cooler than comfortable, 1.2% of the respondents were slightly cooler than comfortable, 15.5% of the respondents were comfortable, 50.5% of the respondents were slightly warmer than comfortable, 26.7% were much warmer than comfortable while 6.1 of the respondents were hotter than comfortable. It can be deduced from Figure 4.5 that only a few numbers of staff felt comfortable between 2pm and 3pm. A total of 83.3% of the respondents felt warmer and hotter than comfortable. It therefore implied that most of the respondents did not feel comfortable between 2pm and 3pm.

1.8. Recommendations

Based on the findings obtained in the study, it is recommended that;

1. The school management should ensure that the offices of the staff are provided with air-conditioner system particularly in offices that have more than two staff.
2. The management should also endeavour to supply the staff with electricity to power the air-conditioner system and lighten up the offices between 12noon and 3pm so that desired offices temperature can be maintained towards staff health and productivity.
3. Here is need for the school management to do a yearly or quarterly evaluation of staff thermophysiological comfort to ascertain their level of comfort at work and also to provide hints on ways to improve such. This can be done by sending a survey to the workers email, which will contain few but concise questions on their overall level of comfort at work. This will help the university management know where to improve on in ensuring environmental health and safety.

1.9. Conclusion

It was revealed in the study that the staff of Ekiti State University felt uncomfortable between 12noon and 3pm, most especially female staff and non-teaching staff. The level of discomfort experienced was closely tied with their health status and productivity. This implies that between 12noon and 3pm the staff experiences some discomfort which results to health issues such as headache, dizziness, fatigue and partial loss of consciousness that subsequently reduced their productivity at work. This study therefore concluded that there was a significant relationship between workplace indoor thermophysiological comfort, health and productivity of workers.

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